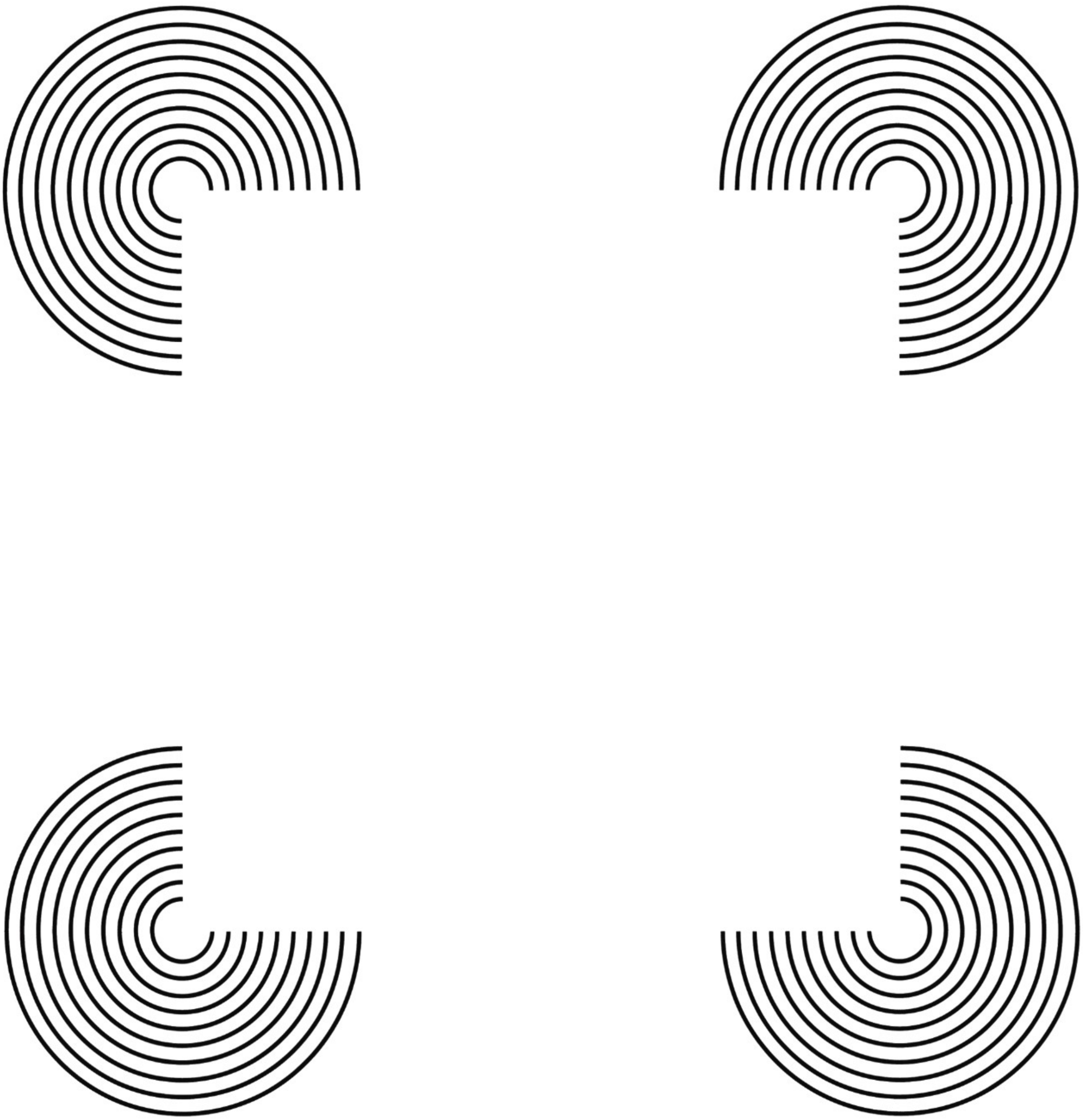

BEYOND ART: A THIRD CULTURE

Peter Weibel

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a comparative study in cultures art and science in 20th century Austria and Hungary

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Thanks to their common history, Austria and Hungary seem to be ideal candidates for a comparison of two cultures — not just the cultures of two states, but also the two cultures of science and art. In comparing the two countries, selected examples will reveal certain cultural achievements not familiar to them or others. From 1918 to the present day, Austria and Hungary either founded or contributed a great deal to art movements and schools of thought that have made original, specific contributions to world culture. This book is primarily about securing evidence for the future. The achievements and works of about two hundred Austrian and Hungarian artists and just as many scientists are worked into a mosaic-like network and presented according to a new type of issue-related model designed to interweave art and science. Thus original articles, short essays, thematic portraits, and primary texts create not just an innovative, informative cultural map, but also a model for culture building — a case study for a new understanding of culture beyond traditional notions of geopolitics. Reciprocal influences, and asynchronized, diachronized, and synchronized affinities and convergences form an image of culture as a transnational republic of scholars and artists: nomads between states, between art and science.

The Vienna Circle was interested in the idea of unified science as early as 1930, and published some journals and book series on the subject (see the "Vienna Circle" essay in this book, p. 456). Sociobiologist E.O. Wilson continued this tradition of enlightenment with his book, *Consilience: The Unity of Knowledge*, to which this book considers itself obliged.

Culture is created by nomads who rove among art and science, as well as nations. Anthony Heilbut's 1983 book, *Kultur ohne Heimat*, is titled *Exile in Paradise* in the U.S., but its German title literally means 'culture without homeland.' Could we take the original title of this book, which is specifically about German and Austrian emigration to the U.S.A. between 1933 and 1938, and apply it to culture in general? Is culture always homeless, in exile?

Peter Weibel

Foreword

1. Gertjan Dijkink, *National Identity and Geopolitical Visions* (London: Routledge, 1996).

Nations only have their great men against their will. (Charles Baudelaire)

Even today, conventional national exhibitions generally adhere to the geopolitical visions of the nineteenth century. In keeping with G. Dijkink,[1] we understand geopolitical visions as concepts of national identity translated into geographical terms and symbols. In extreme cases, such geopolitical identities tend to justify nationalist aggression and expansion based on assertions of spatial or even biological necessity. Although relating national identity to a place, a demarcated space, or a geographical location — that is, transforming place into politics and politics into place — is a cruel universal practice, it has at least fallen into disrepute since Nazi geopolitics. Only the cultural world is oblivious to this fact and still goes about defining national culture as an experience of place and space.

We, too, understand the appeal of the idea that people within a national territory produce (national) culture. But as agreeable as the idea may be that an Austrian grows up in Austria, absorbs Austrian art, literature, and philosophy and then produces Austrian art, literature, and philosophy in Austria, in reality, this proves to be a naïve, wishful notion. However, by virtue of its simplicity and lack of empirical substantiation, the notion is very suitable for sustaining illusions that are reassuring. Reality is more complex and crueler.

Is Lazlo Moholy-Nagy, who had a formative influence on the identity of the German Bauhaus, who founded the New Bauhaus in Chicago in 1937 and the School of Design in 1939 (renamed the Institute of Design in 1944), a representative of Hungarian culture? Is Margarete Schütte-Lihotzky (1897-2000), who resisted the Austrian Fascism and whose most famous product is called the Frankfurt Kitchen, a representative of Austrian culture? Is Lily Greenham, born in Vienna in 1928, who has lived for decades in Paris and of whom nobody in Austria takes any notice, an Austrian artist? Sándor (Alexandre) Trauner, whose film sets had an essential formative influence on French poetic realist films of the pre-war period (e.g., Marcel Carné's *Quai des brumes* 1938), also produced *The Apartment* (1960) in Hollywood with Billy Wilder (another Austrian exile). Is Trauner a Hungarian artist? Is Nikola Tesla, born in Smiljan, Croatia, in 1856 — who studied in Graz and Prague and who gave birth to the idea of the induction motor in Budapest, but lived in New York until 1943 — an Austrian physicist just because Smiljan was part of the Austro-Hungarian empire at the time Tesla was born? Of course, there are artists who were born and raised in Hungary or Austria and who, for the most part, worked in Hungary or Austria, apart from a few years abroad. Is it the passport, is it territorialism, which determines national identity? Most of the artists represented at the exhibition "Beyond Art" and in this publication cannot be linked to any one territory and, more often than not, they have no ethnic identity, either. Culture evolves beyond the constraints of geopolitical codes, particularly in Europe, which was torn asunder and remapped by two World Wars, and suffered mass forced emigration and extermination of its intelligentsia under Fascism, Communism, and National Socialism.

Hence, a national exhibition today can no longer be based upon historical concepts of state, nation, country, people, and culture. In view of the fact that many artists and scientists were compelled to leave their home countries for religious, ethnic, or political reasons, and found themselves living, working, and realizing their ideas abroad — in exile, in Diaspora — we must naturally ask to what extent nationality, state, and culture are constructed, fictitious identities. Too often and too thoroughly, politics has destroyed its own (and foreign) culture in the name of its own (or a foreign) nation and in the name of some tribe of people. At the same time, individuals and groups have defied political upheavals, ravages, and crimes, and continued to produce world-renowned artistic and scientific achievements in or outside their own countries, even though they have long been (and still are) expelled, driven out of their homes as a result of decades of totalitarian rule. Culture, it would seem, is a network that is constantly being reconstructed and rewritten beyond geopolitical, state, national, and ethnic identities. Folklore is the only thing that can evolve within such confines. Although culture is indeed influenced by national traditions, it is not confined to national territories. It is possible for national traditions to live on elsewhere, in a third place, in other places. Culture is a heterogenous project — a "third space."

The traditional model of the cultural nation, which beguiles with its simple way of constructing identity, could be characterized as a cylinder of concentric discs. The first disc is the country, the geographical unit. The tribal disc (ethnic unit) arises out of it, for a people ought to inhabit an enclosed space. From this disc arise the discs of language and religion (everyone should speak the same language and belong to a common religion). All of these distinct discs, which should be congruent, then form a nation or state. The Greeks based their civilization on such a monistic model, and called everyone lacking the purity of the Greek people barbarians. And yet this monistic, purist model of the nation is itself barbaric in a modern sense. For in reality, there is no unity of geography, people, language, religion, and culture in a state. The concentric circles disintegrate, overlap, and exceed the respective borders of the other discs. The border of the geography disc is not the border of language or religion. The religion border is not the border of culture. Being a member of a people does not rule out the possibility of living in another country and writing in another language. Nations are not cylinders made up of vertical discs of pure entities. Different "peoples" in a particular country speak different languages and have different cultures. The culture (of the country, of the nation) evolves in various languages, beyond the national borders, through members of different peoples and nations. Nations and states should not be treated as entities of any fixed identity. National identity is continuously being written and rewritten on the basis of outside events, but also as a result of self-analysis and self-renewal. Culture is a rewriting program. Culture is a community that goes beyond geographic and national borders. Culture is produced by members of a community who are not made identical to one another through territorial, ethnic, linguistic, political, religious, or governmental connections.

Experience conditioned by culture can construct identity better than ethnic or territorial experience. Anyone who geopolitically identifies culture with national or geographical borders misconstrues the very essence of culture. The identity-constructing function of culture is an informational function. Culture has a memory function. It produces knowledge. Yet unlike the nation-state, which links historical events with certain "peoples" and territories, culture is an information system that links events with certain people and ideas. "The history of the sciences is a large gap in which the voices of nations gradually emerge," wrote J. W. v. Goethe in his *Maxims and Reflections* in 1822. Culture could not teach the state not to equate national borders with geographical borders. Culture and the nation-state are structural opponents, for while the nation-state demands borders, culture seeks to transgress them. As a system that produces knowledge, the nation-state will always resort to space, place, territory, and geographical borders. As a different knowledge-producing system, on the other hand, culture refers back to history and time, transgresses the borders of a territory, a language, a state, a people, a nation, a religion. Culture is evidently a work of translation and rewriting, passing from generation to generation, beyond the realm of the geographical, state, and ethnic entity. Emigrants thus protect the culture of a particular country from itself by taking it abroad with them, and immigrants do more to foster cultural memory than native inhabitants do. In this way, despite the fact that many participants have been exiled, it is possible for common intellectual movements to lose their geographical unity, but nevertheless to be continued and further developed — re-imported into Austria and Hungary.

In view of their common "Kakanian" history,[2] the cultural landscapes of today's Austria and Hungary seem fated to serve as the backdrop for much-loved illusions, interchangeable clichés, and outdated historical concepts benefiting ideologies that range from being reactionary to obscure.[3] Hungary is still seen from the colonial or anti-Communist perspective. Austria has no identity anyway, no distinctive features; to extrapolate from Robert Musil's *Man without Qualities*, it is a "country without qualities." The kitsch notion of Austria is also the result of the colonial view from the outside. Generally speaking, inhabitants and foreign visitors alike know precious little about the culture of these countries. The ahistorical consciousness industry of post-Fascism, which has endured to this day, has indeed cheated Austria of its history. The main focus of this analysis is the period following the fall of the Austro-Hungarian Empire, which is regarded as a key point for a new beginning in culture and politics. Secessionism, Art Nouveau, and Expressionism are therefore not dealt with in detail in this book, since they were art movements linked to the monarchy. Quite the contrary, we feel it to be a typical mistake of conservative ahistoricity to write about art history in Austria and Hungary without mentioning this turning point or these political changes. It was not just an empire that died in 1918: art movements did, as well.

Thus, in an attempt to counter the distorting anecdotes, misrepresented appropriations, and occult curios, the main goal of this book is to present, for the first time, the unknown reality of cultural history since 1918, by using selected examples. The notion of culture applied here is that of a "third culture," which reasons that the culture of the humanities and the arts is connected to that of the natural and formal sciences. It is therefore a complex model, full of mutual influences and common disciplines. Therefore, this is not a traditional exhibition catalogue but rather a portrait of a kind of cultural production and the cultural connections that were suppressed to the point of invisibility by official cultural policy. In comparing the two countries of Austria and Hungary, we focus on making readers aware of particular, mostly unknown cultural achievements as a result of the oppressive political circumstances (from the collapse of the monarchy to the Cold War).

I have been trying to collect, archive, and reconstruct this destroyed, dispelled, foiled, and forgotten culture for more than twenty years. Both the exhibition and its book are the results of these decades of research. Yet every reconstruction is also construction. Thus I would like to indicate the parameters of this re/construction. First, I selected art movements and intellectual trends in which both, Austria and Hungary, have brought forth achievements. The contributions might not be of equal weight: in some cases, there would be more from Austria, in other cases, more from Hungary, but an imperative criterion for selection was that the only

2. "Kakania" was the ironic name Robert Musil gave to the Austro-Hungarian Empire. cf. Robert Musil, *The Man Without Qualities* (Vintage Books USA, 1996) (*Der Mann ohne Eigenschaften*, 1930-1952)
3. See the two official state-organized millennium exhibitions of 1996, "Kunst aus Österreich 1896-1996" at the Kunst- und Ausstellungshalle in the FRG, Bonn, and "Austria im Rosennetz" at the Museum for Applied Arts in Vienna.

disciplines considered were those in which people from both countries had been active. The aim was to discover how their cultural achievements intersected: For example, the foundation of game theory by John von Neumann and Oskar Morgenstern in 1944 or Kurt Kren's film *Szondi-Test* (1964), named after the test of the same name devised by Lipot Szondi (1947) in Switzerland. Second, we selected intellectual and art movements founded or substantially promoted in Austria and Hungary, which also represent autonomous specific contributions to world culture. This does not imply that they were perceived as such in their countries of origin.

Focus was placed on analytical and abstract ways of looking at the world (from formal sciences to formal arts). First of all, the formal sciences have long been a central, albeit invisible, part of our culture. Second, Austria and Hungary have achieved outstanding things precisely in the area of the formal sciences, quite in contrast to the repressive and reactionary image of a baroque, expressive Austria and Hungary, as drafted by other countries. So we had to go beyond the classical disciplines of art in order to be able to draw an adequate picture of culture beyond all clichés. The book presents achievements in the formal arts and sciences, mathematics, logic, and in the social and natural sciences that operate on the basis of formal methods. It is not possible to offer a complete presentation. Rather, the aim is to select individual persons and groups who have helped Austria and Hungary give a specific impetus to the world of international science and art, and who have contributed to the development of a third culture.

Ten sections present the interdisciplinary experimental methods and connections between formal arts and sciences that have been of decisive importance in the cultural development of both countries. Michael Stöltzner and I wrote the introductions and abstracts for these sections. Employing a holistic view, we attempt to reintegrate the fragments towards a "third culture," on the basis of various philosophical topoi, which are predestined to form a synergy between science and art. The problem I have been pointing out for the past twenty years, which others have been dealing with in recent years,[4] is the fact that these cultural achievements were accomplished by Austrian and Hungarian nationals but, in some cases, not in Austria or Hungary. This problem precisely describes the schisms and wounds inflicted by the political systems in Austria and Hungary, which are still capable of engendering dangerous identity crises, even today.

Hungary is a successful cultural nation because it has not made the division between formal arts and formal sciences. Artists are thus able to found their artistic practice theoretically and scientifically in manifestos and books. Moreover, Hungary also fosters close contacts with its emigrant scientists through its academies and other institutions. Unlike the corporative state and Fascism in Austria, Hungary has a homomorphic culture that even withstood Stalinism. The Catholic corporative state continued anti-progressive tradition in Austria in the form of national policy. The rational sciences were curbed; public opinion was stirred up against mathematics, physics, positivism, empiricism, the Vienna Circle, all critical and analytical philosophy as early as 1920, and abstraction in art. Vienna University became a breeding ground for National Socialist criminals in the 1920s. Expulsion and loss of rationality became part of the corporative state program after 1927. However, since it was not possible to banish rationality completely from science (at the most, formal science was separated from culture), art was compelled to forego all analytical formal elements. Austria's First Republic thus came to be the country that all avant-garde art movements passed by, with the exception of the few supranational, unofficial approaches I will be presenting. From 1920-1950 (!), the time of the corporative state and Austro-Fascism, Austrian culture was produced in exile by emigrants. This lost generation was neither brought back nor honored in the Second Republic. Quite the contrary, the division of art and science continued. Although it was not possible to ban rationality from science, it was banned all the more from philosophy and art. The formal sciences remained in exile, formal art omitted. Hence, in opposition to the corporative state perspective, we focused our selection on the analytical formal sciences and abstract arts.

This work was done for reasons of sadness and anger. Anger at the power of destructive political systems and sadness at the irretrievably lost lives of great scientists and artists. But also in the hope that the culture of the expelled, forgotten, and outcast can be restored; that the expulsion of rationality is reversible. In remembering, we oppose political systems. However, this collection of evidence is also aimed at securing a future. This is why I am presenting a new methodical approach to researching cultural developments, to depicting the historical emergence of cultural production: culture as a transnational, transterritorial, transethnic dynamic system of knowledge production. In comparing two cultures (art and science) of two countries, Austria and Hungary, as they developed throughout the twentieth century, a new, complex model of cultural history, development, and production is created: the vision of a third culture.

Scientia sine arte nihil est; ars sine scientia nihil est. (Jean Vignot, 1392)

4. Felix Kreissler, *Kultur als subversiver Widerstand* (Munich/Salzburg: Edition Kappa, 1996); John Czaplicka, ed., *Emigrants and Exiles. A Lost Generation of Austrian Artists in America 1920-1950* (Vienna: Österreichische Galerie, 1996); Matthias Boeckl, ed., *Visionäre und Vertriebene. Österreichische Spuren in der modernen amerikanischen Architektur* (Vienna: Kunsthalle, 1995); Christoph Bertsch, Markus Neuwirth, eds., *Die ungewisse Hoffnung. Österreichische Malerei und Graphik zwischen 1918 und 1938* (Salzburg/Vienna: Residenz Verlag, 1993), especially the article "Zur österreichischen Kulturgeschichte der Zwischenkriegszeit" by Manfred Wagner, pp. 7-15; Felix Kreissler, ed., *Fünfzig Jahre danach – Der 'Anschluß' von innen und außen gesehen* (Vienna: Europa Verlag, 1989); Oswald Oberhuber, *Zeitgeist wider den Zeitgeist. Eine Sequenz aus Österreichs Verirrung* (Vienna: Academy for Applied Arts, 1988); Gabrielle Koller, Gloria Withalm, *Die Vertreibung des Geistigen aus Österreich. Zur Kulturpolitik des Nationalsozialismus* (Vienna: Academy for Applied Arts, 1985); Oswald Oberhuber, Manfred Wagner, Erika Patka, *Die verlorenen Österreicher 1918-1938. Expression. Österreichs Beitrag zur Moderne* (Vienna: Löcker Verlag, 1982); Hans Bisanz, Almut Krapf-Weiler, Elfriede Baum, *Die uns verließen. Österreichische Maler und Bildhauer der Emigration und Verfolgung* (Vienna: Österreichische Galerie, 1980).

P. Weibel, F. Stadler (eds.), *Vertreibung der Vernunft / The Cultural Exodus from Austria*, Löcker, Vienna 1993. Reprint: Springer, Vienna/New York 1995.

Michael Stöltzner

Formal Intuition Beyond and Within Art

If one wants to acquire a sense of how to exhibit science, the natural place to go is the technology museum. Through its technical applications, the tremendous progress of twentieth-century science can be grasped, even literally touched. In most cases, the theoretical sciences also have made their way into the museum — sometimes in a very ambitious manner, sometimes in a way that is embarrassing at best. Thus, the task of a "scientific coordinator" in an arts and science exhibition seems to be no more than to devise a suitable combination of didactics of both science and museum pedagogy. To this end, she or he will build heavily upon models. For example: "The electron in a quantum-mechanical double-slit experiment feels whether one or two slits are open;" "Quantum mechanical observables are a sort of infinite-dimensional matrices;" "A non-pathological curve is defined by the continuous motion of a point."

Unfortunately, there is danger in any model. The examples given above, for instance, have attracted severe criticism in our century because they mislead by suggesting a flawed continuity between classical and modern science. This has produced a flood of pseudo-problems, such as the question of whether quantum particles possess a free will. Moreover, scientific theories determine our present worldview to such an extent that their basic results are often misunderstood as being a priori conditions of any scientific knowledge. This is especially the case if intuitively appealing and memorable models are found. As there were no such models to assist laymen in accessing the core tenets of relativity theory and quantum mechanics, these theories have frightened or even disturbed the common sense of two entire generations.

At the turn of the century, even mathematics ran into a severe "crisis of intuition."[1] Concepts so elementary and widely used as "dimension" or "curve" became plainly inconsistent if defined according to common-sense intuition. Rectifying the definition necessitated the introduction of new concepts that embraced objects that could only be construed algebraically, without the assistance of non-paradoxical pictures. As a matter of fact, quite a few of these alleged pathologies turned out to be useful to theoretical physics; just think of the importance of functional analysis in quantum mechanics, the singularity theorems in modern cosmology, and the non-trivial topologies in elementary particle physics.

History teaches, accordingly, that all models and pictures are only applicable within a definite domain or over a limited scale. Once a model is extended beyond these limits, it becomes scientifically meaningless and creates paradoxical questions — not to say that all paradoxes in science result from simple errors, some may have great heuristic value to the expert. Thus, if one exhibits a model to laymen, one also has to show its domain of validity. Small print in the guide or in the commentary won't do. If, however, the limitation is integrated into the model itself, at first glance it produces an apparent contradiction. If the model and its limitations or the old and the new concepts are shown side by side and almost equally, a possible unity of the scientific concept could be destroyed, because, nonetheless, a new definition is often just a suitable generalization of the old one. Well-balanced museum pedagogy will certainly mitigate these problems but cannot eliminate them entirely. Moreover, the pedagogical solution might raise new problems. Unless the curator questions the model and seeks some direct contact to the scientific fact, she or he might just exhibit the pedagogy of the model of the theory. Impressive aspects emphasized to attract interest might be completely marginal from a scientific point of view. The expressive colors of the popular fractal pictures, for instance, obscure the fact that self-similarity is the gist of all fractals. Moreover, some might even consider nature herself as the artist, although the colors simply arise from associating them to certain parameter values.

There is less danger of such false anthropomorphism if formal relations such as size, number, or direct causation are pictorially modelled. This, to my mind, is a very important advantage of the ISOTYPE method created in Red Vienna by Otto and Marie Neurath and Gerd Arntz. To Neurath, this method was part and parcel of his program of "scientific world conception" that strove for public education in the sciences and, on the philosophical level, primarily attacked the misalliance between naïve realism and classical metaphysics that might indeed result from an uncritical use of popular models.[2]

Even if an unambiguous presentation of a theory has been reached, there is still a major problem because any model is deeply conservative, akin to an item in a textbook. Thus, visitors will typically take the facts displayed for final truths without being able to grasp the approximations and simplifications — beyond just specifying a domain of validity — upon which the model rests within science proper. Such models contain many idealizations, like frictionless surfaces, which simply become contradictory if used in the wrong context. The gravest danger, however, arises from naïve realism: once a model has been understood as directly representing nature, all its internal limitations and discrepancies regarding other areas of physics may contribute to a general skepticism toward science that, perhaps, fails in revealing the true facts. Even worse is the possibility that future scientists will declare the model utterly wrong; postmodern critics will then quickly conclude that scientists are no more right about science than Aborigines.

1. See, for instance, Hans Hahn, "The Crises of Intuition," in *Empiricism, Logic, and Mathematics: Philosophical Papers*, ed. Brian McGuinness (Dordrecht: D. Reidel, 1980), pp. 73–102.
2. See Otto Neurath, "Visual Education — Humanization Versus Popularization," in *Encyclopedia and Utopia*, ed. Elisabeth Nemeth and Friedrich Stadler (Dordrecht: Kluwer, 1996), pp. 245–336; for a practical application, see Roger Miles, "Otto Neurath and the Modern Public Museum: The Case of the Natural History Museum (London)," in *Encyclopedia and Utopia*, pp. 183–90; and the contributions of Friedrich Stadler and Angela Jansen in *Beyond Art*.

Oswald Spengler's *Decline of the West* is certainly the most prominent source of the declaration of the "end of modern science" at the root of the so-called "anti-science phenomenon."[3] Spengler held a very narrow view of science that would soon be replaced by belief. After the impressive successes of classical physics, many nineteenth-century physicists held exaggerated hopes for classical mechanics, such that they proclaimed it as an a priori condition of any scientific theory that one should be able to devise a mechanical model of it. With the advent of Boltzmann's statistical thermodynamics these hopes were dashed. Spengler, however, heard the swan song of science in the random motion of microscopic particles. Similar to Spengler, many modern critics of science misunderstand the openness in principle of the scientific discourse. No theory will ever be final, and over time there might exist two equally well-corroborated theories that are not isomorphic on the conceptual level. This is anything but carte blanche for esoterics because there are important preconditions for a theory to be scientific (i.e., a rigid methodology, empirical adequacy, comparability with other theories, and conceptual homogeneity). Theories that explain one single fact only but draw conclusions for the whole universe therefrom can hardly be counted as scientific. It is a pity that this combination of openness and a relative rigidity in truth-value does not play a key role in the present "science wars" that emerged from the famous Sokal hoax. Typically, radical deconstructionists clash with (philosophically rather simple-minded) reductionists who still dream the dream of a final theory.

If on the contrary, science is considered an open, always partially finished enterprise, this must be expressed when it is exhibited, too. In these reflections I will argue that modern art can support such endeavors because understanding modern art no longer requires acquaintance with a rich set of allegories, symbols, and colors. Instead of referring to an explicitly defined, closed semantics, objects of modern art are semiotically open, stand in dialogues, represent processes akin to experiments, are localized in virtual space (e.g., in the Internet), and cross the frontier to everyday objects including those of modern technology. There are panel paintings that succeed in maintaining an in-between state, that depict geometrically impossible objects, or that are self-referential. In their works, many artists have intensely studied the process of perception and its limits, the role of perspectives, the relation between the internal and the external aspects, and even possible internal inconsistencies.

This leads me to ponder how far the means of modern art can contribute to the exhibition of science and which aspects of science are suitable for them to come into play. I shall approach the second question first, from a historical perspective. The main strategy will be to find a concept of intuition, of understanding at first glance, which is applicable to formal objects. A seminal contribution in this respect is from Austrian physicist Ernst Mach and his concept of "intuition," which he himself regarded as a major achievement.

Galileo runs his eye over several different uniformly retarded motions, and suddenly picks out from among them a uniform, infinitely continued motion, of so peculiar a character that if it occurred by itself alone it would certainly be regarded as something altogether different in kind. But a very minute variation of the inclination transforms this motion into a finite retarded motion, such as we have frequently met with in our lives. And now, no more difficulty is experienced in recognizing the identity between all obstacles to motion and retardation by gravity, wherewith the ideal type of uninfluenced, infinite, uniform motion is gained.[4]

Science progresses by means of such intuition, both historically and in each learning individual. New concepts of the type conceived by Galileo are the milestones in the progress of successive economization of our experiences — an economy that, according to Mach, is tantamount to scientific development. Or, more briefly, the history of science is driven by "adaptation of thoughts to facts and adaptation of facts to each other."[5] Science is of humble beginnings. It starts from instinctively withdrawing one's hand from the course of a falling body and develops by successive economizations into intuiting mass as the circumstance that determines the acceleration of a body — an intuition that Newton was able to cast into very general mathematical terms. Such "intuition" of a higher order represents a wide realm of elementary experiences, a "grand fact" as Mach terms it. If at a certain point we have acquired a sufficiently reliable knowledge of a certain "grand fact" — such as optical refraction — then it is possible to construe an apparatus that enables the student to grasp at once the unity of the fact in its various aspects, and by merely turning a screw or a switch not only to understand but also to "feel" it. Mach's works are full of such apparatus, many of which he had designed himself for didactic purposes. It is interesting in this respect that among the roots of his famous principle of economy, Mach also lists his own teaching experience.

Thus, Mach attributes to models a very high systematic status in the development of science. But in any case, their value is merely economical, especially in communicating and storing experiences. Neither models nor theories represent reality, and they are always subject to change, even if this change is very unlikely. Mach, in effect, considers theories as a kind of analogy that enable a physical phenomenology that is void of hypotheses involving nonobservable concepts. Analogies provide an important heuristic element in gaining

3. One of the most fundamental criticisms of Spengler is Otto Neurath's "Anti-Spengler" of 1921, reprinted in *Gesammelte philosophische und methodologische Schriften*, ed. Rudolf Haller and Heiner Rutte (Vienna, 1981), pp. 139–96. For a more recent look on the debate, see Gerald Holton, *Science and Anti-Science* (Cambridge: Cambridge University Press, 1993).

4. Ernst Mach, *The Science of Mechanics: An Account of Its Development* (La Salle, IL: Open Court, 1989), pp. 335–36.

5. Ernst Mach, "Die Leitgedanken meiner naturwissenschaftlichen Erkenntnislehre und ihre Aufnahme durch die Zeitgenossen," Scientia 7 (anno IV): 226.

knowledge, but they cannot replace intuition because scientific success is not guaranteed even by the finest method. Nonetheless, they prepare the ground for intuition by furnishing a provisional conceptual framework for further investigations. Especially the fuzzy fringe of an analogy pushes further because it goes beyond the facts already known. New scientific theories therefore result from those features of an analogy that are also a source of error.[6] This also becomes a problem once a theory built upon this analogy has been successfully established. At this stage, the old analogy can delay scientific progress because it pretends to be more promising than it actually is. Moreover, like any model or pictorial representation it entices us into naïve realism.

Atomic physics and quantum mechanics have revealed the inadequacy of Mach's understanding of theory. To him, theoretical objects that are not directly observable are nothing more than useful hypotheses or successful economizations of scientific facts. In comparison to the five senses, Mach accordingly grossly underestimates the importance of theoretical and mathematical concepts for science. Nevertheless, to my mind, his notion of intuition is sufficiently promising to inquire whether there exists a similar intuition that is directed toward theoretical entities and that can be learned and perfected to higher level. As a matter of fact, to most experienced mathematicians, infinite-dimensional Hilbert spaces are as familiar as the back of their hand, and good experimentalists develop an intuition of their measuring devices that permits them to quickly spot defects in such a manner, like a mechanic hears the malfunction in a car. Roughly speaking, there are two types of mathematical intuition, one that stems from geometry and another that concerns algebraic structures. The former, which had been cultivated in almost two millennia of Euclidean geometry and was later extended to non-Euclidean geometries, ran into the above-mentioned crises of intuition at the turn of the century. Hilbert's axiomatization program that was launched with his *Foundations of Geometry* attempted to provide a purely syntactical solution to all mathematical questions in order to avoid the mirages of intuition. He expected that for all meaningful mathematical problems a solution could be found within a suitably chosen system of axioms. Intuition within this program became reduced to describing the technical capabilities of a mathematician or a surprising argument that opens a beautiful proof. After initial doubts within the community, Hilbert's new strategy of doing mathematics was quickly accepted because it had proven so extremely successful. This was also the major reason why most mathematicians pursued it further although they found the intuitionist criticism, in principle, valid. But Brouwer's strictly finitary concept of intuition as used in his justification of mathematics was never able to replace the classical concept of intuition because on this basis practically every second mathematical result — and even those that had found successful applications in the sciences — had to be dropped.

In 1930 Kurt Gödel proved that Hilbert's program of deciding all mathematical problems purely syntactically was unfeasible. No formal language that was sufficiently strong to express classical mathematics could contain a strictly defined truth predicate. This led to the quandary of either accepting that certain mathematical problems were not solvable in an absolute sense, or claiming that the human mind infinitely surpasses the powers of any finite machine, which was tantamount to holding that there is an objective mathematical truth even if at present we cannot prove it. Gödel chose the second alternative, mathematical Platonism. If mathematical truth exists independently of us, there must be a way to find and experience it. Here intuition again enters the scene, and is given a most prominent place:

> *For these axioms there exists no other rational (and not even practical) foundation except either that they (or propositions implying them) can directly be perceived to be true (owing to the meaning of the terms or by an intuition of the objects coming under them), or that they are assumed (like physical hypotheses) on the grounds of inductive arguments, e.g., their success in the applications.... To eliminate mathematical intuition or empirical induction by positing the mathematical axioms to be true by convention is not possible*[7]

In a certain sense the Incompleteness Theorems also bridge the gap between mathematics and physics. The inconsistency of a formal system implies arbitrary propositions, in particular also empirical ones. On the other hand, presupposing the truth of certain laws of nature one can obtain inductive evidence for the truth of genuinely mathematical theorems. Moreover, intuiting these facts in a Machian sense could lead to successful mathematical intuitions. Gödel even continues the analogy between physics and mathematics from a philosophical perspective. Similar to the way he believes in the existence of successive layers of objectification that permit human beings to approach, at least step by step, the Kantian "things in themselves," he distinguishes a subjective and an objective element in mathematics. In a conversation with Hao Wang, he contemplates on the continuum hypothesis:

6. Ernst Mach, *Knowledge and Error: Sketches on the Psychology of Enquiry* (Dordrecht: Reidel, 1976).
7. Kurt Gödel, "Is Mathematics Syntax of Language," in *Collected Works, vol. III*, ed. Solomon Feferman et al. (New York and Oxford: Oxford University Press, 1995), pp. 346–47.

8. From a conversation with Gödel, in Hao Wang, *A Logical Journey: From Gödel to Philosophy* (Cambridge, MA: MIT Press, 1996), p. 260.

8.3.2 In some sense, the subjective view leads to the objective view. Subjectively, a set is something which we can overview in one thought. If we overview a multitude of objects in one thought in our mind, then this whole, the one thought, contains also as a part the objective unity of the multitude of objects, as well as its relation to our thought ...
8.3.3 ... The psychological act of thinking together all objects of a multitude in one thought yields more sets from the objective viewpoint because stronger idealizations are appropriate [than from the subjective viewpoint]. From the idealized subjective view, we can get the power set. But the indefinability of the universe V of all sets can't be got by the subjective at all. The difference in strength becomes clear only when you introduce new principles which make no sense at all in the subjective view ... For every set there is some mind which can overview it in the strictest sense.[8]

Again, these principles are introduced by intuition, but the new intuition has to be stronger than the old. As Gödel in the above quote associates each set to a mind that is able to intuitively review it at one glance, each axiom system calls for an intuition of appropriate strength that justifies it. Thus it becomes clear that Gödelian intuition is not directed to statically "given" things, to those ultimate components of the world the naïve realist strives for. Instead, just as we intuit functional dependencies among the Machian elements as constitutive for a "grand fact," Gödelian intuition concerns algebraic relations, rich concepts, and proof strategies. Again, as in the case of ISOTYPE, this formal orientation prevents intuition from relapsing into the conservatism that inherently looms in any pictorial representation. Notice that rejecting finality claims for axiom systems does not concern the validity of proofs given the system, but the ability of the system to encompass all relevant true propositions. Like the intuition of craftsmen and scientists, which Mach had in mind, mathematical intuition develops — not necessarily in a linear increase — both on the level of individuals and on the level of culture. Thus, it is quite natural that the intuition that an experienced mathematician has cultivated over decades is not immediately accessible to laymen. But as intuition, mathematical facts are more accessible for an approximate understanding than if they were considered purely syntactic constructions, because on the merely formal level there are no "fuzzy fringes" and no analogies, but identities, consequences, limits, and so on.

Gödel's concept of mathematical intuition points back to modern art. More than being mimesis of or empathy for nature or humans it directly addresses abstract forms — not within a technical study testing the frontiers of picturability, but as the theme itself. Formal language is permanently at stake within art. This development culminated at the beginning of the century, at the same time when the naïve discussions about rigor were superseded by a broad meta-theoretic discourse. Before this epoch, logic and aesthetics were both outside the mathematical or artistic process as such — which, of course, would not exclude intimate connections, important inspirations, and the practitioners' prominent participation in the meta-discourse. Once, as Gödel claims, once intuition is integrated into the process of doing mathematics and not only figures in the communication of its results, it can provide an unsharp glimpse into mathematics itself. Certainly, this intuitive glimpse will be less precise than a properly reworked model, but it contains the combination of openness and rigidity of truth alluded to above. Within "Beyond Art," the exhibition on which this book is based, some attempts in this direction were undertaken.

If the presentation of science originates from formal intuition, the openness and ambivalence of these forms requires a framework that attributes a definite meaning to them. If such a semantic frame can develop out of the surroundings of the form or the fuzzy fringe of the analogy on which the intuition of form rests, then the form acquires an inevitability that could never be supplied by outside information. Let me give three examples: (i) In "Beyond Art" we exhibited two surprisingly similar computer-generated videos. One (by Harald Posch) is a simulation of a star formation based on a simple model of short-range attraction, the other (by Gabor Body) is an art video produced quite some time before. (ii) To understand what experimental science is, one has to take part in a process because the experiment actually decides whether a theory is true although, of course, all data are treated by counting devices and are evaluated according to certain theories assumed to be true. The visitor had the opportunity to perform a simple quantum-mechanical experiment (set up by Anton Zeilinger and his group). This experience differs starkly from the one in a "hands-on museum" because what the visitor sees is far from her own world. Intuiting what the experiment is all about requires a very abstract or goal-directed approach. This is not too different from artistic performances which also respond to a focused concept of reality. (iii) Another strategy was the exhibition of objects that are a part of the scientific process: books, autographs, works with dedication, letters, lecture notes, and so on. They stand for the act of writing down results, communicating them, defending them. Of course, they are selected snapshots which cannot represent the entire historical development. But, "Beyond Art," neither the exhibition nor the book, were after completeness. Intuition is not exhausted by momentary glimpses or snapshots. Just as they acquire meaning by being embedded into a formal context, they can also be linked to each other. Axiom systems are built on a well-structured set of intuitions concerning their basic concepts; lengthy proofs require more than one intuition to be carried out. Notice that the (intuitive) linkage of the intuition does not necessarily correspond to the logical relation. It is often advantageous to change the intuition about a single object in the course of a proof, for instance, if one uses techniques from different fields of mathematics. A very illuminating study of such complexes was undertaken by the Italian mathematician and philosopher Federigo Enriques, who, in later years, had contact to the Vienna Circle. In his 1906 book, *Problems of Science*,[9] he treats "systems of images" as the metaphysical content behind a mathematical theory. If one does not advocate realism on both levels, this duplicity is anything but paradoxical and corresponds to many everyday experiences of working mathematicians. Often the validity of an argument can be quickly seen by a single intuition, whereas rigorously formulating leads to a very clumsy proof while an unintuitive proof that makes use of a formal trick or refers to a remote area of mathematics is much shorter. In a debate on rigor in mathematics, William Thurston curtly remarked: "When the idea is clear, the formal set-up is usually unnecessary and redundant."[10] This debate was stirred up by recent intercourse between string theory and geometry, during which physicists' intuition yielded spectacular successes in mathematics proper, especially by connecting distinct areas. But the physicists did not keep to the strict standards of rigor which, for many mathematicians, characterize their discipline more than anything else. Indeed, intuition is always fallible however strongly physicists advocate it. But this, to my mind, does not preclude attributing to them a far more important role than just heuristics, in particular because systems of intuition (or images) enjoy a certain stability against dropping one of them.

Let me finally study the extent to which the visitors of modern art exhibits are prepared to assess complex systems of images. While readers of popular science books usually expect that authors adapt the presentation to their level of knowledge, all introductions to art exhibitions presuppose a certain acquaintance with art history. Moreover, only few visitors will read more than a couple of lines. Experience in art exhibition is fragmentary in yet another respect. Even for an important retrospective, not every picture is available and only a limited number of cross-references can be displayed. The epochs in the development of an artist can be shown only piecemeal by well-chosen representatives. Thus, the general view on the artist's work emerges from initially unsharp impressions that are linked into a system of images that can also be amended with pictures seen in other exhibitions. After a certain time, each of us will step by step develop our own understanding of, say, Cezanne. But, of course, each single picture is already a complete Cezanne in itself that permits an intuitive glimpse into his whole world of views or ideas. So, I claim, is mathematics. If one really understands the way of arguing in certain core theorems, one obtains sufficient intuition to operate within the whole field. In this sense, "Beyond Art" provided some knots in the "system of images" without being able to spin a web, it intends to be a sketch pad that propels further reflections instead of a seducing textbook.

In the end, there might be a caveat to such a program. Isn't it fundamentally quite dangerous to count on the momentary glimpse of the eye when conveying the spirit of science and some basic themes? By evading the pseudo-problems mentioned above, might we not end up producing other pseudo-evidences that, in turn, will relapse into pseudo-problems again? There is, in my view, only a modest answer to this. In our times in which the sciences and the humanities are so far apart from each other — and the reader of this book can even study this process in the course of our century — no exhibit whatsoever will succeed in satisfactorily explaining one single scientific theory. Today it seems more promising, instead, to instill object-wise into the visitors that science is a part of general culture, viz. beyond mere declaration, and simply to impart some good taste that shall enable him or her to pick out the few good popular science books in this rapidly growing market.

The author thanks Veronika Hofer for critical discussions.

9. Federigo Enriques, *Problemi della Scienza* (Bologna: Nicolo Zanichelli, 1906). An English translation was published by Open Court, La Salle, IL.
10. William Thurston, "'Theoretical Mathematics': Toward a Cultural Synthesis of Mathematics and Theoretical Physics," Bulletin of the American Mathematical Society 30 (1994): 167. For an overview of this debate in a philosophical perspective, see my "What Lakatos Could Teach the Mathematical Physicist," in *Appraising Lakatos – Mathematics, Methodology, and the Man*, ed. G. Kampis, L. Kvasz, and M. Stöltzner (Dordrecht: Kluwer, 1999).

perception movement

The catalytic function of color essential to the development of art in the nineteenth century was taken over in the twentieth century by the issues of motion and perception, the questions of seeing and moving (see László Moholy-Nagy's descriptive book title, *vision in motion*, 1947). Hungary and Austria's contributions to perception theory and optical art have been considerable, yet this is the first time they have been coherently presented in one volume.

Geometrical Abstraction: Under the influence of the wheel — the technology used in moving machines — changes in representation began to occur, regardless of whether the theme was moving objects or observers in motion. The human body in particular was shown in various phases of movement. The world of objects splintered into a simultaneous representation of various perspectives (Cubism) and different phases of movement (Futurism) on one surface, which gave rise to geometrically abstracted forms of art, such as Viennese Kinetic Art (the Cizek School) and Hungarian Constructivism. Taking advantage of the break in perception caused by speed, the Hungarian avant-garde developed an increasingly abstract vocabulary of lines and surfaces — the dynamic geometry of Constructivism — which led to the methodic visualization of "Abstraction Création" (1931) and "Concrete Art" (1935). The "abstract ornamentation" of Viennese Art Nouveau, circa 1900, anticipated a great deal of Geometric Abstraction and Op Art.

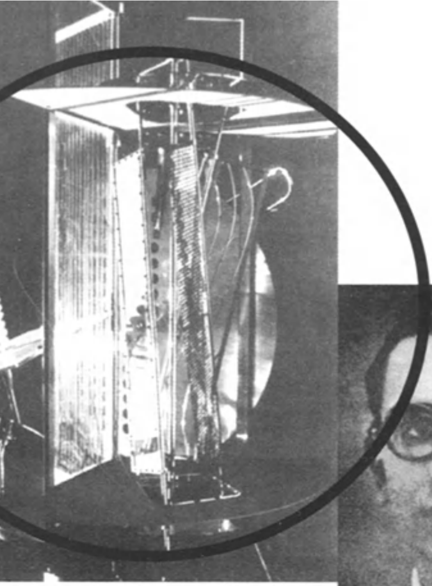
Media: Parallel to the development of Abstract Modernism in the 1920s, another type of abstract art also developed: film, the art of the moving picture (accompanied by numerous experiments in photography), which likewise contributed to the abstraction of the image and the discovery of new kinds of images.

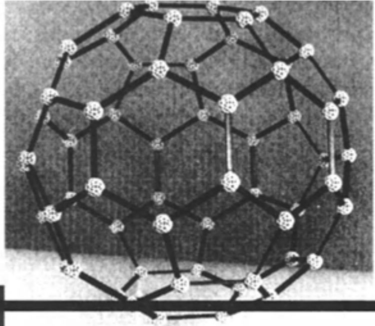
Pattern: Taking cues from textile ornamentation and experiments with color on endpapers, the first forms of abstraction arose in Vienna at the turn of the century. They in turn lead to a kind of geometric abstraction that already displayed early signs of Op Art.

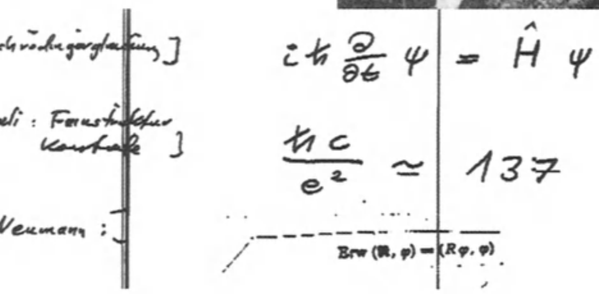
Op Art: During the first phase, artists were freed from having to depict objects with lines, colors, and surfaces, changing to the autonomous representation of lines, colors, and surfaces. In the second phase, the laws of form were set forth in relation to the laws of perception. The optical effects themselves, evoked by autonomous lines, colors, and surfaces, became the content of the picture (Victor Vasarely). Geometric Abstraction reached such a degree of abstraction that perception itself became a theme.

Kinetics: The synaesthetic dreams of painting and music, and the games of motion played with visual and media light effects gave rise to mobiles, light sculptures (some of them motorized), electronically controlled cybernetic objects and mobile steel constructions, which united kinetic and optical effects (Nicolas Schöffer).

Seeing Machines: Soon the investigation of optical phenomenon moved past the frame of the picture and sculpture to join with machines and media in the production of optical illusions that went beyond the illusory motion of film. The two-dimensional illusions of optical art expanded to three-dimensional illusions. As machines of all kinds, from analog to digital, assisted perception, illusionary spaces and bodies arose as precursors to electronic cyberspace (Friedrich Kiesler, Alfons Schilling) .



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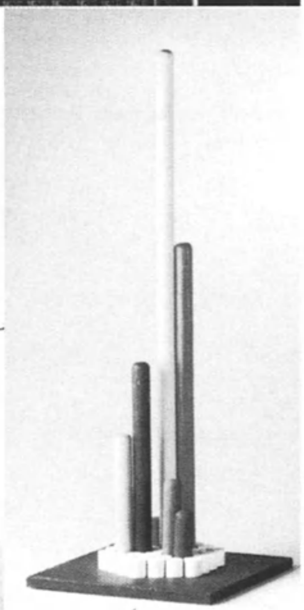

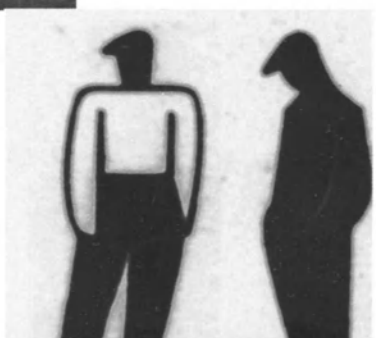

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1 perception movement

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Peter Weibel

Contours of a History of the Theory and Art of Perception in Austria

I. From Color Dominance to the Problematic of Movement and Perception

After painting had explored the phenomenon of color and its composition and effect on the eye in the nineteenth century,[1] at the beginning of the twentieth century its attention turned to the perception of motion and the mechanisms of the perception of form. The artistic movements of Cubism, Futurism, Suprematism, Constructivism, De Stijl, as well as the experimental photography and film of the 1920s bear witness to this. The study of motion and perception as isolated and absolute phenomena logically came into play through the investigation of color as an isolated and absolute element. The catalytic position that color had held for the evolution of art in the nineteenth century was held by the visualization of motion in the twentieth century.

This shift of attention and artistic focus towards the phenomenon of movement was necessitated by the emergence of machines, i.e., wheel technology. There were suddenly machines that could move faster than the human and animal body, and machines — namely photographic and cinematic — that could document movement more precisely than painting; therefore, the historic visual arts had to deal more intensely with the problem of the representation of motion, be it the representation of moving objects (Futurism) or the representation of observers in motion (Cubism). The task was: how can movement that occurs in four dimensions, in space and time, be represented on the two dimensions of the picture? Art began to face this problem of movement around 1900.[2]

From this task posed by the problem of movement — the two-dimensional representation of a four-dimensional event — arose the necessity of abstraction. As the motion was mostly carried out by wheel technology, or rather, was made by it, wheels or abstracted wheels such as circles and other visual symbols for motion, acceleration, and speed found their way into painting. An abstract representation of motion developed very quickly from the realistic representation of movement machines, since this corresponded more closely with the subjective sensation of seeing. Since the elements of the movement machines — wheels, pistons, and so on — were already geometric figures such as circles, lines, and rectangles, the abstraction followed geometrically. The "More geometrico," as a method of visual representation, had been predominant in the tradition of painting ever since the development of perspective in the Renaissance. Geometric abstraction was therefore the logical result of painting's search for a visual vocabulary that could represent four-dimensional movement (in space and time) two-dimensionally (on a flat surface). Parallel to that, technical image media such as photography and film also developed new approaches to the problem of the representation of motion that were somewhat more artistically advanced and more convincing than those in painting since film had three dimensions at its disposal (namely surface and time) with which it could better depict the changing of forms in time, the phenomenon of movement.

Film thus became the actual art of movement, the language of motion, cinematography. It was only in the course of its own artistic development that film became the language of vision: opseography.

In this confrontation with the problem of movement, answers to the questions of how the eye perceives motion and how perception functions became more urgent. The new problem of movement and the historical problem of color converged upon the common problem of perception. Thus, distinct branches of art that dealt explicitly with movement and optical processes developed from the motion and perception problematic: Kinetic Art and Op Art. The contribution of Hungary to these art forms, from Moholy-Nagy to Kepes and Vasarely to Schöffer, enjoys international renown, whereas the contribution of Austria (similar to almost everything modern in Austria) remains relatively unknown both domestically and abroad. Nonetheless, Austria has achieved a great deal in these areas, both scientifically and artistically.

II. The Picture between Manual Color Analyses and Machine-Supported Movement Studies

Under the influence of the performance of machines, not only was the phenomenon of motion analyzed but also the processes of perception. Experimental physiology, particularly that studying the eye, as well as experimental psychology developed in the nineteenth century out of the confrontation between human and machine.

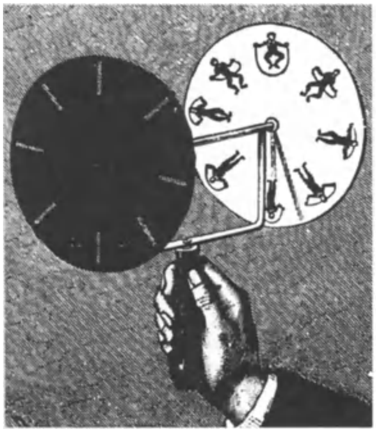
Around the middle of the nineteenth century, the progress of the machine-based Industrial Revolution had led to questions about the relationship between human and machine performance. One example was the measurement of the time the human organism required for its diverse activities compared with the machine's time (Taylorism). Human behavior was measured and recorded. This obsessive study of the functioning of the human body, which was now itself considered a machine, gave rise in the nineteenth century to experimental physiology, psychology, and medicine. Cinema and the technical arts would never have developed without this experimental physiology, psychophysiological research, and early physiochemical experiments. The conversion of technical knowledge from physics and physiological properties of vision — gained from

1. To remember how catalytic the scientific color theory of the nineteenth century was in the development of painting up to the beginning of the twentieth century, refer to the well-known enormous influence of the publications from: Michel Eugène Chevreul, *De la loi du Contraste Simultané des Couleurs* (Paris, 1839); Charles Henry, *Cercle Cromatique* (Paris, 1888); Charles Blanc, *Grammaire des arts du dessin* (Paris, 1867); Charles Ogden Nicholas Rood, *On the Relation between Our Perception of Distance and Color*, American Journal of Science, 2nd ser., 32, no. 95 (1861): 184, and *Modern Chromatics, with Applications to Art and Industry* (New York, 1879), as well as Impressionism, Pointillism, Divisionism, and so on. Also the related works of James Clerk Maxwell ("color top," 1855); Hermann von Helmholtz, *Handbuch der physiologischen Optik* (Leipzig, 1867); Gustav Theodor Fechner, *Elemente der Psychophysik* (Leipzig, 1860); Jakob Stilling, *Tafeln zur Bestimmung der Blau-Gelb-Blindheit* (Kassel, 1878); *Pseudo-isochromatische Tafeln zur Prüfung des Farbensinns* (1878); David Sutter, "Les Phénomènes de la vision," in L'Art 1 (1880), are mentioned in connection with this, as well as the influence which Ernst Brücke had with *Die Phänomenologie der Farben* (Leipzig, 1866) on Frantisek Kupka and Dr. H. Schoenmaeker's *Het Nieuwe Wereldbeeld* (1915) with his theory of the three primary colors (red, blue, yellow) on Mondrian. See also William J. Homer, *Seurat and the Science of Painting* (Cambridge, MA: MIT Press, 1964).

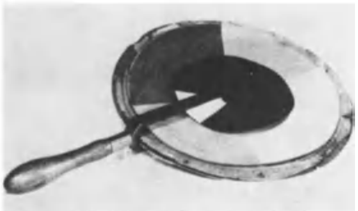
2. Ludwig Volkmann, *Das Bewegungsproblem in der bildenden Kunst* (Esslingen: Paul Neff, 1908).

comparison with machines — builds the historical basis for not only the art of film but also every art oriented on perception.

With the help of experimental perception psychology, the properties of vision and the mechanisms of perception were investigated methodically for the first time. In 1824, persistency of vision was discovered by Dr. Peter Mark Roget, whom we also thank for *Roget's Thesaurus*.



Simon Stampfer
***Stroboscopic disks*, 1833**



James Clerk Maxwell with his *color disc*, 1855

The afterimage effect — the light impression that remains approximately 1/20 of a second after the influence of the light — and the stroboscopic effect caused by it — the apparent melting of a rapid succession of images on the retinal surface — were scientifically analyzed and used for the construction of so-called "optical toys" that produced illusions of motion. The discovery of the afterimage effect and, most importantly, the stroboscopic effect, build the physiological basis of cinematography: the art of the mechanical, visual simulation of motion.

Around 1830, the great physicist Michael Faraday constructed Faraday's disc, which, "with the help of a technically produced stroboscopic effect" gave rise to "illusory motion."[3] At the same time, the Belgian physicist Joseph Ferdinand Plateau made initial investigations into stroboscopic effects (Greek: *strobos* = whirl or spin, *skopein* = seeing), such as the flicker limit or the fusion effect of images.[4] In 1839 he formulated the law of the "stroboscopic effect."[5] The Austrian professor of geometry Simon Stampfer discovered stroboscopic discs independently in 1833. In these, a disc with perforated slits carrying sequential drawings is spun quickly similar to Plateau's *Phenakistiscope* (Greek for "deceitful vision") motion wheel. In order to observe movement, the observer looks through the slits onto a mirror that reflects the drawings in simulated motion. In order to do away with the mirror, the devices were improved so that two counter-rotating discs rotated on one wavelength.[6] In 1912, the gestalt psychologist Max Wertheimer formulated a further law of illusory movement, the "phi phenomenon."[7]

The nineteenth century was addicted to the analysis and synthesis of sequential movement. New forms of a technical art developed through the comparison of bodily and machine functions, primarily those that involved time sequences. With the help of a machine, static images could be moved so quickly that the eye experiences the illusion of naturally continuous motion. The machines used, so to speak, the eye's optical deficits as measured by physiologists to create a machine-supported art of optical illusion, especially the simulation of motion. Because this early mechanical phase of the industrial revolution was marked by wheel technologies, the first cinematographic devices were called *Lebensrad* [wheel of life] (Stampfer), *Faraday's wheels* (Faraday), *Scheiben* [discs] (Stampfer), *Zoetropes* (W. G. Horner), and *gyroscopes* (J. C. Maxwell).

The manual color wheels and color gyroscopes in the nineteenth century were supplemented by machine-produced optical discs (image and split discs), whose function was to call forth the illusion of motion. These discs merged the analysis of movement, the dissection of the motion into individual phase images, and movement synthesis; the fusion of the individual images to the creation of illusory motion. In the course of development, the picture camera and the film camera took over the task of motion analysis, while the film projector took on the task of movement synthesis.

All of these wheel, disc, and revolver apparatuses, which mirrored the movement apparatus of industrial wheel technologies, had the disadvantage of not collectively, but rather only individually, allowing access to

3. Michael Faraday, "On a Peculiar Class of Optical Deceptions," Journal of the Royal Institution of Great Britain, no. 1 (1831): 205–223, 333–336.
4. J. A. F. Plateau, "Sur un nouveau genre d'illusion optique," in Corresp. mathem. et pys. de l'observatoire de Bruxelles, no. 7 (1832): 365–368.
5. The stroboscopic effect determined the frequency at which the individual bits were sequentially perceived as continual image impressions, and through that, brought about an illusion of movement. To avoid the flittering or flickering of the light, twenty-four pictures per second are not enough. To achieve the necessary frequency of fifty impulses per second, each of the twenty-four images must be broken by the wings of a revolving mixer in two dark pauses during the projection time of 1/24th of a second.
6. Simon Stampfer, "Über die optischen Täuschungs-Phänomene, welche durch die stroboskopischen Scheiben (optischen Zauberscheiben) hervorgebracht werden," in Jahrbücher des k.u.k. polytechnischen Instituts in Wien [Yearbook of the Royal Polytechnic Institute of Vienna], vol. 18 (Vienna, 1834), p. 239. In 1833, this was already included in the second edition of the "Zauberscheiben" as a brochure.
7. Two stationary short light lines that are spatially separated are shown for a time one after the other. If the interval between the illumination of both of the lines is short (1/32nd of a second), both lines appear simultaneously. If the interval is long, the two lines are seen one after the other. At a certain interval, markedly at the frequency of 1/16th of a second, the two lines are seen as the movement of one line.

the optical phenomena. Only the *Magic Lantern*, an early form of projection, allowed a group experience of machine-supported images. The first suggestion to combine the *Lebensrad* and the *Magic Lantern* came from T. W. Naylor in 1843. The Viennese magician Ludwig Döbler developed "a new Magic Lantern" in 1847, "which conjures up moving images on the wall." The Austrian Franz Uchatius delivered an improved version of the device from Naylor and Döbler in 1853.[8] In the nineteenth century, a mechanical device was created from the basic laws of the physiology of vision that would eventually lead in 1895 to the birth of film, to the *Cinématographe* of the brothers Lumière, which at that time was still described as "Cinétoscope de projection," which it actually was, as it combined the photo-cinematic series of shots with theatrical projection.

III. Marey, Muybridge, Mach

Painting and sculpture at the beginning of the twentieth century learned from the photographic and cinematographic experiments in movement analysis and synthesis of the nineteenth century. In tackling the problem of motion, painting relied on the results of photography, especially on the work of Etienne Jules Marey and Eadweard J. Muybridge. Also the physico-photographic experiments of Ernst Mach were helpful in creating a visual vocabulary for motion. The significance of the scientific study of movement through photography was the same for painting that confronted the problem of movement as the scientific color theory had been for abstract color painting.

Marey's works offered painters more advantages than Muybridge's, as Marey placed the various phases of a movement together on a single two-dimensional photo, something that naturally fit with painting, limited to a two-dimensional surface. Marey developed the method of simultaneity. As a physiologist, he was primarily concerned with a graphic method for recording movement, as attested to by his article, "Moteurs Animés. Expériences de physiologie graphique" (1878).[9] Marey's procedure showed the different phases of movement side by side on a single plate; at first from a single perspective, but as of 1887 with three cameras simultaneously from above, from the side, and from below. The paintings of Cubism and Futurism found a solution to the movement problem in Marey's simultaneity of various movement phases and his synthesis of the multifold perspective. Through that, simultaneity and synthesis became central concepts of Cubism and Futurism.

The sequential method originates with the British-American photographer Eadweard J. Muybridge. Muybridge developed a method that was, in a way, opposite to Marey's: the method of (photo)graphic representation of movement. With Muybridge, every image showed only a single phase of movement. He set up as many as twenty-four cameras at a distance of half a meter apart, and received a series of twenty-four pictures that showed twenty-four phases of movement. Muybridge's decisive step was to distribute the photographic registration of movement from one image to many images and to represent consecutive movement phases through consecutively placed images in "An Electrophotographic Investigation of Consecutive Phases of Animal Movements," as the subtitle of his book *Animal Locomotion* (1887) explains. Muybridge paved the way for the art of film as cinematography, as a language of movement; Marey paved the way for art as opseography, as a language of vision. The experiments and theories of Mach were especially relevant for the art of observing vision when seeing, opseoscopy, as well as for the continued advancement of experimental perception psychology in the twentieth century.

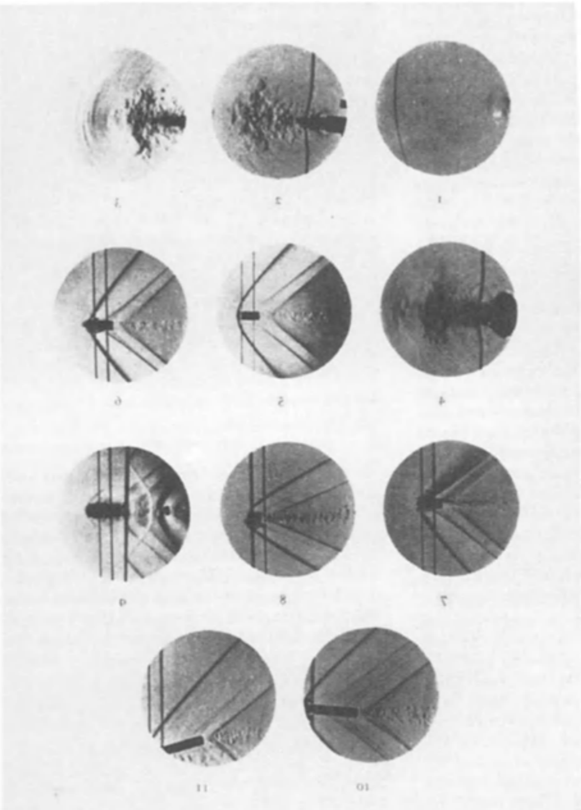
In addition to the photographic research of the French physiologist Marey and the British-American photographer Muybridge, the conclusions of the Austrian physicist Mach were of particular importance for the development of those pictorial arts that strove to depict movement two-dimensionally. Through contacts with the physiologists Ernst Brücke and Carl Ludwig, through studying the writings of Gustav Theodor Fechner and Hermann von Helmholtz, Mach tied together physics, physiology, and psychology. Thus in 1873 he published *Optisch-akustische Versuche* [Optical-acoustic experiments] and, in 1875, *Grundlinien der Lehre von den Bewegungsempfindungen* [Fundamentals of the theory of movement perception] and several additional fundamental research results on optic-acoustic sense perception.[10] He compiled all of his research results in his first major comprehensive work on this subject, *Beiträge zur Analyse der Empfindungen* [Contributions to the analysis of perception] (1886). His subsequent books, such as *Populärwissenschaftliche Vorlesungen* [Popular scientific lectures] (1896) and *Die Analyse der Empfindungen und das Verhältnis des Physischen zum Psychischen* [The analysis of the sensations and the relationship of the physical to the psychic] (1900), as well as his posthumous publication, *Die Principien der physikalischen Optik* [Principles of physical optics] (1921), not only made him a central intellectual figure at the turn of the century in Vienna but also assured his influence in the international avant-garde to the present day. It is, however, typical for the imbecilic and revisionist conservatism in Vienna that Mach was completely left out of an influential 1985 Viennese exhibition on the fin-de-siècle, *Traum und Wirklichkeit. Wien 1870–1930* [Dream and reality: Vienna

8. L. L. Döbler and T. W. Naylor, *Die verschwimmenden und die beweglichen Bilder. Zwei neue Anwendungen der Laterna Magica* (Leipzig, 1844); Franz Uchatius, "Apparat zur Darstellung bewegter Bilder an der Wand," in Department Report of the Mathematics-Science Class of the Kaiserliche Akademie der Wissenschaften [Imperial Academy of the Sciences], no. 4 (1853): pp. 482-485.

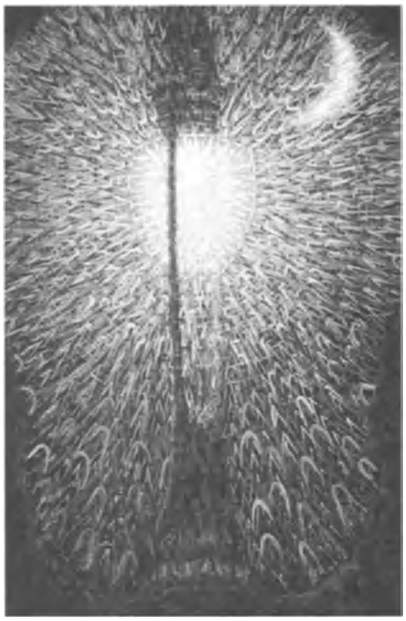
9. In *La Nature* 28.9 and 5.10 (Paris, 1875). See also E. J. Marey, "Dévelopement de la méthode graphique par l'emploi de la photographie," in *Supplément à la méthode graphique* (Paris, 1885). E. J. Marey, "Photography of Moving Objects and the Study of Animal Movement by Chrono-photography," Scientific American supplement (February 5, 1887): p. 12.

10. Ernst Mach, "Über die Änderung des Tones und der Farbe durch Bewegung," Sitzungsbericht der kaiserlichen Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Classe (hereafter SW) 41 (1860): 543–560; "Über das Sehen von Lagen und Winkeln durch die Bewegung des Auges," SW 43 (1861): 215–222; "Zur Theorie des Gehörgangs," SW 48 (1863): 283–300; "Vorträge über Psychophysik," Österreichische Zeitschrift für praktische Heilkunde 9 (1863); "Zwei populäre Vorlesungen über musikalische Akustik" (Graz, 1865); "Über den physiologischen Effect räumlicher vertheilter Lichtreize," part 2, SW 54 (1866): 131–144; part 3 and 4, SW 57 (1868): 11–19; "Bemerkungen zur Lehre vom räumlichen Sehen," Zeitschrift für Philosophie und philosophische Kritik, N.F. 46 (1865): 1–5; *Einleitung in die Helmholtzsche Musiktheorie, Populär für Musiker dargestellt,* (Graz, 1866); "Über wissenschaftliche Anwendungen der Photographie und Stereoskopie," SW 54 (1866): 123–126; "Beobachtungen über monoculare Stereoskopie," SW 58 (1868): 731–736; Ernst Mach, *Contributions to the Analysis of the Sensations* (Bristol, UK: Thoemmes Press, 2001); *Open Popular Scientific Lectures* (Chicago: Open Court, 1986); *Science of Mechanics* (Chicago: Open Court, 1988); L. R. Young, V. Henn, and H. Scherberger, eds., *Ernst Mach: Fundamentals of the Theory of Movement Perception*, book/CD-ROM (New

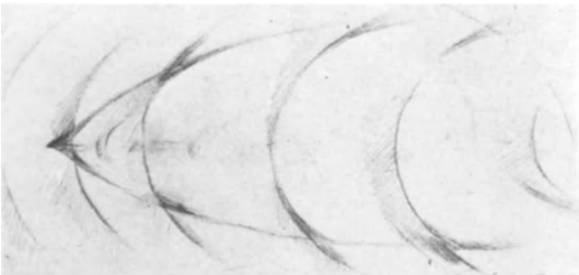
1870–1930). Mach contributed in various ways to the development of the optical arts. First, his work *Zur Analyse der Empfindungen* [On the analysis of sensations] (1886), where the terms "Tongestalt" (sound shape) and "Raumgestalt" (space shape) made their appearance, contributed to the founding of Gestalt theory. Second, his studies of spatial vision such as *Beobachtungen über monoculare Stereoskopie* [Observations on monocular stereoscopy] (1868), and his popular essay "Warum hat der Mensch zwei Augen?" [Why does man have two eyes?] advanced stereoscopic research — the fusion of two flat images into a picture with an apparent depth effect. Third, his work on the appearance of flying projectiles, snapshot photographs, and attempts at ballistic photography[11] in the years 1887–1895 delivered the basis for a vocabulary with which painters could visually express speed and movement, the three-cornered arrow form. His photos of flying projectiles show, namely, a waved head at the tip, the supersonic cone, also called a Mach cone, which became the sign (index, or symbol) for speed. This cone, or arrow form, cultivated by air resistance, has been visually appropriated by many painters since the beginning of the twentieth century, especially the Futurists, to visualize accelerated movement, speed, light rays, wave expansion, and so forth.



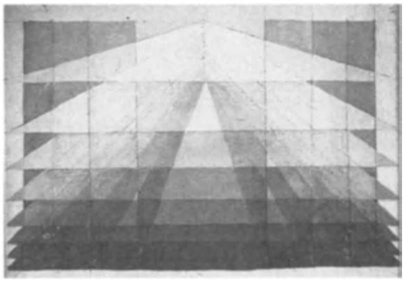
Ernst Mach, *Photographies of a flying bullet, 1887*
Graphische Lehr- und Versuchsanstalt, Vienna



Giacomo Balla
Lantern with Arcs, 1909
© VBK, Vienna, 2005



Giacomo Balla, *Study of a Flying Swallow*, 1913
Pencil on paper, 40 × 60 cm
© VBK, Vienna, 2005



Giacomo Balla
Study for *Iridiscent Penetrations*, 1912
© VBK, Vienna, 2005

York: Plenum Press, 2001; Ernst Mach, *Space and Geometry: In the Light of Physiological, Psychological, and Physical Inquiry* (Chicago: Open Court, 1988); *Knowledge and Error: Sketches on the Psychology of Enquiry* (Dordrecht: D. Reidel, 1976); *Principles of the Theory of Heat* (Dordrecht: D. Reidel, 1987); J. Blackmore, *Ernst Mach's Vienna 1895-1930, or Phenomenalism as Philosophy of Science* (New York: Kluwer Academic Publishers, 2001); J. Blackmore, *Ernst Mach – A Deeper Look: Documents and New Perspectives* (New York: Kluwer Academic Publishers, 1992).

11. E. Mach, Salcher, "Photographische Fixierung der durch Projectile in der Luft eingeleiteten Vorgänge," SW 95 (1887): 764–778; "Über die Fortpflanzungsgeschwindigkeit des durch scharfe Schüsse erregten Schalles," SW 97 (1888): 1045–1052; "Über eine Lichtquelle zum Photographieren nach der Schlierenmethode," in Jahrbuch für Photographie und Reproduktionstechnik 2, ed. J. M. Eder (1888): 284. E. Mach, Salcher, "Über die in Pola and Meppen angestellten ballistisch-photographischen Versuche," SW 98 (1889): 41–50; "Über die Schallgeschwindigkeit beim scharfen Schuß nach von dem Krupp-schen Etablissement angestellten Versuchen," SW 98 (1889): 1257–1276. E. Mach, Salcher, "Optische Untersuchung der Luftstrahlen," in SW 98 (1889): 1303–1309; together with L. Mach, "Weitere ballistisch-photographische Versuche," in SW 98 (1889): 1310–1326.

Wolfgang Paalen, born in 1905 in Vienna. Joined the surrealist movement as a painter. Invented "fumage" (fire) painting. Many surrealist objects. Emigrated to Mexico in 1939, died there in 1959.

Wolfgang Paalen
The Discovery of Infraspace I, 1940
77,7 × 57,3 cm

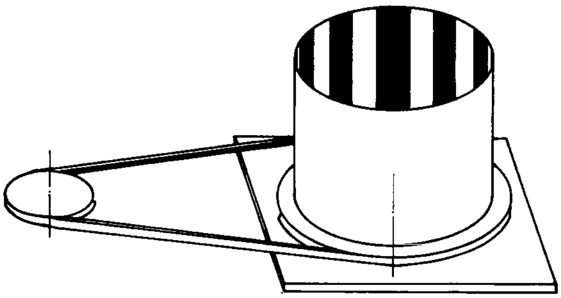
Kenneth Noland
Drive, 1964
© VBK, Vienna, 2005

As an experimental photographer, Mach therefore had an important position alongside Marey and Muybridge in the modeling of visual images for the representation of movement. In addition to Simon Stampfer (1833), Ludwig Döbler (1847), and Franz Uchatius (1853), among others, with Mach Austria not only had a technical pioneer of photography and cinematography to show for itself but also a philosopher who connected experimental physiology and physical experiments on the analysis of sense perception with experimental technical research into optical and acoustic laws. In 1873 he furnished the proof that special organs for the perception of movement sensations are found in the labyrinth of the inner ear.

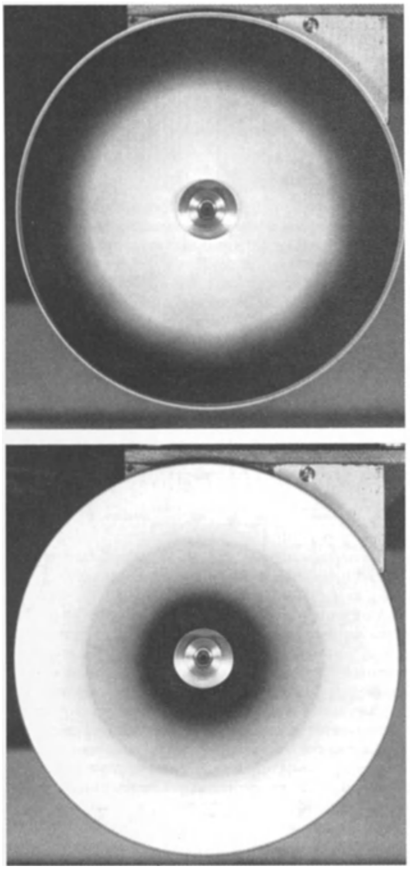
Apart from this, of Mach's numerous contributions to the physiology of sensory perception, Gestalt theory, and the psychology of perception, Mach banding is probably still the most well known today.[12] This effect of contrast perception discovered by Mach is a quite mysterious interaction between contrast and adjustment, a sensory illusion of the distribution of brightness. Contrasts or contours that deviate from the actual distribution of brightness appear before the eye. In the change from white fields to black the separator, for example, is accentuated. In the transition from the white to the black surface, a narrow ring of brightness in the white surface and a darker ring in the black surface is subjectively seen. This effect was already consciously employed by Paul Signac (see *Le Petit Dejeuner*, 1886/1887). Such effects of brightness contrasts and adjustments, which Mach himself described as neuronal inhibition procedures or sensory inhibition, are still employed today, for example by Mark Rothko. Rupprecht Matthaei, in *Das Gestaltproblem* (1929), expanded this lateral interaction of fields of vision, this interaction of the powers of contrast and adjustment.

The Mach drum is an example of induced movement of the observer. Observers who are in the middle of such a drum while it is moving feel themselves to be turning in the opposite direction. Mach developed sophisticated physical methods and experiments to mathematically grasp and document the objective reality of mental and sensory perceptions, particularly of movement. Thus in this way a physicist became the forerunner of Gestalt psychology.

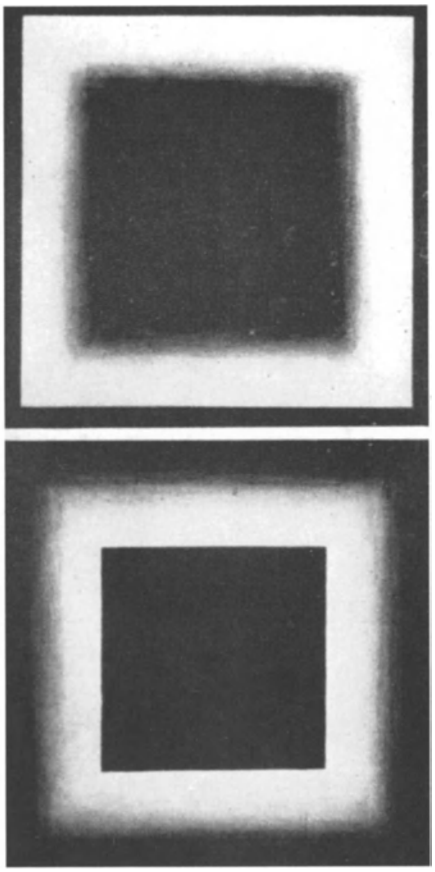
12. Floyd Ratliff, *Mach Bands: Quantitative Studies on Neural Networks in the Retina* (San Francisco: Holden Day, 1965); "Contour and Contrast," Proceedings of the American Philosophical Society 115 (1972): 150–216.



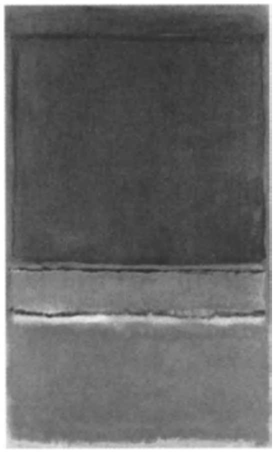
The Mach drum



Mach Bands (top dark, bottom light). Mach Bands (left: dark, right: bright) are created where two different, steep gradients of strong light meet.



Conditions for contrast and comparison: the actual color of the two interior squares is exactly the same. However, the square below looks much darker than the upper. The sharp edges are dominated by contrast; the fuzzy edges are compared to the bright frame (after R. Matthaei, *Das Gestaltproblem*, 1929).

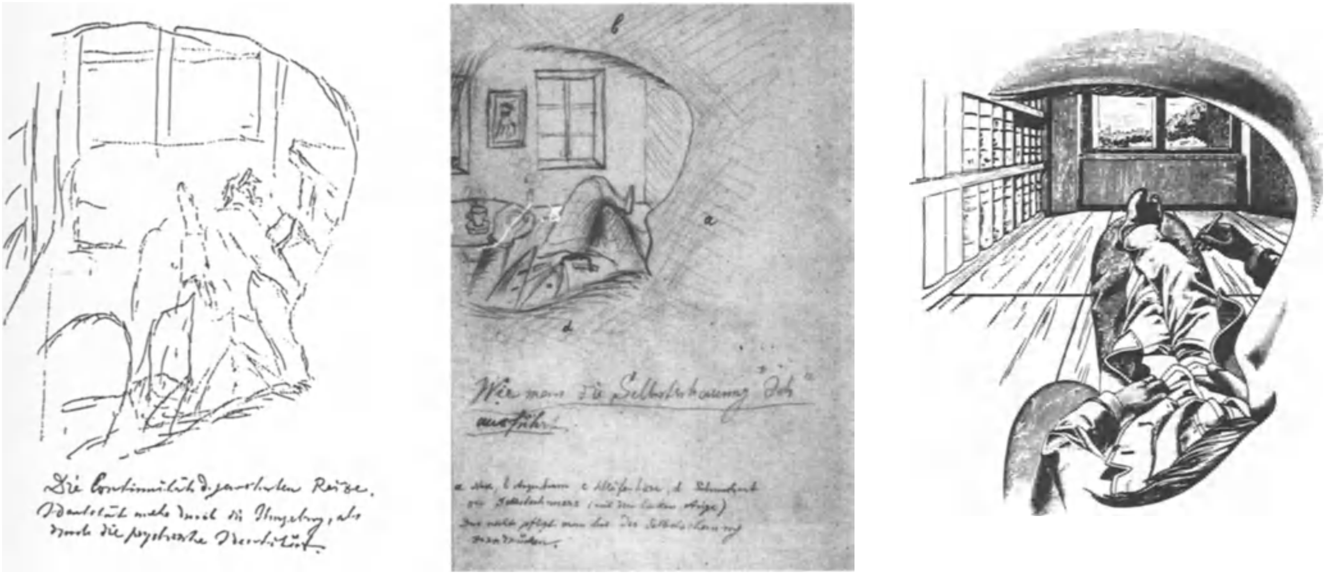


Mark Rothko, *No. 18*, 1952
© VBK, Vienna, 2005

Notebook 11, (17 February 1877)

The I from ideas, which hold together more strongly. Borders of the I.
Transition of I in one-another. Dissolving of I in another expanded I. Distance.
Memory of grasping?
Holding the distance constant.
How do the three local sketch-series become one and the same?
Understanding the body.
The eye is a grasping instrument equipped with light sensitivity.
It feels before the position, the tactile instrument after the position.
The tactile space is a space for memory and imagination.
The visual space less so. The great distance of further removed points is perhaps no longer optical (perspective enlargement).
The eye moves without obstacles.
The arm doesn't always. One sees bodies.
One detaches form from them,
Herbart insufficiently*
... leads to physiological theory. Visual sensations bound to spatial sensations.
Which type are the spatial sensations? The mere impulse of movement shifts the object.
Natural reversal (time).
Grasping is associated with a sense of space and arises through the same.

* Johann Friedrich Herbart (1776-1841), German philosopher, psychologist and pedagogue. 1802-1809 private docent and professor in Göttingen, afterwards he held Kant's chair in Königsberg, 1833-1841 he was again professor at the university in Göttingen.



Excerpts from the note books (1871-1910) from Ernst Mach, probably drafted around 1871.

Mach can therefore be considered among the great nineteenth-century perception psychologists, who still exercise an enormous influence on art and philosophy to the present day. Mach was, incidentally, so influential in his time that Lenin found it necessary in 1909 to compose a polemic against Mach and his corrupting influence on Bolshevism, namely *Materialism and Empiriocriticism. Critical Remarks on a Reactionary Philosophy* (see Alexander Bogdanov's *Empiriomonism* [1904].) It is also interesting how the Hungarian psychiatrist Thomas S. Szasz takes up Mach's line of thought in order to criticize psychiatry and psychoanalysis.[13]

IV. Gestalt Psychology in Vienna and Graz

Franz Brentano

Among the most important forerunners of modern psychology was Franz Brentano (1839–1917), who lived in Vienna from 1874, and prior to that taught in Würzburg (where Carl Stumpf was his student). With his work *Psychologie vom empirischen Standpunkte* [Psychology from an empirical standpoint] (1874) and *Untersuchungen zur Sinnespsychologie* [Investigations on sensory psychology] (1907), he laid the foundation for phenomenology, the psychology of action (aktpsychology), and the Graz School of Psychology and the Würzburg School of Thought Psychology (Karl Bühler, Otto Selz). At the core of his teaching lay the concept of intentionality: all psychic acts are directed at objects. Every psychic phenomenon is characterized by its intentionality. Among his students in Vienna were Edmund Husserl, Alexius Meinong, and Sigmund Freud.

Christian von Ehrenfels

Building on Mach's analyses and Franz Brentano's teachings on intentionality, Christian von Ehrenfels (1859–1932), a student of Brentano, developed his thoughts on gestalt and published them in his famous article "Über Gestaltqualitäten" [On gestalt qualities], which founded Gestalt psychology.[14] Ehrenfels was professor of philosophy at the University of Vienna in 1888, and also from 1899-1929 in Prague. Mach, who held the chair for experimental physics at the University of Prague from 1867 to 1895, published the *Analyse der Empfindungen* (with the terms "tongestalt" and "raumgestalt") in 1886; Ehrenfels published his essay in 1890. In it, he defined gestalt: "a gestalt is that perceived something that is more than and something other than the simple summation of its constitutive parts, although these are essential for its existence."

Alexius Meinong

The founder of the Graz School of Theory of Objects, Alexius Meinong (1853–1920) became involved early on with the treatise of his friend Christian von Ehrenfels, who had graduated with him in Graz in 1885.[15] But Meinong wanted to present the concept of gestalt theoretically. He believed that a special psychic act was

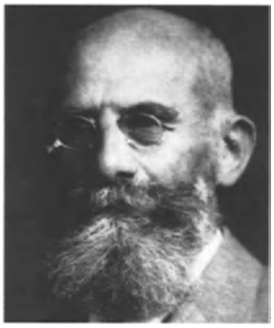
13. Thomas S. Szasz, introduction to E. Mach, *The Analysis of Sensation and the Relations of the Physical to the Psychical* (New York, 1959). Thomas S. Szazs, "Mach and Psychoanalysis," Journal of the Nervous and Mental Diseases 130 (1960): 6–15.

14. Christian von Ehrenfels, "Über Gestaltqualitäten," Vierteljahresschrift für Wissenschaftliche Philosophie 14 (1890): 242–292; B. Smith, ed. *Foundations of Gestalt Psychology* (Munich: Philosophia, 1988).

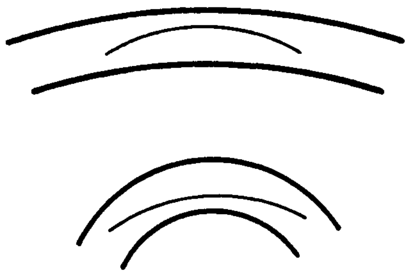
15. A. Meinong, "Zur Psychologie der Komplexionen und Relationen," Zeitschrift für Psych. und Physiolog. der Sinnesorgane 2 (1891): 245–265; A. Meinong, *On Emotional Representation* (Evanston, IL: Northwestern University Press, 1972); *On Assumption* (Berkeley and Los Angeles: University of California Press, 1985); D. F. Lindenfeld, *The Transformation of Positivism: Alexius Meinong and European Thought, 1880-1920* (Berkeley and Los Angeles: University of California Press, 1981).

16. M. Wertheimer, "Experimentelle Studien über das Sehen von Bewegung," Z. f. Psychol. 61 (1912): 161–265; English translation in T. Shipley, ed. *Classics in Psychology* (Philosophical Library, 1961); M. Wertheimer, *Productive Thinking* (New York: HarperCollins, 1945, 1959); K. Koffka, *Principles of Gestalt Psychology* (Lund Humphries, 1935).

necessary so that from the professed elements of perception the corresponding gestalt impression followed. A gestalt idea is the result of a psychological procedure that should be understood as idea production. Therefore, he suggested replacing the label "gestalt quality" with "higher-order object." In his autobiography (published posthumously in 1921) Meinong admitted that Ehrenfels's treatise "Über Gestaltqualitäten" was the most important preliminary work for his theory of objects. Meinong, together with his students in Graz, Stephan Witasek and Vittorio Benussi, and his Viennese friend Alois Höfler, developed a "Substantiation and Production Theory" of gestalt that stood in contrast to the Berlin School, which believed that gestalts are primary. According to the substantiation theory, gestalts are higher-order ideas first added to the complex of sensations by the subject.

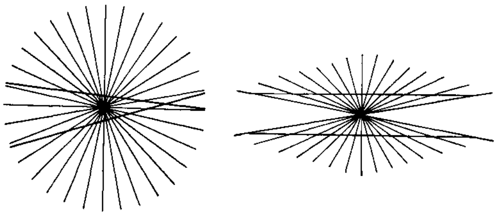


Christian von Ehrenfels



Curve contrasts according to Höfler. Between the flatter curves, the same arc appears stronger than it does between the more steeply graded curves.

Alexius Meinong



Höfler's Deception: If the angles on both halves of the straight lines oppose each other, they must appear bent.

Max Wertheimer and Wolfgang Köhler

Max Wertheimer, who came from Prague (where Christian von Ehrenfels taught), was considered the founder of the Berlin (and Frankfurt) School of gestalt psychology. At first Wertheimer worked with Wolfgang Köhler and Kurt Koffka, students of Carl Stumpf, from 1910 until 1914 in Frankfurt where, as of 1910, he investigated the phi phenomenon of illusory movement.[16] Following that he went to Berlin. Kurt Koffka (1886–1941) went to Giessen and, in 1924, to America.

Wolfgang Köhler (1887–1967) worked with chimpanzees from 1914 until 1920 on Tenerife,[17] and from 1922 to 1935 he worked in Berlin. In Frankfurt and Berlin, Wertheimer, Köhler, and Koffka developed the world-famous school of gestalt psychology.[18] There they joined with the psychologist Kurt Lewin. Wertheimer returned to Frankfurt between 1929 and 1933 as chair and institute director; Wolfgang Metzger,[19] previously assistant to Köhler in Berlin, became his assistant. In 1933, Wertheimer emigrated to the U.S.A. out of necessity; in 1935 Köhler went by choice. Leon Festinger (theory of cognitive dissonance) was Lewin's student there.

The immediate beginnings of gestalt psychological thought are bound with the names Franz Brentano, Ernst Mach, Christian von Ehrenfels, and Alexius Meinong, and the effects they had in Vienna, Würzburg, Prague, and Graz. Gestalt psychology developed in Berlin through Brentano's student, Carl Stumpf (1848–1936) of Würzburg, who went in 1894 by way of Prague, Halle, and Munich to Berlin, where his students were, among others, Köhler, Wertheimer, Koffka, Lewin, and Friedrich Schumann. Through Meinong, phenomenological holistic and gestalt theory developed in Graz, especially through his students Vittorio Benussi (1878–1924) and Stephan Witasek (1870–1915).

But these schools came to contrasting conceptions of gestalt, as can be shown through the example of the understanding of a melody. The Graz School said that the act of production by the subject makes the melody from the individual tones. In the Berlin School (Wertheimer, Koffka, Köhler) however, the gestalts are primary. When the notes C and G sound together, a quint is produced whose quality lies neither in the note C nor the note G, and is also independent of these two notes. Every pair of notes with the oscillation relation of 2:3 is recognized as a quint. The quint is a gestalt that is not only more than the sum of its parts, but rather,

17. W. Köhler, *Intelligenzprüfungen an Menschenaffen* (Berlin: Springer, 1921); W. Kohler, *The Mentality of Apes* (London: Routledge, 1999); R. Ley, *Whispers of Espionage: Wolfgang Kohler and the Apes of Tenerife* (Harmondsworth: Avery Penguin Putnam, 1990).

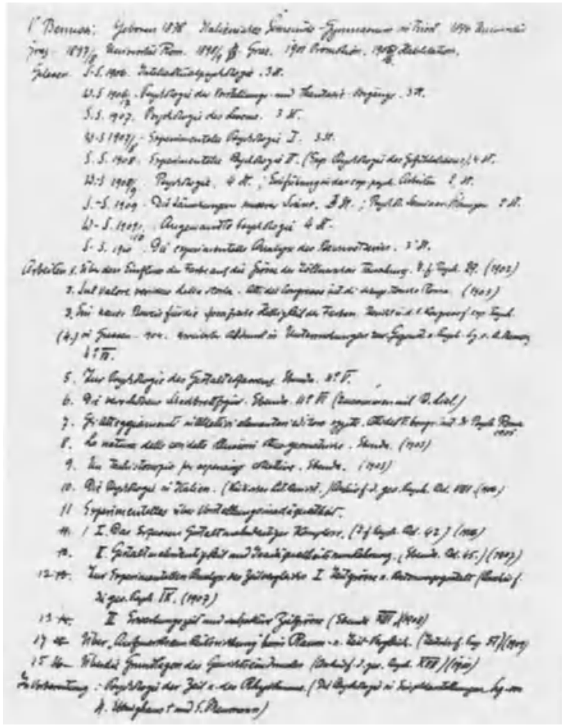
18. M. Wertheimer, "Untersuchungen zur Lehre von der Gestalt," Psychol. Forschung I (1922): 47–48; V (1923): 301–350; English translation in W. D. Ellis, ed. *A Source Book of Gestalt Psychology* (New York: Harcourt, Brace, 1938); M. Wertheimer, *Drei Abhandlungen zur Gestalttheorie* (Berlin, 1925). K. Koffka, "Zur Grundlegung der Wahrnehmungspsychologie," Z. f. Psychol. (1915); "Perception. An Introduction to Gestalttheorie," Psychol. Bulletin (1922); "Über Feldbegrenzung und Felderfüllung," Psychol. Forschung 4 (1923); *Principles of Gestalt Psychology* (New York, 1935). W. Köhler, *Die Physischen Gestalten in Ruhe und im stationären Zustand* (Braunschweig, 1920); "Komplextheorie und Gestalttheorie," Psychol. Forschung 6 (1925); *Gestalt Psychology* (New York, 1929). Viktor v. Weizsäcker, *Der Gestaltkreis. Theorie der Einheit von Wahrnehmen und Bewegung* (Stuttgart, 1950).

19. Wolfgang Metzger, *Gesetze des Sehens* (Frankfurt am Main, 1936).

above all, shows that the gestalt as a whole is different than the sum of its parts. Wertheimer and Köhler formulated the hypothesis from the psychophysical isomorphism: "psychological facts and causal brain processes are similar in all of their structural characteristics."[20]

Vittorio Benussi

Playing a particularly central role in this discussion was Vittorio Benussi (1878–1924), born in Trieste, where he later completed his secondary education in 1896. In the 1896/ 1897 academic year he enrolled at the University of Graz. In 1899–1900 he attended Meinong's lectures and in 1901 wrote a dissertation, "Über die Zöllersche Figur. Eine Experimentalpsychologische Untersuchung" [On Zöller's figure: An experimental psychological investigation]. He had spent most of his time as a second assistant in Meinong's psychological laboratory, which Meinong had founded in 1894. Benussi became a close student and active colleague of Meinong. In 1904, Meinong published the festschrift *Untersuchungen zur Gegenstandstheorie und Psychologie* [Investigations on the theory of objects and psychology] for the ten-year anniversary of the psychological laboratory at the University of Graz, in which Benussi established himself as psychologist par excellence of the Graz School.[21] In 1905 Benussi made his home in Graz. In the following years he dedicated himself solely to his research on geometric-optical-illusion, the psychology of time perception, and especially gestalt perception.[22]



Facsimile of a handwritten page by Vittorio Benussi: summary of his courses and publications

Despite his international renown as experimental psychologist, he was never named as a professor due to his Italian heritage. In December 1918, after the end of the war, he was dismissed. In 1919 he was awarded a chair for experimental psychology in Padua, where he founded the psychological school of Padua (1919–1927), whose most important (and initially only) student was Cesare L. Musatti, who later taught Gaetano Kanizsa and Fabio Metelli.[23] In the last years of his life Benussi drew closer to psychoanalysis, a move intensified through his friendship with Doctor Edoardo Weiss of Trieste. Benussi committed suicide on November 24, 1927 at the age of forty-nine. Particularly relevant for the position of gestalt psychology is the discussion between the Graz production theory and the Berlin Gestalt theory, or the Benussi-Koffka controversy. In 1912 Benussi published his work on stroboscopic illusory movement.[24] In the same year, Max Wertheimer published his essay "Experimentelle Studien über das Sehen von Bewegungen" [Experimental studies on the perception of movement], the manifesto of gestalt theory from which came the previously mentioned discovery of the phi phenomenon.[16] In 1913, on the other hand, Kurt Koffka and Friedrich Kenkel published a work about the same phenomenon, at the end of which they criticized Benussi,[25] who replied in a review.[26] Koffka reacted to that with a thorough critique of production theory.[27]

From today's perspective, Benussi's standpoint was closer to cognitive neurosciences because he extended the experimental analysis of perception to an analysis of consciousness and the latent subjective factors in the construction of the perceived world.[28] Benussi's students, the Italian successors of the Graz School of Gestalt Psychology (Cesare L. Musatti, Fabio Metelli, Gaetano Kanizsa, Renzo Canestrani) further crucially developed gestalt theory into cognitive psychology, as the following titles show: *Seeing and Thinking: Vittorio Benussi and the Graz School* (Natale Strucchi),[29] and *Seeing and Thinking* (Gaetano Kanizsa).[30] What we thank Benussi for, above all, is the discovery of stereokinetic phenomena, the seeing of illusory movements and illusory bodies. In 1912, through a relatively simple experiment, he researched the connection between movement and depth perception that had already been suggested by Helmholtz: Patterns of circles on rotating discs create moving cones and with that the illusion of spatial perception; the perception of a three-dimensional picture in motion.[31]

20. W. Köhler, *Die Aufgabe der Gestaltpsychologie* (Berlin: De Gruyter, 1971), p. 50; W. Kohler, *Gestalt Psychology: An Introduction to New Concepts in Modern Psychology* (1947; London: Liveright, 1992; W. Kohler, *The Task of Gestalt Psychology* (Princeton, NJ: Princeton University Press, 1969); M. Henle, ed. *The Selected Papers of Wolfgang Kohler* (London: Liveright, 1971). (Berkeley and Los Angeles: University of California Press, 1981).

21. V. Benussi, "Zur Psychologie des Gestalterfassens (Die Müller-Lyersche Figur)," in A. Meinong, ed., *Untersuchungen zur Gegenstandstheorie und Psychologie* (Leipzig: Barth, 1904), pp. 303–448.

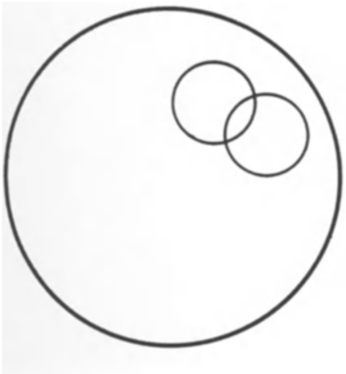
22. V. Benussi, "Gesetze der inadäquaten Gestaltauffassung," Arch. f.d. ges. Psychol. 32 (1914): 396–419; "Versuche zur Analyse taktil erweckter Scheinbewegungen (kinematohaptischer Erscheinungen) nach ihren äußeren Bedingungen und ihren Beziehungen zu den parallelen optischen Phänomenon," Arch. f. d. ges. Psychol. 36 (1917); "Experimentelles über Vorstellungsinadäquatheit. I. Das Erfassen gestaltmehrdeutiger Komplexe," Z. f. Psychol. 42f, (1906); *Psychologie der Zeitauffassung* (Heidelberg, 1913); "Zur experimentellen Grundlegung hypnosuggestiver Methoden psychischer Analyse," Psychol. Forsch. 9 (1927).

23. C. L. Musatti, "La scuola di psicologia di Padova (1919–1927)," Rivista di psicologia 24, no. 1 (Bologna 1928).

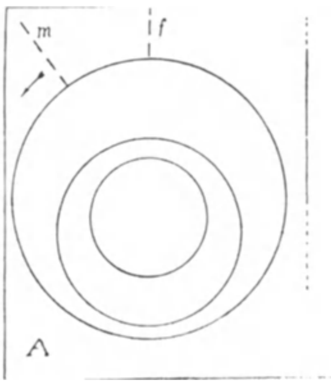
24. V. Benussi, "Stroboskopische Scheinbewegungen und geometrisch-optische Gestalttäuschungen," Arch. f. ges. Psychol. 24 (1912): 31–62.

25. Kurt Koffka and Friedrich Kenkel, "Beiträge zur Psychologie der Gestalt- und Bewegungserlebnisse in Untersuchungen über den Zusammenhang zwischen Erscheinungsgröße und Erscheinungsbewegung bei einigen sog. optischen Täuschungen," Z. f. Psychol. 67 (1913): 353–449.

26. V. Benussi, "K. Koffka, F. Kenkel, Beiträge zur Psychologie der Gestalt- und Bewegungserlebnisse," Arch. f. ges. Psychol. 32 (1914): 50–57.



Vittorio Benussi, 1912; apparent transparency in stereokinetic phenomenon. If the circular pieces are glued or drawn in three colors on a card and then set to rotating slowly, it looks as if two circles, like sections of a cylinder, each of one color, are lying next to each other.



Cesare L. Musatti, 1924; circles that create stereokinetic effects when rotating.

Marcel Duchamp, 1925-26; optical disk from the film *Anémic Cinéma*
© VBK, Vienna, 2005

The unfinished stereo-films of Duchamp (1920), the optical disc of his film *Anémic Cinéma* (1925-1926), and the *Roto-Reliefs* from 1935 are based on these stereokinetic phenomena. Benussi's student, Musatti, refined and built on Benussi's discovery of the stereo-kinos in 1924.[32] He gave the phenomenon the lasting name, "stereokinetic effect." The discovery of stereokinetic spatial images and illusory bodies in motion was forgotten and first rediscovered by Metzger and Hans Wallach.[33] The results of Brentano's, Mach's, and Ehrenfels's research on gestalt theory and perception psychology continued not only in Berlin, Graz, and Würzburg (Carl Stumpf), but also in Vienna.

Karl Bühler

Bühler (1879–1963), a student of Stumpf, published an important work on gestalt perception in 1913. In 1922 he moved to Vienna, where he was professor of psychology at the university from 1922 until 1938. Together with his wife Charlotte he built a center for perception and developmental psychology,[34] the Institute for Psychology at the University of Vienna (1924–1938), which was supported by donations from the Rockefeller Foundation and had an amazing assembly of students: Peter R. Hofstätter, Ernest Dichter, Kurt Eissler, Paul F. Lazarsfelder, Konrad Lorenz, Heinz Hartmann, Lajos Kardos, Karl Popper, Else Frenkel-Brunswik, Emil H. Erikson, and Egon Brunswik.[35] By the end of his life Bühler had expanded gestalt theory to become gestalt philosophy, which also took into account new results from cybernetics, cognition theory, and automation theory.[36]

Cornell symposium on the "Effects of the Gestalt Revolution," 1957.
From left to right: Wolfgang Metzger, Fritz Heider, George Klein, James Drever, Robert B. Macleod, James J. Gibson, Hans Wallach, Egon Brunswik, Gunnar Johannson, Ivo Kohler, Julian E. Hochberg, and T.A. Ryan.

27. Kurt Koffka, "Beiträge zur Psychologie der Gestalt und Bewegungserlebnisse. III. Zur Grundlegung der Wahrnehmungspsychologie. Eine Auseinandersetzung mit V. Benussi," Z. f. Psychol. 73 (1915): 11–90. See also Fabio Metelli, "La polemica Benussi-Koffka," in *Vittorio Benussi nelle storia della psicologia italiana*, ed. G. Mucciarelli (Bologna, 1988), pp. 119–132.

28. See the excellent monograph from Mauro Antonelli, *Die experimentelle Analyse des Bewußtseins bei Vittorio Benussi* (Amsterdam, 1994), published in the series "Studien zur österreichischen Philosophie," ed. Rudolf Haller, vol. 21.

29. P. M. Simons, ed., *Essays on Meinong* (Munich: Philosophia, 1994).

30. In Acta Psychologica 59 (1985): 23–33.

31. V. Benussi, "Stroboskopische Scheinbewegungen und geometrisch-optische Gestalttäuschungen," Arch. f. ges. Psychol. 24 (1912): 31–62; "Kinematohaptische Scheinbewegungen und Auffassungsumformung," in Report on the VI Congress of experim. Psychol. in Göttingen, ed. F. Schumann (Leipzig: Barth, 1914), pp. 31–35. "Über Scheinbewegungskombinationen (Lissajoussche S-, M- u. E-Scheinbewegungsfiguren)," Arch. f. Psychol. 37 (1918): 233–282; see also J. Wittmann, *Über das Sehen von Scheinbewegungen und Scheinkörpern* (Leipzig, 1921); R. Renvali, "Zur Theorie des stereokinetischen Phänomenons," Ann. Univ. Aboensis Abt. B (1929). G. Tampieri, "Sulle condizioni del movimento stereocinetico," in Kanizsa Vicario, "Ricerche sperimentale sulla percezione," (Trieste, 1968).

32. C. L. Musatti, "Sui fenomeni strecientici," Archivo Italiano di Psicologia 3 (1924); "Sulla plasticita reale stereciinetica e cinematografica," Arch. Ital. Psicol 7 (1929).

33. W. Metzger, "Tiefenerscheinungen in optischen Bewegungsfeldern," Psychol. Forschung 20 (1934): 195–260. H. Wallach and D. W. O'Conell, "The Kinetic Depth Effect," Journal of Exp. Psychol. 45 (1953): 205–217; H. Wallach, "Über visuell wahrgenommene Bewegungsrichtung," Psychol. Forsch. 20 (1935).

34. Karl Bühler, *Die Gestaltwahrnehmungen. Experimentelle Untersuchungen zur psychologischen und äesthetischen Analyse der Raum- und Zeitanschauung* (Stuttgart, 1913); "Die Erscheinungsweise der Farben," *Handbuch der Psychologie: Die Struktur der Wahrnehmungen*, vol. 1 (Jena, 1922).
35. K. Bühler, *Die Krise der Psychologie* (1927); *Ausdruckspsychologie. Das System an der Geschichte aufgezeigt* (Jena, 1934); *Theorie der Sprache. Die Darstellfunktion der Sprache* (Jena: Fischer, 1924); K. Buhler, *The Representational Function of Language* (Amsterdam: John Benjamins, 1990); A. Eschenbach, ed., *Karl Buhler's Theory of Language* (Amsterdam: John Benjamins, 1988); R. E. Innis, ed., Karl Bühler: *Semiotic Foundations of Language* (New York: Plenum, 1981).
36. K. Bühler, *Das Gestaltprinzip im Leben der Menschen und Tiere* (Bern: Huber, 1960).
37. Fritz Heider, *Thing and Medium: On Perception, Event, Structure, and Psychological Environment: Selected Papers* (Guildford, CT: International Universities Press, 1959); *The Psychology of Interpersonal Relations* (New York: John Wiley & Sons, 1958); *The Life of a Psychoanalyst* (Lawrence: University of Kansas Press, 1983).

Meeting in Rostock, 1928. From left to right: Fritz Heider, Kurt Lewin, David Katz, Heinz Werner, Rose Katz, Wolfgang Köhler, A.E. Michotte, E. Rubin, Max Weimar

International congress for psychology, Bonn, 1960. From left to right: Ludwig Kardos, Philipp Lersch, Fritz Heider, Richard Meili

Fritz Heider

A further link between the gestalt schools in Graz and Berlin is Fritz Heider. He was born in 1896 in Vienna but after half a year moved with his family to Graz, where he completed secondary school in 1914. He studied psychology with Karl and Charlotte Bühler in Munich in 1918, and graduated with a Ph.D. in 1920 under Alexius Meinong and Hugo Spitzer in Graz. There, he also came into contact with Benussi, who awakened his interest in gestalt psychological problems, so that from 1921 to 1927 (except for short breaks in Florence and Naples) he was at the psychological institute in Berlin studying with Wertheimer, Köhler, and Lewin. In 1926 he published his most well-known article, "Ding und Medium," which appeared in English in 1959 as "Thing and Medium."[37] In this article, the difference between distal and proximate stimulation led to a perception-theoretical definition of mediation whereby mediation was understood as the negotiation of information on things to our sense organs.

It is insufficient to say that the distal object causes the proximate stimulation as the environmental conditions that make the perception of the distant object possible must also be taken into consideration. Things (or objects), therefore, are only perceived through mediation. Such concepts were later developed by information theorists and cybernetics experts. Heider developed these aspects further in his *Attitudes and Cognitive Organization* (1946). In 1927 he went to William Stein in Hamburg and in 1930 to the U.S., where he first worked as an assistant professor with Koffka at the Clarke School of Smith College in Northampton, Massachusetts, and later, in 1947, at the University of Kansas. In 1958, he published his standard work, *Psychology of Interpersonal Relations*, which investigates the influence of perception and cognition through subjective factors. In 1959, his autobiography, *The Life of a Psychologist*, was published.

V. Experimental Perception Psychology

Else Frenkel-Brunswik

Else Frenkel-Brunswik

Born in Lemberg, Frenkel-Brunswik (1908–1958) moved to Vienna in 1914. In 1926 she began her studies at the University of Vienna (mathematics, physics, psychology). In 1927 she studied with Karl Bühler, with whom she later wrote her dissertation in 1930. Until 1938 she worked at the psychological institute of the University of Vienna as Charlotte Bühler's assistant. In 1938 she emigrated and became a research associate at UC Berkeley. She became well known (together with Theodor W. Adorno, D. A. Levinson, and R. N. Sanford) in 1950 through the publication of *The Authoritarian Personality*,[40] which she had been working on since 1944. In 1954 she became a fellow at Stanford University; in 1956 she had a Fulbright scholarship in Oslo. She died in Berkeley, probably through suicide.

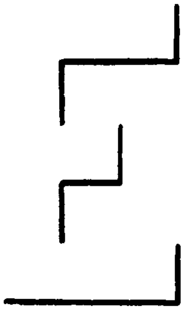
Egon Brunswik

Karl Bühler's assistant, Egon Brunswick (1903–1955), who also remained close to the positivism of the Vienna Circle and its successor in America, Unity of Science, developed the psychology of perception in Vienna.[38] Egon Brunswik's work, *Experimentelle Psychologie in Demonstrationen* [Experimental psychology in demonstrations), published in Vienna in 1935, contained the results from experiments that Brunswik conducted at the university alongside the general lectures on psychology from Karl Bühler. This book is a methodological masterpiece. He introduced probabilistic functionalism into psychology as he believed the pro-babilistic methodology of physics also suitable for psychology. Brunswik was born in Budapest in 1903 and finished his secondary education in Vienna in 1921. In 1923, after two years studying engineering , he began to study psychology, philosophy, mathematics, and physics at the University of Vienna. In 1927 he completed his dissertation; in 1929 he became an assistant to Bühler; in 1934 he completed his Habilitation; and in 1935–1936 he held a Rockefeller fellowship at the psychological laboratory of the University of California at Berkeley under the direction of Edward Chase Tolman. He emigrated to the U.S. in 1937, and from 1937 was an assistant professor at Berkeley. The renowned neo-behaviorist Tolman (1886–1959), who brought cognitive concepts into learning theories ("cognitive maps"), was in Vienna in 1934 and worked together with Brunswik at Karl Bühler's institute.[39] In 1938 Brunswik married Else Frenkel, whom he had known since 1928. In 1955 he committed suicide in Stanford.

After his emigration Egon Brunswik became an important methodologist and science theoretician of psychology. In his final work in 1952 he referred to the newer results of cybernetic and mathematical communications theory (from Warren McCulloch to Gregory Bateson up to Claude Shannon).[41] His colleagues, Bühler's students, also provided important contributions to the study of color, depth perception, volume estimation, and the study of perception in general.[42] Friedrich Kainz from the University of Vienna wrote an interesting art historical work in 1927 on gestalt regulation and ornament development.[43]

Egon Brunswik

Comparing the volume of different-shaped bodies, taken from E. Brunswik, *Experimentelle Psychologie in Demonstrationen*, Vienna: Springer, 1935, p. 101.



Supplementing lines. Instead of three black, interrupted lines, experience leads us to easily discern a white E. In this case, exactly half of the entire outline has been supplemented (after Brunswik).

	T7	W7	D7	W4	G7
Sad	1st				
Old	1st				
Bad	6th	5th			
Unlikeable	3rd	1st	7th		
Ugly	6th	2nd	1st		
Unintelligent		3rd	7th	1st	
Unenergetic					1st

Schematic heads after Brunswik and Reiter, 1937

In the 1930s, the Austrian art historian **Ernst H. Gombrich** began his research into the problematic of perception in art. With his friend and teacher, the psychoanalytically oriented art historian Ernst Kris (1900–1957) — to whom, in addition to Emanuel Loewy and Julius von Schlosser, the book *Art and Illusion*[44] is dedicated — he conducted several experiments on the understanding of expressions of pictures for a study on the history of caricature.[45] For this, also Brunswik volunteered as a test subject. He had conducted perception experiments in 1936 together with L. Reiter using schematic heads. These experiments had confirmed the sensitivity of our physiognomic perception to minor changes. He defined the face as a field of face variables, as a thick bundle of countless variables. Tiny shifts within these facial variables (such as eye distance, nose length, distance of mouth to nose, etc.) radically change the facial expression.[46] Gombrich's world-renowned work on art and optical illusion is the product of a milieu, which Gombrich mentions in the foreword to his book.[47] In it, he points out the concurrence of his views with those of Brunswik as expressed in the well known collaborative work of Tolman and Brunswik, *The Organism and the Causal Texture of Environment* (1935), which emphasizes the hypothetical character of all perception processes.[39] Gombrich is therefore the convergence and culmination point of Austrian Gestalt psychology and art history methodology.

Through the forced migration of these academics in the 1930s, this style of thought spread abroad, but in Austria itself broke off.

VI. Vision Machines: Perception of Illusory Bodies and Illusory Movements

By the end of the nineteenth century Helmholtz had worked with prismatic distortion and George Stratton (1865–1957) had used inversion lenses on one eye for eight days. Theodor Erismann, head of the Psychological Institute at the University of Innsbruck, updated and carried these experiments further. Beginning in 1928, through his experiments with inversion glasses and mirrors, in part in collaboration with Hubert Rohracher, he recognized the inversion of the retinal image as an illusion problem.

Ivo Kohler (1915–1985) first studied theology, then philosophy, and finally psychology. He was Erismann's assistant at the Psychological Institute of the University of Innsbruck for eighteen years before he became its head. His experiments, carried out at the same university in 1947, have shown that in the field of vision the body's senses alone determine what is above or below, what is left or right. Kohler experimented with

38. K. R. Hammond, *The Psychology of Egon Brunswik* (New York, 1966); K. R. Hammond, *The Essential Brunswik: Beginnings, Explications, Applications* (Oxford: Oxford University Press, 2001); E. Brunswik, "Prinzipienfragen der Gestalttheorie," in *Beiträge zur Problemgeschichte der Psychologie, Festschrift for Karl Bühler's 50th Birthday* (Jena, 1929); E. Brunswik et al., eds. "Die Zugänglichkeit von Gegenständen für die Wahrnehmung und deren quantitative Bestimmung in Untersuchungen über Wahrnehmungsgegenstände," Arch. f. die ges. Psychologie 88 (1932): 377–418; *Psychologie vom Gegenstand her* (Leipzig/Vienna, 1934); *Experimentelle Psychologie in Demonstrationen* (Vienna, 1935); "Die Eingliederung der Psychologie in die exakten Wissenschaften," Einheitswissenschaft 6 (1938): 17–34. "The Conceptual Focus of Some Psychological Systems," Journal of Unified Science (Erkenntnis) 8 (1939); "Points of View," in *Encyclopedia of Psychology*, ed. P. L. Harriman (New York, 1946); *Systematic and Representative Design of Psychological Experiments, With Results in Physical and Social Perception* (Berkeley, 1947).

Kurt R. Fischer, *Wahrnehmung und Gegenstandswelt. Zum Lebenswerk von Egon Brunswik* (Vienna/New York: Springer, 1997).

39. E. C. Tolman and E. Brunswik, "The Organism and the Causal Texture of Environment," Psychol. Rev. 42 (1935). E. C. Tolman, *Purposive Behavior in Animals and Men* (Berkeley, 1949).

E. Brunswik, "Representative Design and Probabilistic Theory in a Functional Psychology," in Psychol. Rev. 62 (1955); *Perception and the Representative Design of Psychological Experiments* (Berkeley and Los Angeles; University of California Press, 1956).

40. T. Adorno, E. Frenkel-Brunswik, D. A. Levinson, and R. N. Sanford, *The Authoritarian Personality* (New York: W.W. Norton, 1993); J. Grant, ed. *Else Frenkel-Brunswik: Selected Papers* (Springfield, IL: Charles C. Thomas, 1974).

41. E. Brunswik, *The Conceptual Framework of Psychology* (Chicago, 1952).

42. E. Haschek, *Quantitative Beziehungen in der Farbenlehre* (Vienna, 1927). L. Kardos, "Die Konstanz phänomenaler Dingmomente. Problemgeschichtliche Darstellung," in *Bühler-Festschrift* (Jena, 1929); "Ding und Schatten," additional vol. 23, Z. f. Psychol. (Leipzig, 1934).

43. Friedrich Kainz, "Gestaltgesetzlichkeit und Ornamententwicklung," Z. f. angew. Psychol. 28 (1927): 267–327.

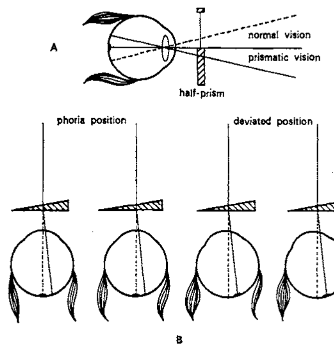
44. E. H. Gombrich, *Art and Illusion*, rev. ed. (Princeton, NJ: Princeton University Press, 1961).

45. E. H. Gombrich and E. Kris, "The Principles of Caricature," 1938. Second edition in E. Kris, *Psychoanalytic Exploration in Art* (New York, 1952). See also E. H. Gombrich and E. Kris, *Caricature* (Harmondsworth: Penguin, 1940).

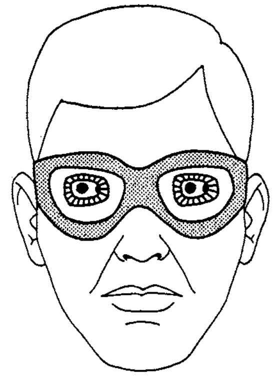
46. E. Brunswik and L. Reiter, "Eindruckscharaktere schematisierter Gesichter," Z. f. Psychol. 142 (1937): 67–134; E. Brunswik, *Perception and the Representative Design of Psychological Experiments*, 2nd ed. (Berkeley: University of California Press, 1956), p. 115.

47. Gombrich, *Art and Illusion*, see note 44.

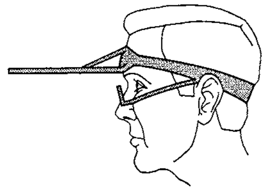
48. T. Erismann, "Wesen und Entstehung der Scheinbewegung," Arch. f. ges. Psychol. 100 (1938); *Allgemeine Psychologie III* (Göttingen, 1962). Ivo Kohler, "Über Aufbau und Wandlungen



The optical arrangement of Kohler's "half prisms":
A. Side view of the upper and lower sections of the half prism.
B. If the upper section of the image falls on the fovea, the lower section is displaced; if the lower section of the image falls on the fovea, the upper section is displaced.



Kohler's prism glasses, which allows right-left inversion of vision.



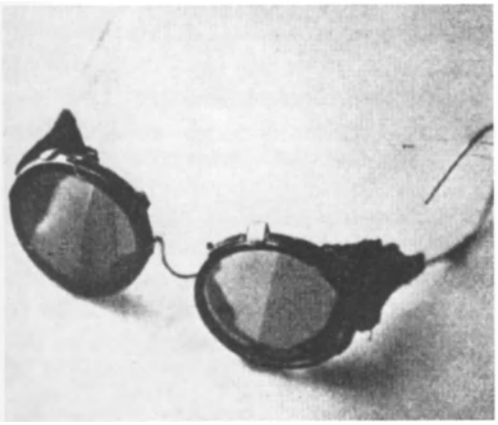
Reverse mirror; Kohler's mirror headdress, which produces top-bottom inversion of vision.

technological twists, distortions, and inversions of the visual field: he and his test subjects wore special glasses, prisms, and mirrors.[48] Erismann helped Kohler build the optical instruments with which the visionary field was turned from left to right and upside-down. They also built devices that allowed the user to only look up or over his shoulder while at the same time navigating his surroundings.

We know that the eye receives images of the world in reverse and that the brain compensates for this inversion. The brain "repairs" the false, inverted pictures that the eye brings to us. We see the world of objects right side up and upright, although the eye does not. The brain adjusts the received images with the help of mental mechanisms to fit the experience of other bodily senses. In these experiments, the rotations and shifts of the field of vision were again distorted through the inversion glasses, so subjects moved in an inverted world until they became used to it and once again saw "correctly." These prism glasses were worn between six and ten days, or even as long as twenty-four to thirty-seven days, during which subjects were artificially returned back to an early stage of the development of visual powers. After putting on the glasses the perceived world, at first upside-down, righted itself in four to nine days, depending on the subject. Eventually it worked so perfectly that subjects could ski or ride a bike in city traffic unimpeded by the glasses. After taking off the glasses, the world, as expected, looked upside-down once again but returned to normal much more rapidly.

Through this, the process of perceptual development could be observed, as it was assumed that the mechanisms that led to the adjustment to a disorienting situation were the same as those that define normal perceptual development. During the adjustment time to the inversion, objects were seen again "correctly," but not letters — for example, writing on the sides of buildings — which appeared as in a mirror. Several subjects broke off the tests because they became dizzy and depressed. At first the subjects needed assistants to help them navigate daily life. Kohler's experiments on adjusting to inversion glasses, published at the beginning of the 1950s, showed that internal models of the environment can be modified through experience. The organization of data is changeable. It does not appear necessary to theoretically presume a constructive organizational process between stimulation and perception, as gestalt theory does, but rather, perception processes could be explained through mechanisms of adaptation, conditioned reflexes and learning.[49] Beyond that, the experiments showed that no insurmountable barriers exist between the diverse sense modalities, for example, perception and movement; on the contrary, they can be synchronized. There is an interesting film by Erismann and Kohler that shows these experiments.[50] Incidentally, Kohler, together with Erika Kohler and Marina Grover, translated the classic work of James J. Gibson, *The Senses Considered as Perceptual Systems* (1966), into German [as Die Sinne und der Prozess der Wahrnehmung (Bern, 1973)].

Also in the 1950s, Theo Hermann analyzed and summarized in a methodological treatise the radical change from the elementary and association psychology of the nineteenth century to the holistic and gestalt psychology of the twentieth century.[51] He discusses the gestalt principles of biology, the gestalt perception of animals, the holistic moments in purposeful behavior, and the value of meaning in social relations of animals as investigated by Lorenz, Tinbergen, and Uexküll.[52] The economist Friedrich von Hayek also made an attempt as a perception psychologist when he published *The Sensory Order* (Chicago, 1952).

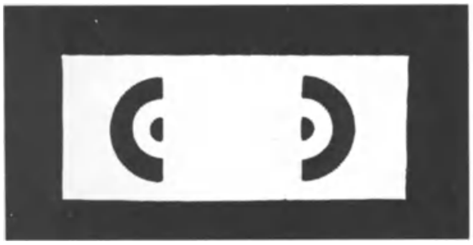


Glasses with "colored half-discs," after I. Kohler. On both sides, the left half is blue; the right half, yellow.

Brimmed cap with mirror, which turns everything upside-down (after I. Kohler)

Gaetano Kanizsa

From Trieste and of Hungarian origin, Gaetano Kanisza (1913–1992) continued the scientific investigation of the subjective – that is, illusory contours of apparent edges, borders, and contours that are not real but are perceived by our sense of sight. Schumann first determined the existence of illusory contours in 1900.[53] Kanizsa put forward as explanation the hypothesis of completion or the inclination of the sense of sight to complete incomplete elements and open figures in the visual field. At the end of his well-known article from 1976,54 he refers to a further example for the perception of contours in insufficient levels of brightness, namely to the scattered dot pattern developed by Béla Julesz in 1960,55 the so-called random-dot stereogram.



The first published "pseudo contour," 1900 (after F. Schumann)

B.N. Kompaneysky, *Random-dot-stereogram*, 1939

Béla Julesz

A random-dot stereogram (RDS) shows three-dimensional forms and contours under a stereoscope. The RDS produces an illusory depth perception that creates three-dimensional pictures hidden in a field of dots. This stereogram from randomly distributed dots has no depth if looked at with the naked eye but under a stereoscope, three-dimensional forms and contours are visible. Benussi had already pointed out the stereokinetic effect, the connection between movement and depth perception, in 1912. Stanley Coren, in 1972, formulated the hypothesis that the perception mechanism that brings forth subjective contours and forms is the same as the one that makes three-dimensional depth perception possible.[56] The work from Julesz on spatial perception go back to that of Charles Wheatstone[57] (1838) and Boris Kompaneysky, who, in 1939, published two fields of randomly distributed dots[58] in which faces of Venus were hidden. Julesz needed computers for the production of his clever stereograms of imperfectly corresponding dots. His student and assistant, Christopher W. Tyler, produced the first automatic stereogram in 1979 with an Apple II computer and the BASIC programming language. Auto-stereograms are computer-generated stereograms that can be seen without gadgets, in which only one picture instead of two are necessary for the production of stereo vision.[59] The Japanese graphics designer Masayuki Ito, in the wake of Julesz, developed a single-image stereogram in 1970. These single-image stereograms became more and more popular in the 1990s as "magic images."

Alfons Schilling, originally from Switzerland, moved to Vienna at the end of the 1950s, and was associated with the initial phases of Viennese Actionism as an "informal" painter. From 1962–1986 he lived

der Wahrnehmungswelt insbesondere über bedingte Empfindungen," Gest. Akad. Wiss. Phil. Hist. Klasse. Sitzungsber 1 (1951): 22; "Warum stehen wir aufrecht?," Die Pyramide 2 (1951): 30–33; "Umgewöhnung im Wahrnehmungsbereich," Die Pyramide 3 (1953); "Experiments with Prolonged Optical Distortion," Acta Psychol. 2 (1955): 176ff; "Experiments with Goggles," Scientific American 206 (May 1962): 65–72; "Anpassung der Wahrnehmung an fehlerhafte Gläser," 14, special printing of the Wiss.-Vereinigung der Augenoptiker (Mainz, 1964); "Die Zusammenarbeit der Sinne und das allgemeine Adaptationsproblem," in *Handbuch der Psychol., vol. 1*, 1st half (Göttingen, 1966).

49. H. Werner and S. Wapner, "The Innsbruck Studies on Distorted Visual Fields in Relation to an Organismic Theory of Perception," Psychol. Rev. 62 (1955): 130–138. L. Spillman and B. Wooten, eds., *Sensory Experience, Adaptation and Reception, Book in honor of Professor Ivo Kohler* (Hillsdale, NJ: Erlbaum, 1984).

50. T. Erismann andl. Kohler, "Upright Vision through Inverting Spectacles," Psychol. Cinema Reg. No. Penn. State College (1953): 2070.

51. Theo Herrmann, "Problem und Begriff der Ganzheit in der Psychologie" Österreich Akad. d. Wiss. Phil. hist. Kl. Sitzb. 3. Abh. (1957): 231; "Der Methodendualismus in der Psychologie," Jahrbuch f. Psychol. u. Psychother. (1958).

52. Konrad Lorenz, "Ganzheit und Teil in der tierischen und menschlichen Gemeinschaft," Studium Generale 3 (1950); "Gestaltwahrnehmungen als Quelle wissenschaftlicher Erkenntnis," Z. f. exp. und ang. Psych. 6 (1959); *Studies in Animal and Human Behavior* (Cambridge: Harvard University Press, 1974). N. Tinberger, *The Study of Instinct* (Oxford: Oxford University Press, 1951). J. von Uexküll, *Streifzüge durch die Umwelt von Tieren und Menschen* (Hamburg, 1955).

53. F. Schumann, "Beiträge zur Analyse der Gesichtswahrnehmungen," Z. für Psychol. I, 23 (1900): 1–32, II, 24 (1900): 1–33, III, 30 (1902): 241–291, IV, 36 (1904): 161–185.

Leopold Szondi, *Experimental Pyschology Test*, 1947

Kurt Kren, ***2/60 48 Köpfe aus dem Szondi-Test (2/60 48 Heads, from the Szondi Test)*** © VBK, Vienna, 2005

in New York and experimented quite early with different lenses, self-constructed cameras, and instruments to create 3-D stereo systems – all with the goal of artificially expanding the field of perception. He occasionally worked as a cameraman for the video artist Woody Vasulka. Unlike to Julesz, he decided to develop his own method for 3-D stereogram by painting directly on the canvas without the help of a computer. In 1973 he drew pictures for the left and right eye that consisted of dots and spots to produce stereoscopic effects of illusory depth perception. In 1974 he produced a handmade single-image stereogram (from C. W. Tyler). He also went on to produce vision machines with prisms with which color and black and white pictures on the wall created an amazing appearance of depth in color and black and white (figures, geometric shapes) and stereokinetic effects.

This meeting between the Hungarian Julesz and the Austrian Schilling also had an amazing counterpart from ten years earlier: the Austrian film maker Kurt Kren used optical test material from 1947 from the Hungarian experimental psychologist **Lipót (Leopold) Szondi**[60] to create a moving film from still shots, the famous *Szondi-Test* (1964). With this film, Kren completed the transformation from cinematography as the language of movement to opseography as the language of vision, and with that transformed the art of movement into the art of perception. A perception test, an experimental perception situation, became a work of art.

At the beginning of the 1940s, **Friedrich Kiesler** drafted his *Vision Machine*. In 1927 he had also sketched a telematically networked telemuseum in which pictures could be seen in other museums. Kiesler also propagated machine-supported perception similar to that which Schilling later took up.

My drawing shows the two ways in which painting and sculpture will contribute to future interior design: 1. Light-sensitive plates will serve as receiving screens for sent pictures. 2. Original masterpieces will be kept in built-in "shrines" sunk into the walls and will be only occasionally revealed. The use of pictures as permanent wall decorations will cease.[61]
The Telemuseum
Just as operas are transmitted by wireless, this will also happen with picture galleries. From the Louvre, the Prado to you, from everywhere to you. You will enjoy the privilege of choosing any picture which fits your mood or the needs of a certain situation. With the help of the dial on your teleset you will be a partner in the greatest treasures of the world.[62]

This area of research has been historically established, from Kiesler right up to the Innsbruck studies on distorted fields of vision – that is, changing perception using analog devices (prisms, inversion glasses, mirrors) and digital machines, and exploiting the laws of perception to create two- and three-dimensional illusions. The linking of experiments with illusory movement and illusory forms on the one hand and inversion glasses and vision machines on the other led directly to the ideas of cyberspace. Oswald Wiener's essay on the cybernetic *Bioadapter*,[63] a first explicit model of the data-suit, Walter Pichler's TV-helmets and radio-vests, and Peter Weibel's imaginary spaces of perspective-oriented, closed-circuit video installations, are clear precursors to cyberspace.

Walter Pichler, *Man on a Leash with TV Helmet, Radio Vest, Standard Suit, and Fingers Spread*, 1967

Alfons Schilling with his vision machine, *Excavated Bird*, 1986

54. G. Kanizsa, "Subjective Contours," Scientific American 234 (1976): 48–52; "Margini quasi - percettivi in campi con stimulazione omogenca," Rivista di Psicol. 49 (1955); "Randform und Erscheinungsweise von Oberflächen," Psychol. Beiträge 5 (1960); "Amodale Ergänzung und Erwartungsfehler des Gestaltpsychologen," Psychol. Forsch. 33 (1970); *Organization in Vision: Essays on Gestalt Perception* (New York: Prager, 1979).
55. B. Julesz, "Binocular depth perception of computer-generated patterns," Bell Technical Journal 39 (1960); "Binocular depth perception without familiarity cues," Science 145 (1964); *Foundations of Cyclopean Perception* (Chicago, 1971).
56. S. Coren, "Subjective Contours and Apparent Depth," Psych. Review 79 (1972): 359–367.
57. Charles Wheatstone, "Contributions to the Physiology of Vision. 1. On Some Remarkable, and Hitherto Unobserved Phenomena of Binocular Vision," in *Philosophical Transactions* (London: Royal Society of London, 1838). David Brewster, *The Stereoscope. Its History, Theory and Construction* (London, 1856).

VII. Neuropsychology and Cognitive Science

In 1894, in the spiritual tradition of Mach and psychophysical parallelism, the Viennese physiologist **Sigmund Exner** delivered decisive models of thought and vision in that he led psychic manifestations back to the framework and networking of the nerve center, thereby anticipating the later analyses of the perception process done by Donald Hebb in *The Organization of Behavior* (1948) and thus anticipated the cognitive neurosciences.[64]

The first explicit representation of a neural network is found in the text *Untersuchungen zu einer physiologischen Erklärung der psychischen Erscheinungen* [Investigations on a physiological explanation of psychic manifestations] (1894) by Exner (pp. 3 and 225):

> *I view it as my duty to lead the most important psychic manifestations back to the levels of excited states of the nerves and nerve centers, according to which everything that appears as diverse in our consciousness can be traced back to quantitative relationships and the diversity of the central connections of otherwise very similar nerves and centers.*

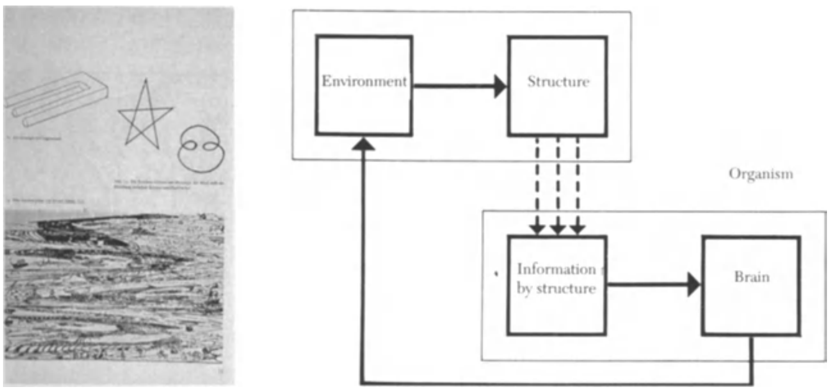
The activation of certain nerve tracts and neuron populations forms the sensations.

> *All manifestations of the qualities and quantities of conscious sensations, perceptions, and ideas can be traced back to quantitatively variable portions of the totals of these tracts. Two sensations are the same for consciousness when the same cortical tracts are stimulated to the same degree. Two sensations are similar when at least a part of the stimulated cortical tracts is identical in both cases.*

Olaf Breidbach wrote in *Die Materialisierung des Ichs. Zur Geschichte der Hirnforschung im 19. und 20. Jahrhundert* [The materialization of the self: On the history of brain research in the nineteenth and twentieth centuries) (1997, pp. 28–29):

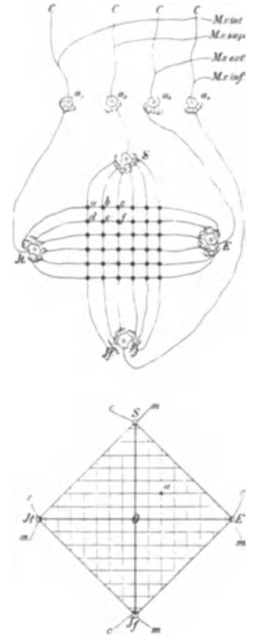
> *In connection with this, Exner sketched in detail the internal representation of spatial coordinates of visual perception. Starting from a detailed description of this perception situation, he formalized his idea of the overlapping of stimulation phases in a topologically strictly defined neuron structure and thereby succeeded in formulating the concept of a neuronal network.*

In this complexly bound architecture of neuronal contacts, there are also self-references and reflexive systems and the phenomena of "modulation" and "pathing," whereby cascades of associational processes arise as functions of interneuronal contacts.



Heinz von Foerster, "Vom Reiz zum Symbol," ***Zeichen, Bild, Symbol, sehen + werten*****, György Kepes, ed., Brussels: La Connaissance, 1972, pp. 55, 57**

The shift from gestalt theory through perception psychology to cognitive psychology — thus the shift in research interests from the physiological and psychological factors to the cognitive, from factors achieved by the brain in perception — cannot be more clearly shown than it was by **Heinz von Foerster**. After the publication of a quantum mechanics model of thought, he moved to the U.S. in 1948, where he became a cofounder of cybernetics and editor of the protocols of the Macy Foundation, *Cybernetics: Circular Causal and Feedback Mechanisms* (5 volumes, 1949–1953). In 1958, he founded the Biological Computer Laboratory



Representation of a neural network (Exner, 1894, p. 193)

58. B. N. Kompaneysky, "Depth sensations. Analysis of the theory of simulation by non exactly corresponding points," Bulletin of Ophthalmology (USSR) 14 (1939): 90–105 (in Russian).
59. C. W. Tyler, "Sensory processing of binocular disparity," in *Vergence Eye Movements. Basic and Clinical Aspects*, ed. L. M. Schor and K. J. Ciuffreda (London, 1983).
60. L. Szondi, *Lehrbuch der experimentellen Triebdiagnostik*, 3 vols. (Bern: Huber, 1972); *Szondi Test: In Diagnosis, Prognosis, and Treatment* (Philadelphia: Lippincott, 1959).
61. F. Kiesler, *Contemporary Art Applied to the Store and its Display* (New York, 1930), p. 110.
62. F. Kiesler, *Contemporary Art Applied to the Store and its Display*, op.cit., p. 121.
63. O. Wiener, *die verbesserung von mitteleuropa. roman* (Hamburg, 1969).
64. Sigmund Exner, *Untersuchungen über Localization der Functionen in der Grosshirnrinde des Menschen* (Vienna, 1881); *Untersuchungen zu einer physiologischen Erklärung der psychischen Erscheinungen* (Leipzig/Vienna, 1894); D. Hebb, *The Organization of Behavior: A Neuropsychological Theory* (New York: John Wiley & Sons, 1949).

at Illinois State University. As a continuation of his psychophysical program, he published a series of writings about the construction of realities, self-organizing systems, observed systems, and cognitive processes in perception. In this series he developed an operative theory of knowledge put together from elements of physiology, information theory, perception theory, technology, and epistemology. This system he called Constructivism,[65] and he defined it as "an epistemology of the observed, signifying that the observer and observed are inseparably connected" (Von Foerster). Von Foerster transferred the cybernetic theory of cyclical causal chains to the epistemology: "knowledge or the process of the expansion of knowledge as a recursive calculation."[66]

In the essay "From Stimulus to Symbol: The Economy of Biological Computation," which appeared in *Sign, Image, Symbol* (1966) in the series *Vision and Value* (George Braziller, New York 1966), edited by György Kepes, Von Foerster explained the function of perception in cognitive processes by analyzing, for example, precisely those neuronal procedures that change signals into visual meanings, thus the course of information between an organism and its surroundings.

Ernst von Glasersfeld, an Austrian born in Munich in 1917, who later went to the U.S. in 1966 and became professor of cognitive psychology in 1970, is acknowledged as the second founder of "radical constructivism," according to which cognition is the creation or invention of reality.

The title of a 1979 essay by John Richards and Ernst von Glasersfeld, "The Control of Perception and the Construction of Reality," shows pointedly that in the theory of Constructivism, there is a great amount of perception in the construction of reality because as Von Foerster states, "an observing organism is itself part, partner, and participant of the observed world." Therefore, the whole appearance and illusion potential of perception is brought into reality. It is thus that reality is separated into real or fictive elements, as expressed in the title of two books by the third Austrian founder of Constructivism, **Paul Watzlawick**: *How Real Is Real?* (1976) and *Invented Reality* (1981).[67]

The Austrian founder of biological systems theory, **Ludwig von Bertalanffy**, worked at the University of Vienna from 1934 to 1948; he was de-Nazified and became active in Ottawa, Canada from 1949 and from 1955 in the U.S. (from 1969 as professor at the State University of New York in Buffalo). He also wrote (in the same volume of the Kepes series) about symbol systems, *The Tree of Knowledge*. In one of his later works, *Robots, Men and Minds* (1967), Bertalanffy also expanded psychology with cybernetic and thermodynamic concepts (from N. Wiener to I. Prigogine).[68]

Perception physiology, which Mach had furthered through his work on the ear (the discovery of the balance functions in the inner ear), was carried further by **György von Békésy**, who developed Mach's discovery of the inhibiting sense phenomenon as demonstrated by the example of the Mach bands. Békésy expanded the function of the Mach bands to other sensory areas and in 1928 discovered inhibiting effects in the inner ear for which he received the Nobel Prize in 1961. Over the years he applied his inhibition theory to all of the senses. In 1961 he published the book *Experiments in Hearing* and in 1967, *Sensory Inhibition*. Another Hungarian, **János Szentágothai**, made significant contributions to experimental brain research and with that, contributed to the definition of the brain as a neuronal machine.[69]

In Austria, **Giselherr Guttman** drafted a neuropsychology of perception,[70] an area of research which flourished abroad as cognitive science. Two Austrians, Peter Baumgartner and Sabine Payr, are responsible for keeping track of the success of this Austrian export in the U.S. and for remembering the Austrian forerunners to cognition theory.[71]

The previously mentioned author, **Oswald Wiener**, also delivered contributions to cognitive research over the past thirty years, in that he laid out a theory of the creation and function of imaginary images.[72]

Perception and motion are distinguished as problem areas in the art of the twentieth century. Hungary and Austria have offered outstanding contributions to these areas. The Hungarian contributions by the golden foursome: Moholy-Nagy, Kepes, Vasarely, and Schöffer are well known throughout the world. The contribution of Austria has remained relatively unknown (apart from Kiesler, although it is not well known that he is actually an Austrian since he lived in New York from 1927 to 1965).

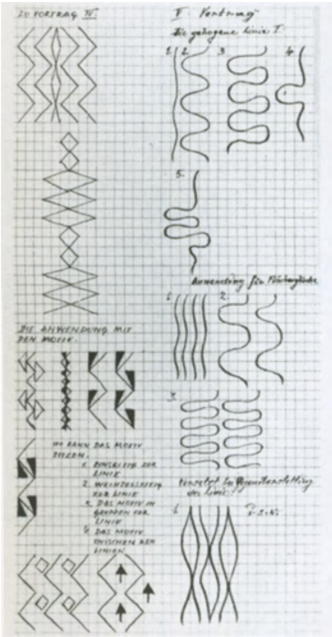
The following is a step-by-step attempt to present, for the first time, a coherent picture of the development of perceptual and motion art in Austria and Hungary.

65. Lynn Segal, *The Dream of Reality: Heinz von Foerster's Constructivism* (Vienna/New York: Springer, 2001).
66. H. v. Foerster, "Kybernetik einer Erkenntnistheorie," in *Kybernetik und Bionik* (Oldenburg, 1974); "Circuitry of Clues to Platonic Ideation," in *Aspects of the Theory of Artificial Intelligence* (New York: Plenum, 1960); *Understanding Systems: Conversations in Epistemology and Ethics* (New York: Plenum, 2002); *Understanding Understanding: Essays on Cybernetics and Cognition* (New York: Springer, 2002).
67. E. v. Glasersfeld and J. Richards, "The Control of Perception and the Construction of Reality," Dialectica 33, no.1 (1979): 37–38; E. v. Glaserfeld, *Radical Constructivism: A Way of Learning* (London: Routledge/Falmer, 1996); P. W. Thompson, *Radical Constructivism in Action: Building on the Pioneering Works of Ernst von Glasersfeld* (London: Routledge/Falmer, 2000); P. Watzlawick, *Invented Reality. How Do We Know What We Believe We Know?* (New York: W.W. Norton, 1984); *How Real Is Real? Confusion, Disinformation, Communication* (New York: Random House, 1977).
68. L. v. Bertalanffy, *General System Theory: Foundations, Development, Applications* (New York: George Braziller, 1976); *Robots, Men, and Minds: Psychology in the Modern World* (New York: George Braziller, 1969).
69. M.A. Arbib, P. Érdi, and J. Szentágothai, *Neural Organization: Structure, Function, and Dynamics* (Cambridge, MA: MIT Press, 1997).
70. G. Guttman, *Einführung in die Neuropsychologie* (Bern: Huber, 1972).
71. P. Baumgartner and S. Payr, *Speaking Minds. Interview with Twenty Eminent Cognitive Scientists* (Princeton, NJ: Princeton University Press, 1995).
72. O. Wiener, *Schriften zur Erkenntnistheorie. 1965-95* (Vienna/New York: Springer, 1996).

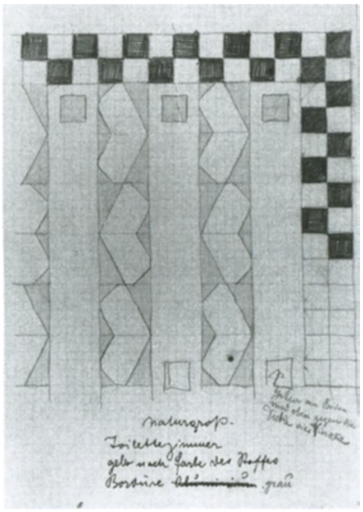
1

Peter Weibel

The Abstract Ornament and the Quadratic World of the Wiener Werkstätte around 1900



Formenlehre IV (teaching of forms), c. 1900

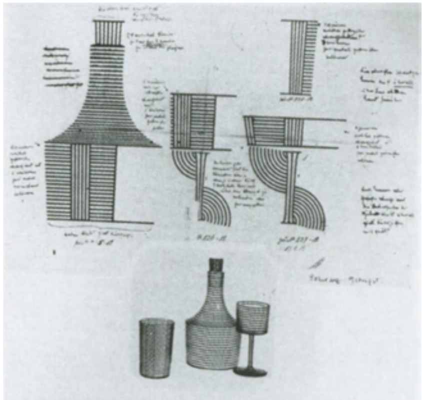


Josef Hoffmann
Sketch for a curtain

Felicien Freiherr von Myrbach among his students, 1902

Koloman Moser, *Foehn*, 1899

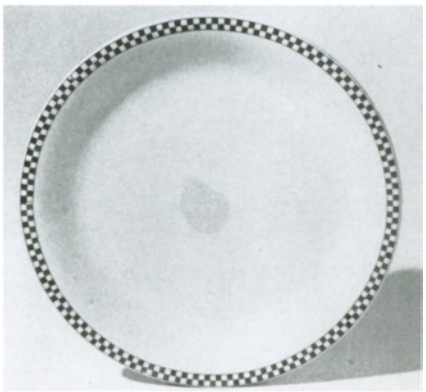
Josef Hoffmann, *Purse*, c. 1910



Josef Hoffmann
Service of glasses with carafe
(design and product)

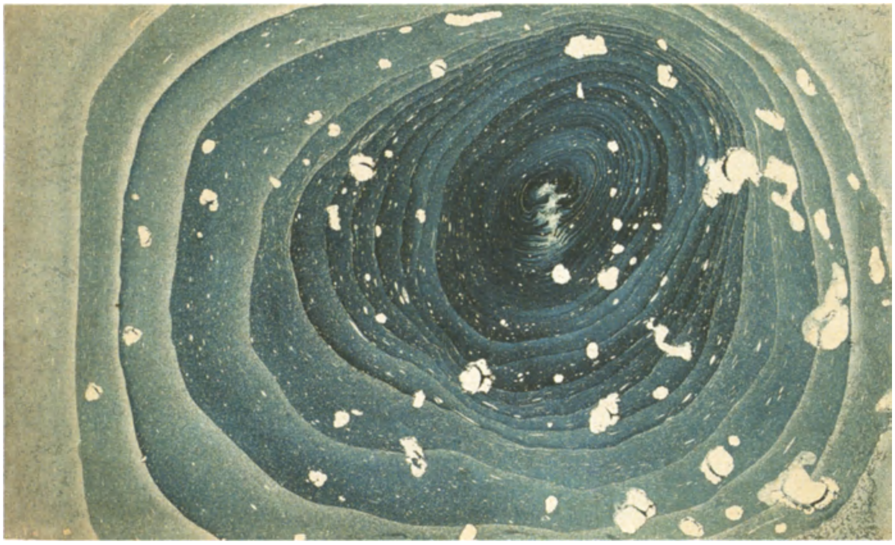
Adolf Hölzel
Abstract Ornament, c. 1900

Adolf Hölzel, *Composition*, 1911

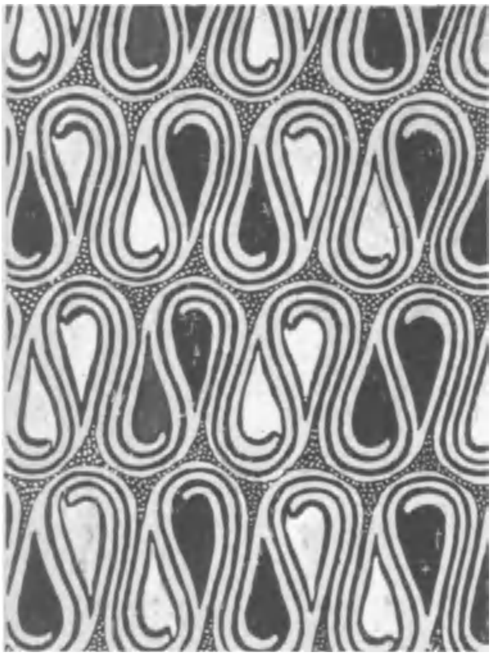


School Koloman Moser
Plate, c. 1902

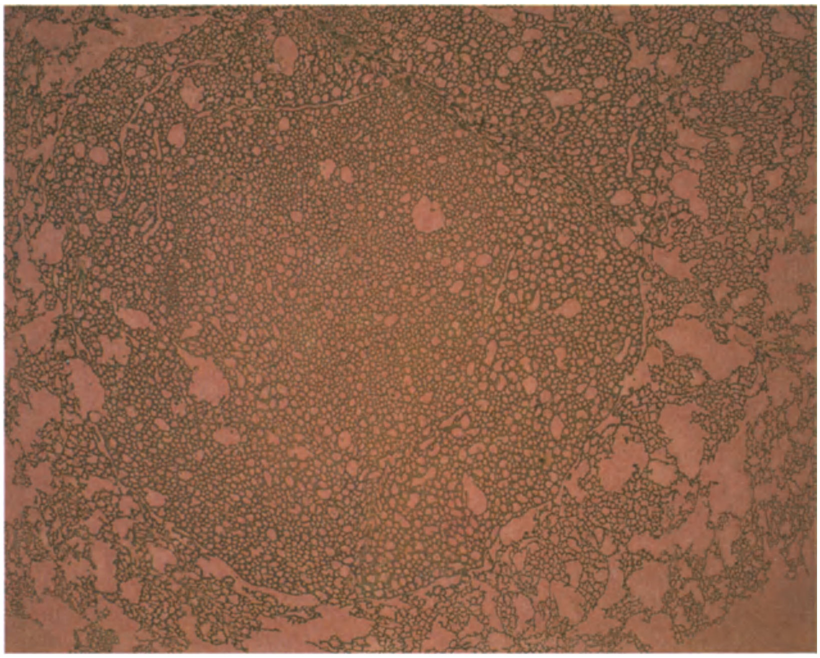
Ernst Stöhr, sketch for *Ver Sacrum*, 1899
Ink on paper, 30 × 25 cm



Leopold Stolba, *Untitled, (Whirling Form)*, 1904-06
17 × 27.5 cm

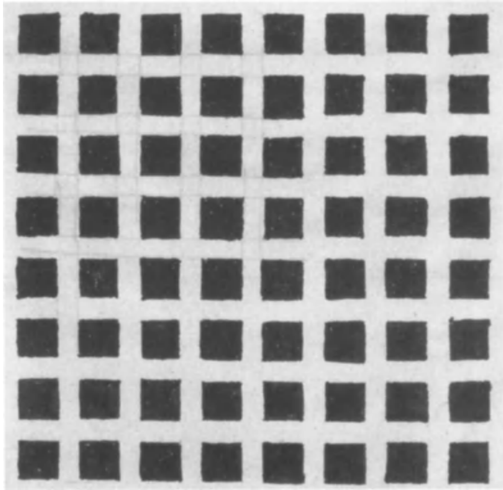


Koloman Moser
Sketch for floor covering *Meauquettes-weaving*, 1899
Indian ink, transparency paper, mounted on cardboard, 20 × 17.5 cm

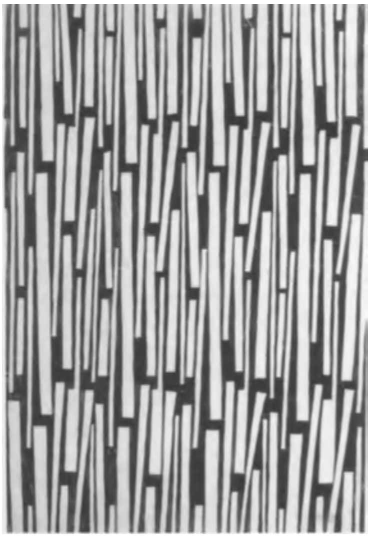


Leopold Stolba
Untitled, (Red Structures), 1904-06
Oil emulsion on paper, 16.5 × 21 cm

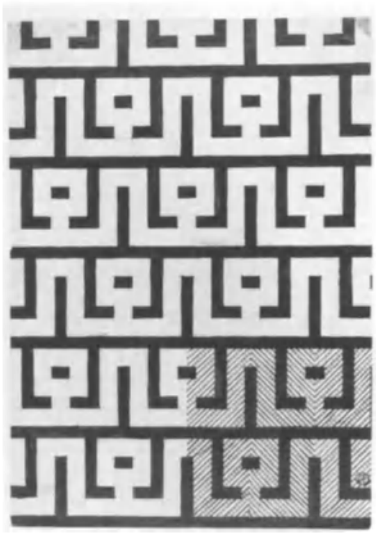
Josef Hoffmann, *Supraporta Relief*, c. 1902
Wood, painted white, 94 × 96 × 15 cm



Josef Hoffmann, *Geometrical Abstraction*, c. 1900
Indian ink on paper, 29.5 × 29.5 cm

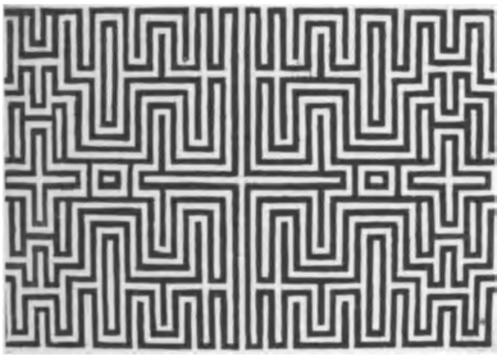


Josef Hoffmann, *Abstract Composition*, c. 1900
Ink, pencil on paper, 42 × 29.6 cm



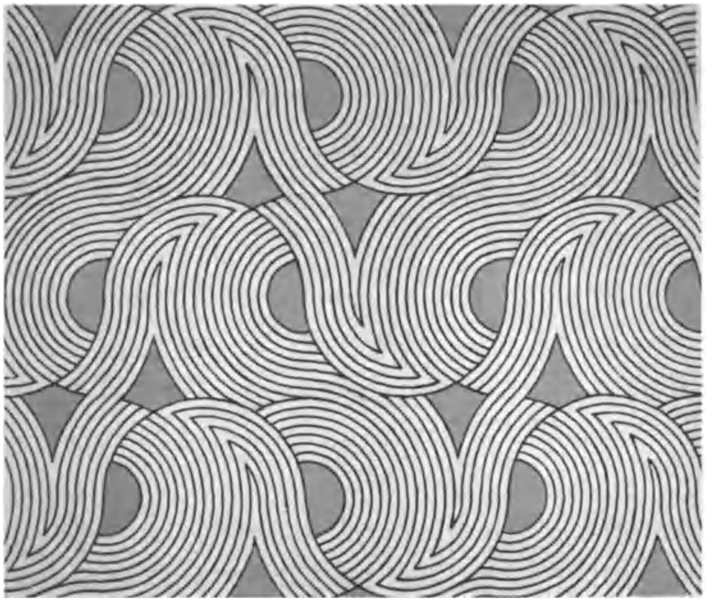
Josef Hoffmann, *Abstract Composition*, c. 1900
Ink, pencil on paper, 29.2 × 21 cm

Josef Hoffmann, *Abstract Composition*, c. 1900
Ink, pencil on paper, 29.2 × 21 cm



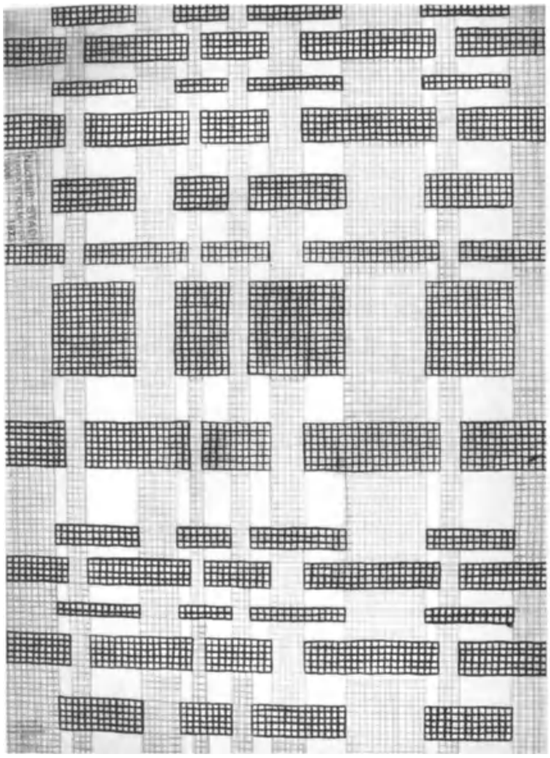
Josef Hoffmann, *Abstract Composition*, c. 1900
Indian ink, pencil, ink, squared paper, 29.9 × 42.2 cm

Josef Hoffmann, *Abstract Composition*, c. 1900
Indian ink, pencil, squared paper, 29.8 × 40.8 cm

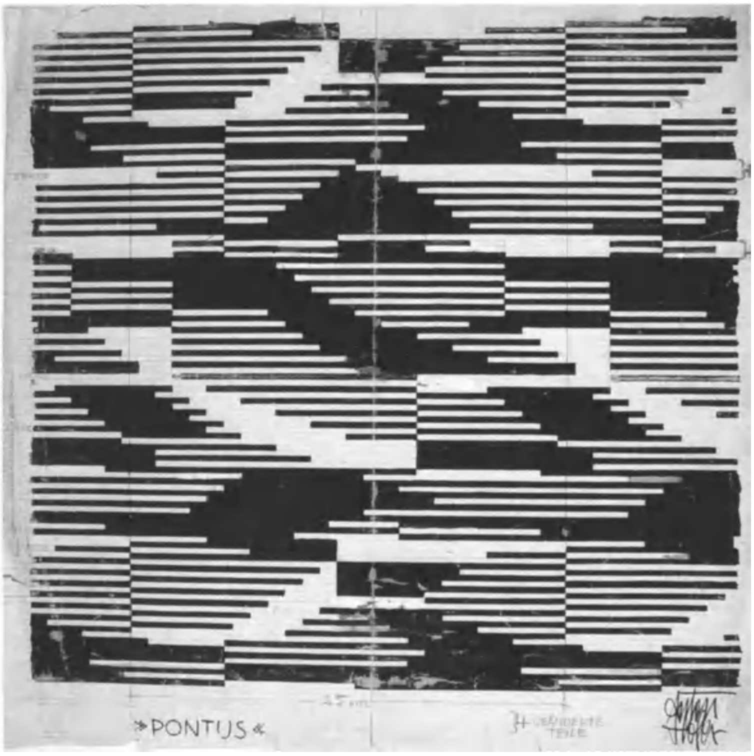


Anton Hofer, *Composition (Wavy Lines)*
Indian ink, opaque water color on paper, 48 × 56 cm

Anton Hofer, *Agata (Plane Ornament)*
Indian ink on cardboard, 50 × 50 cm

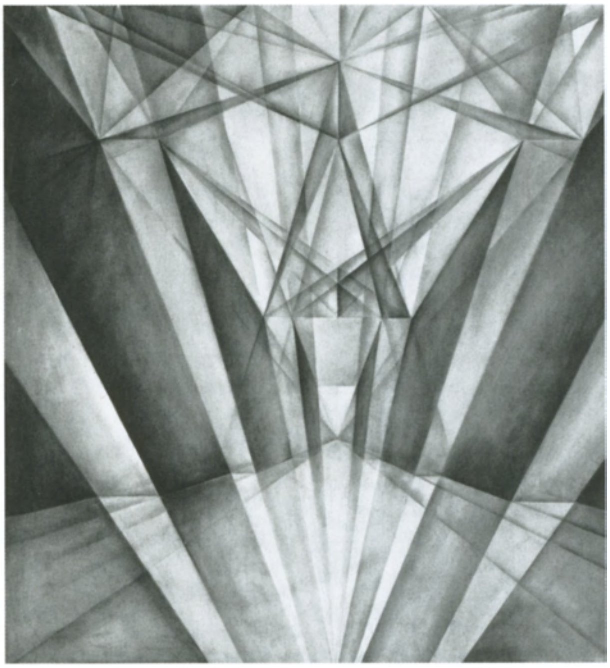


Maria Luzia Stadlmayer-Bieber, *Abstract Composition*
Opaque water color on transparency paper, 58 × 42.5 cm

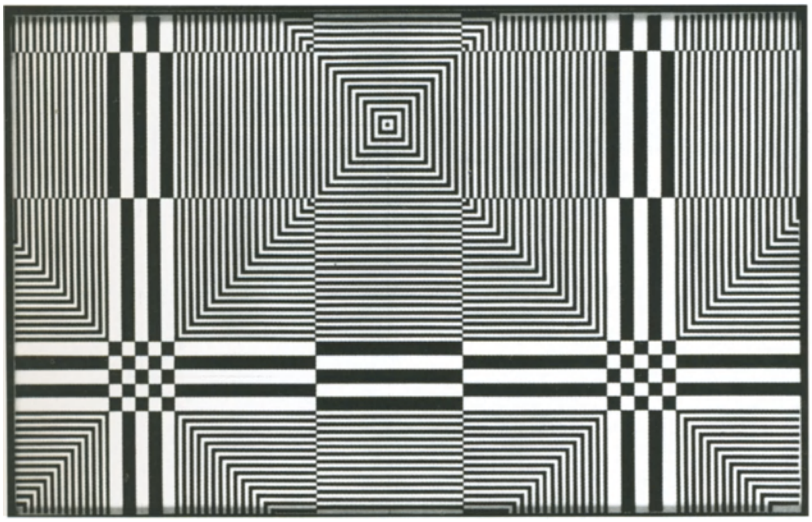


Anton Hofer, *Pontus (Plane Ornament)*
Opaque water color, pencil on cardboard, 43 × 43 cm

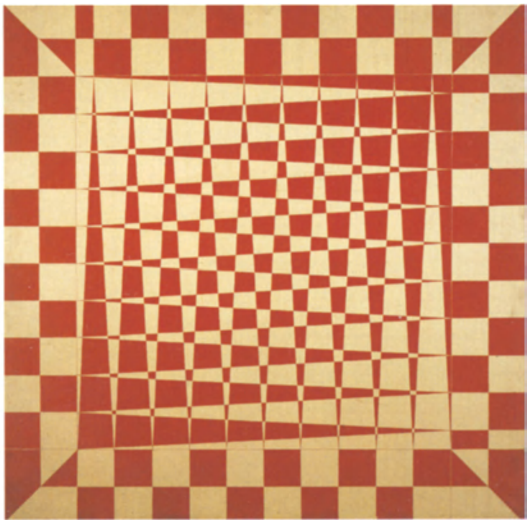
Ilse Bernheimer, *Abstract Composition*, 1913
Tempera on paper, 38 × 39.5 cm



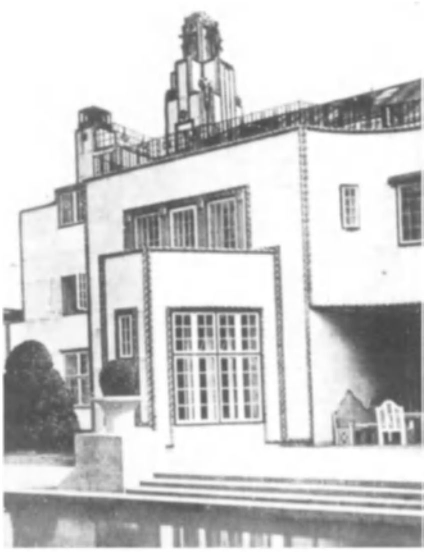
Otto Erich Wagner, *Untitled*, c. 1923-25
Graphite on paper, 101 × 100 cm



Anton Hofer, *Gizeh*, 1936
Indian ink on paper, 39 × 63 cm

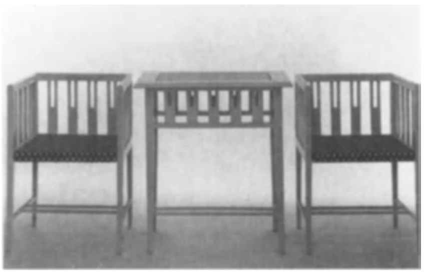


Friedrich von Berzeviczy-Pallavicini, *Composition*, 1932
Tempera on paper, 140 × 140 cm



Josef Hoffmann, *Palais Stoclet*, Brussels, 1905-11

Josef Hoffmann, *Flowerbowls*, c. 1905

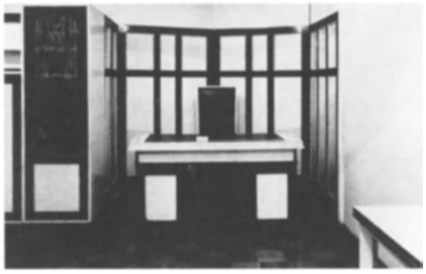


Fritz Zeymer, *Chairs and table*, 1910

Josef Hoffmann, *Dining Room, house of Dr. Hans Salzer*, Vienna 1902

Josef Hoffmann, *Sanatorium Purkersdorf*, 1904-06

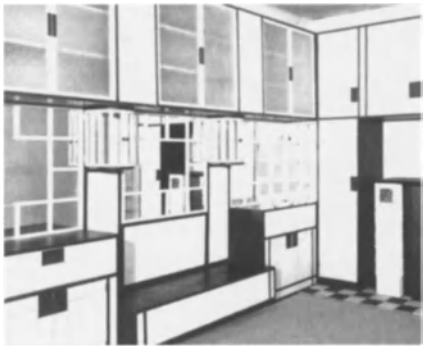
Max Benirschke, *Corner in a library room*, c. 1901



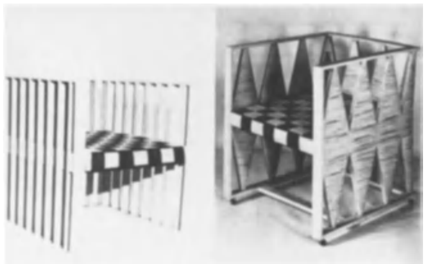
Josef Hoffmann, F. Messner, *Study in Villa Biacy*, Vienna, 1902

Josef Hoffmann, *Dining Room, house of Editha Mautner von Markhof*, Vienna 1904

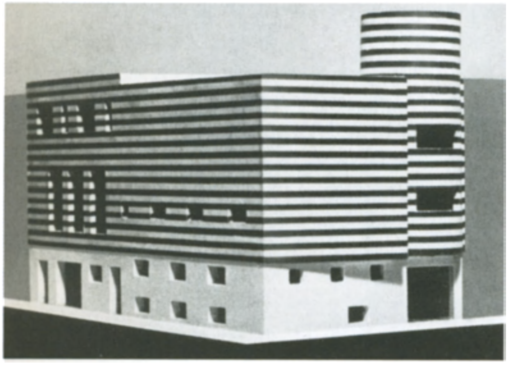
Ludwig Wittgenstein, *Villa Stoneborough*, Kundmanngasse, Vienna, 1927/28



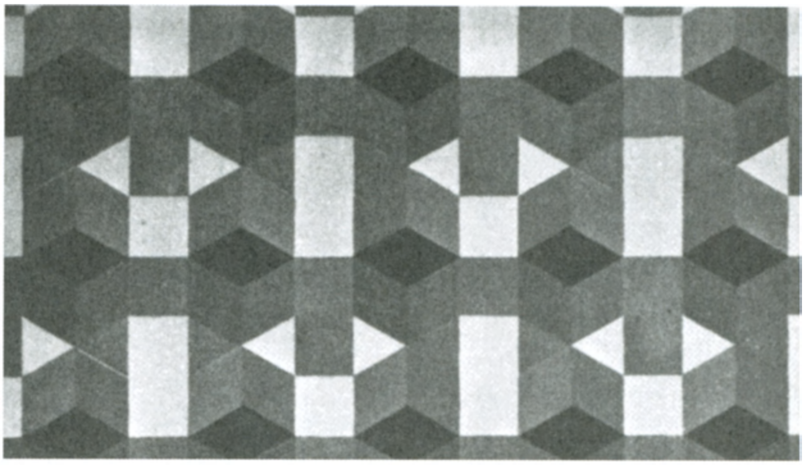
Koloman Moser, *Guest room in his apartment on Hohe Warte*, c. 1902

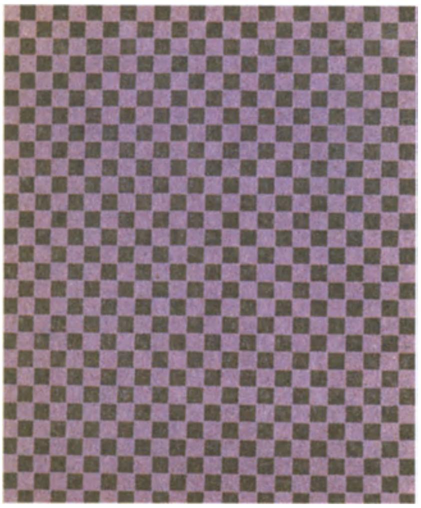


Koloman Moser, *Purkersdorfer chair*, 1903

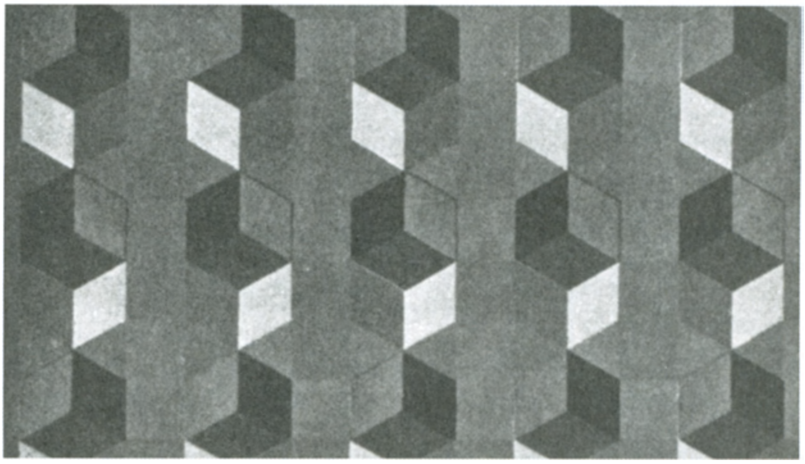


Adolf Loos, *House Project for Josephine Baker,* 1928
© VBK, Vienna, 2005

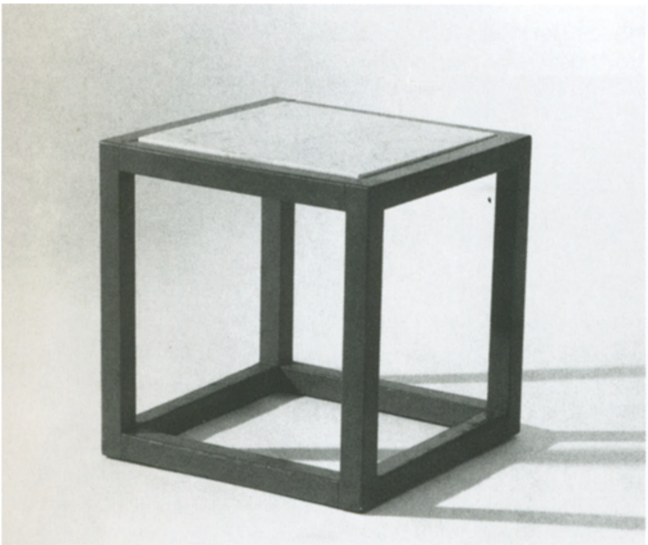




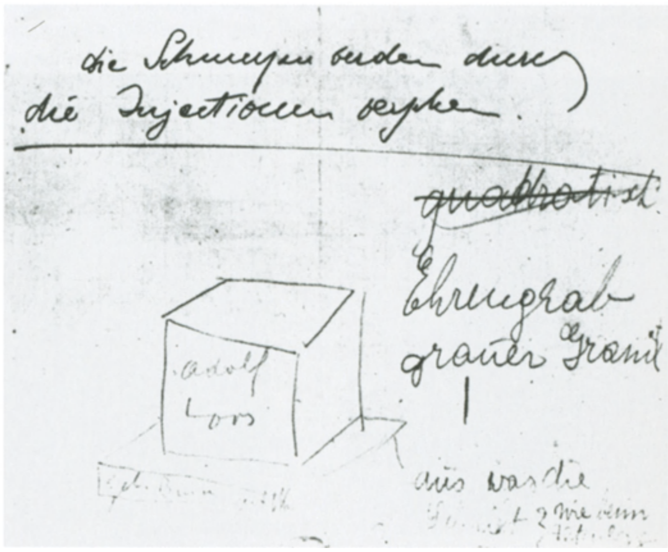
Koloman Moser, *Catalogue Cover,* XIII. exhibition of the Secession, Vienna 1902



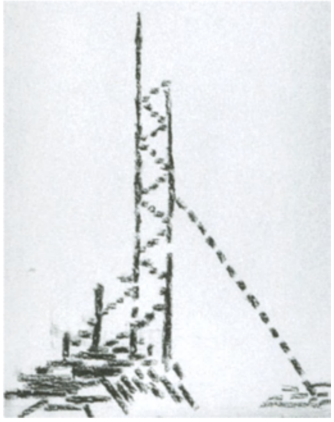
Lily Greenham
Green Cubes in Motion



Josef Hoffmann, *Cubic table*, c. 1904



Adolf Loos, *Sketch for his tombstone*, 1931
© VBK, Vienna, 2005



L.W. Rochowanski, *Rising IV*, 1921
Charcoal on paper, 45 × 31 cm

L.W. Rochowanski
Untitled (Abstraction), 1923
Pencil, gouache on paper
21.5 × 14.5 cm

Leopold Wolfgang Rochowanski, born 1885 in Zuckmantel, Silesia. Studied humanities and at the Faculty of Law at the University of Vienna. Poet, writer, playwright, art writer, and graphic designer. Theater- and art consultant in Berlin, Prague, and Paris. Curator of the exhibition *Modern Austrian Art* in Prague (Klimt, Schiele, Moll, Boeckl et al.), 1908. Publications on A. Hanak, J. Hoffmannn, F. Cizek, Viennese pottery, Viennese youth art. Pen-and-ink drawings (physiognomic character studies), 1944-1945. Founded the Agathon gallery, opening with an exhibition of Franz Cizek's "Viennese Youth Art," 1946. Publisher of the art magazine *Die schönen Künste*, 1946/47. Died 1961 in Vienna.

References:
L.W. Rochowanski, *Der Formwille der Zeit in der angewandten Kunst* (Vienna: Burg, 1922).
B. Leitner, *Rochowanski 1885-1961. Eine Montage*, Academy for Applied Arts, Vienna (Ostfildern: Cantz 1995).

Otto Erich Wagner, born 1895 in Klepacov-Blansko, Moravia. Studied at the Arts and Crafts School in Vienna (F. Cizek, R. Larisch), 1922-1924. From 1924 teaching assistant with Cizek. Taken on as an assistant by C. Kosak, 1935. Teaching assistant with R. Klaus at the workshop for folk and tradition, 1938. Member of Vienna Secession. Besides teaching he worked also as a graphic designer and painter. Participation at the International Arts and Craft exhibition in Paris, 1925. Died 1979 in Vienna.

References:
Otto Erich Wagner (Vienna: Galerie Nebehay, 1985).

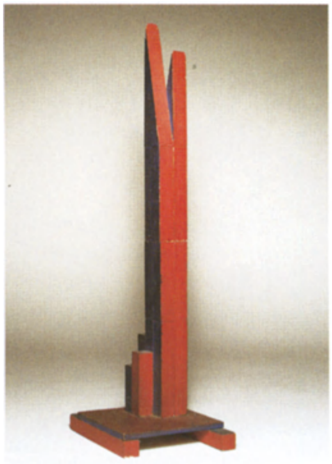
Anton Hofer, born 1888 in Bolzano. Studied at the k.k. Technical College Bolzano, 1901-1905. Studied at Academy for Applied Arts, Vienna (K. Moser). Member of the German Werkbund, 1910. Founding member of the Austrian Werkbund, 1912. Trainee with Franz Cizek, 1912/13. Worked as a designer for interiors, as well as in the field of applied arts. Died 1972 in Bolzano.

References:
Anton Hofer. Ein Leben für künstlerisches Gestalten (Bozen: Südtiroler Künstlerbund, 1978).

Erika Giovanna Klien, born in Borgo, South Tyrol. Attended Arts and Crafts School in Vienna (with F. Cizek). Encounter with Béla Uitz, 1923. Instructor at New School for Social Research, New York. Design of the *Kinetic Marionette Theater*, 1924. Purchase of works by the Société Anonyme, 1926. Moved to the U.S.A., 1929. Instructor at several art schools following the Cizek-method. Until her death, analysis of the optical conversion of kinetic phenomena. Died 1957 in New York.

Group exhibitions
1925 International Arts and Crafts exhibition, Paris
1926/27 Société Anonyme, New York
1930 New School for Social Research, New York
1931 Art Center, New York

References:
Erika Giovanna Klien, Zeichnungen und Graphik von 1920-1950 (Munich: Galerien Maximilianstraße; Galerie Pabst, 1983).
Erika Giovanna Klien und 10 Künstler des Wiener Kinetismus, (Munich: *Galerie* Pabst, 1986).
Erika Giovanna Klien. 1900-1957 (Vienna: Museum of Modern Art, 1987).



L.W. Rochowanski, *Untitled*, 1925
Wood, 44 × 15.5 cm

Cizek School, *Untitled (At the Lake Genezareth)*
Wood, 32.5 × 48 cm

Cizek School, *Untitled (Sinking)*, 1931
Terracotta, 24 × 22 cm

Bernhard Leitner

Viennese Kineticism

Johanna Reismayer-Fritsche
Kinetic Composition with Letters, c. 1921
Tempera, collage

Viennese Kineticism, which lasted only a few years (from 1920 to 1924), was as notable as it was peculiar: notable for both its institutional framework and creative results; peculiar for its relationship to the European avant-garde of that time. Also, above all, it was notable for its key intellectual figure, Franz Cizek.

Franz Cizek (born 1865 in Leitmeritz, died 1946 in Vienna) led the General Department of Ornamental Form Theory at the Kunstgewerbeschule (Arts and Crafts School) in Fichtegasse (Fichte Alley) in Vienna. He also worked with children, teaching courses he developed himself. It was this work with four- to eight-year-olds (the success of which will not be discussed here) that made him known in the 1920s and 1930s well beyond the borders of Austria — in England, France, and the USA.

The legacy of Kineticism, and with it Cizek's achievements, was significantly more Austrian. The principles that Cizek developed in his department were merely tolerated by the school directors, and the work of his students was (according to oral history) often turned down, ignored, and not taken very seriously by Roller, Hoffmann, Peche, Loeffler, and the other influential powers of the school. With the exception of the work *Formwille der Zeit*[1] — a personal interpretation of the Cizek school with an inventory of ninety-three illustrations, published by L. W. Rochowanski in 1922 — Kineticism was hardly known beyond the confines of the school and, as a creative contribution to the period between the world wars, was as good as fully forgotten. Cizek's achievements in this field were even then overshadowed by the success of his children's education program, and this has not changed up to the present.

After some late secessionist years and a short, pompous expressionist phase, after 1920 Cizek concentrated on formal problems of rhythmics. The main focus of Kineticism (the term is Cizek's invention) was on confrontation with rhythmic movement and the deconstruction of movement sequences. Existing rhythms (and their power potentials) should be recognized, experienced, formally changed, or worked out — through new vision, new recognition.

Its relationship to French Cubism, Italian Futurism, Russian Suprematism, and Constructivism is obvious, but Viennese Kineticism insisted on being independent from Picasso, Balla, Malevich, and El Lissitzky. The circumstances of its creation appear to justify this claim: Kineticism was the product of an Austrian governmental official and professor who, in the matter of this artistic confrontation, never set pen to paper. Cizek was the intellectual leader, but mostly untrained (artistically and intellectually) students aged eighteen and older produced the works of Kineticism in charcoal, oil, wood, and plaster.

Cizek himself may have discussed problems involved in the study of form, providing international examples in his course on General Form Theory, but he recorded no so-called "Theory of Kineticism," and no such document was ever distributed. The students of the General Department of Ornamental Form Theory had to define tasks and problems themselves, and Cizek did not correct them. He was intellectually omnipresent and, apparently, stimulating even in his frequent silence.

It is this type of informal institutionalization and its immediate, direct work with new formal and compositional problems, the obvious mixing of Cubist, Supremacist, and Constructivist aspects — the simultaneous absorption and melting and molding in the works of the primarily visually defined Kineticism — that makes Kineticism a very specific, independent art form. The known works of the Cizek school between 1920 and 1924 are interesting enough to qualify Viennese Kineticism as a serious movement, separate from the usual scholastic copying of the reigning avant-gardisms.

The clear dominance of improvisation — the rapid realization of an idea with often very simple, cheap materials — was an expression of the seeking and freeing of new powers of abstraction and rhythm. The works were not made to be popular or widespread phenomena. The improvisational as well as the synthetic character of many of the works is not atypical for Viennese styles. The same applies to a further characteristic: Kineticism was entirely apolitical.

Students could stay one or more years in Cizek's class. For most, the prevailing climate was a guarantee of fruitful, creative work. However, most did not continue to develop as artists after leaving the class. A few grew beyond it and developed an unmistakable artistic personality (such as Erika Giovanna Klien). Cizek was clearly the motivating element. The majority of the pupils were female, and three of these women formed a definitive trio that led the others in productivity and intensity: Ullmann, Klien, and Karlinsky. Their works, as

Franz Cizek, born 1865 in Leitmeritz, Czech Republic. Academy of Fine Arts, Vienna (general painting class, Prof. Rumpler; special class for historical painting, Prof. Trenkswald), 1885-1889. Art teacher at the k.k. secondary school in Vienna VII, 1897-1903. Professor at the School for Embroidery in Vienna and director of the training school at the School for Arts and Crafts of the Austrian Museum of Art and Industry, Vienna, 1903-1906. He taught ornamental drawing and composing, directed the course for juvenile art. From 1908 superintendent for art at commercial state schools. Died 1946 in Vienna.

References:

Franz Cizek, *Papierschneide- und Klebearbeiten des Jugendkunstkurses an der Kunstgewerbeschule in Wien* (Vienna: 1912).

Franz Cizek, *Methodik des freien Zeichnens nach Natur- und Gebrauchsgegenständen an den österr. Gewerbl. Lehranstalten* (Vienna: 1912).

Wilhelm Viola, *Child Art and Franz Cizek* (Vienna: 1937).

Franz Cizek – Pionier der Kunsterziehung (Vienna: Historical Museum of Vienna, 1985.

1. L. W. Rochowanski, *Der Formwille der Zeit in der angewandten Kunst.* [Vienna: Burg Verlag, 1922]; reprint (Munich: Kraus-Reprint, 1980).

School exhibit, 1924

Cizek-School, Vienna
Johann Cornaro
1899 (Vienna) - 1958
Friedl Dicker-Brandeis
1898 (Vienna) - 1944 (Auschwitz)
Oskar Donau 1898 (Vienna) - 1961
Gertrude Fischel 1902 (Vienna)
Helene Gschließer-Cornaro
1900 (Losoncz, Hungary)
Gerta Hammerschmied 1906
Hans Hofmann 1902 (Vienna
Elisabeth Karlinsky-Scherfing
1904
Paul Kirnig 1891-1955 (Vienna)
Erika Giovanna Klien
1900 (Borgo, Italy) - 1957
Georg Kolb 1902 (Salzburg)
Fritzi Nechansky-Stotz
1904 (Troppau, Silesia)
Gertrude Neuwirth-König
1900 (former Czechoslovakia)
Irmgard Lang
1901 (Brünnlitz, Bohemia)
Sylvia Penther 1891 (Vienna)
Hans Pitsch 1900 (Vienna)
Ernst Anton Plischke 1903
(Klosterneuburg) - 1992 (Vienna)
Heinrich Reichenfelser
1901 (Vienna)
R. Ludwig Reutterer
1893 (Vienna) - 1985 (Vienna)
Johanna Reismayer-Fritsche
1900 (Vienna)
Harry Tauber 1900 (Gloggnitz)
Georg Teltscher
1904 (Purkersdorf)
Gertrude Tomaschek
1903 (Lübeck)
Marianne Ullmann 1905
(Vienna)
Otto Erich Wagner 1895
(Klepácov, Moravia) - 1979
(Vienna)
Vally Wieselthier
1895 (Vienna) - 1945 (New York)
Hertha Zuckermann
1907 (Rosenberg) - 1979

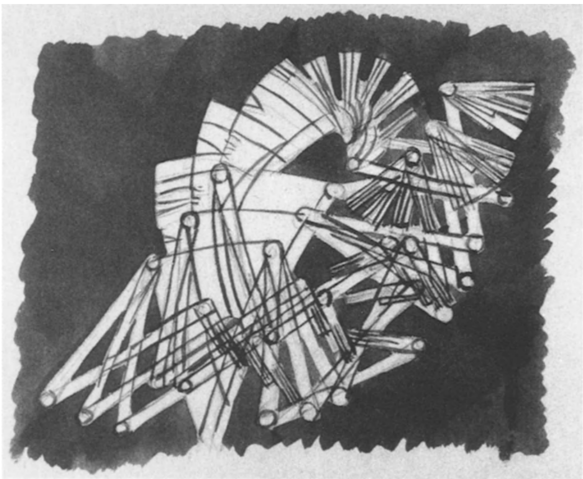
well as those of R. Ludwig Reutterer, Paul Kirnig, Tomaschek, and Wagner best represented the intellectual spirit of Viennese Kineticism. (The quality of all the student works naturally differed, and several slid into the decorative arts.)

Of special interest are the Suprematist kinetic sculptures (now known only through photographs) dating from 1923 and 1924. These works (often up to two meters high) were mostly produced in the department's woodworking shop. Already the material points to the easily producible, improvisational character. These sculptures, however, show a highly astounding formal confidence in the vocabulary of spatial abstraction. Mostly done by pupils who had had training as cabinetmakers, they show a precise and professional handling of the material. Unfortunately, it must be assumed that these sculptures, which were produced as kinetic-spatial exercises, were destroyed. Unsigned (with the exception of Zlamal's), produced by names unknown today, they are — at least in that part photographically documented — impressive anonymous witnesses to a movement that awaits a place in the history of art.

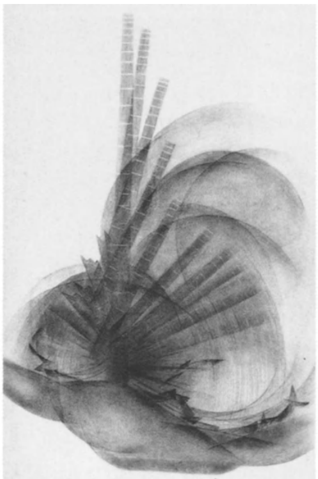
Unannounced and not discussed in the press, the annual exhibit of Cizek's department took place at the conclusion of each school year in a room in the School of Arts and Crafts. (It seems that no kinetic painting or sculpture was ever exhibited anywhere else, and none was ever sold.) Documentary recordings of these yearly exhibits exist in Cizek's archives. The archive is located today in the Historisches Museum der Stadt Wien (Vienna Historical Museum) and in the Viennese City Library.

When Cizek had to take over a new class on Formal Theory (as understood by the directors), in fulfillment of a faculty contract, the basis for Viennese Kineticism and the movement itself ceased (with the exception of the individual developments mentioned). Cizek furnished a room at the Kunstgewerbeschule with paintings and sculptures of his Kineticism, which was open to the public until the 1930s.

Oswald Oberhuber and Peter Weibel, eds., *Österreichs Avantgarde 1900-1938. Ein unbekannter Aspekt* (Vienna: Galerie nächst St. Stephan, 1977), p. 51. (First appeared as a newspaper article in *Die Presse* [Vienna], January 7, 1975.)



Cizek School, *Movement Study*
Pencil, indian ink on paper, 44.5 × 31.5 cm



Paul Kirnig, *Composition*, c. 1921
Charcoal on cardboard,
53.6 × 36.8 cm

Gertrude Neuwirth, *The Recognition*, 1921
Charcoal on paper, 46.5 × 37.5 cm

Valéria Dienes

Valéria Dienes (born Valéria Geiger in 1897 in Szekszárd) was a philosopher, dance teacher, and choreographer. After receiving a degree in piano from the Budapest Music Academy, she did a Ph.D. in philosophy, aesthetics, and mathematics at the Budapest University in 1905. From 1908 to1912 she stayed in Paris where she attended the lectures of Henri Bergson, whose works she later translated into Hungarian. Parallel to her studies, she attended the Greek eurhythmics course taught by Raymond Duncan; she saw Isadora Duncan dance several times. On the basis of her scientific and artistic experiences, she opened a school of eurhythmics in Budapest during the first decade of the twentieth century. She appeared in person onstage only once with her group: on March 1, 1919, in the Great Concert Hall in Vienna. At the beginning of the 1920s, she further developed her system of movement at the Montessori children's home in Grinzing. After that, she worked in Paris as a member of the Duncan colony.

In the middle of the 1920s, she re-opened the school in Budapest, founded the Association of Movement Culture, created eurhythmic compositions with her pupils and performed them in collaboration with Lajos Bárdos for almost twenty years, until March 18, 1944.

Dienes aimed at the scientific analysis of human movement; after decades of work, she set up a system that she called "Orchestics." Her book summarizing the system, *Orkesztika – Mozdulatrendszer* (Orchestics – System of Movement), was first published in 1996. Her system explains the laws governing the natural movements and positions of the human body. The analysis of spatial situation, time lapses, and the energy used by the body in movement introduces us to physical features of movement. Accordingly, three chapters of the book cover plasticity, rhythm, and dynamics, which are joined by symbolism, the semantics describing the movements of the conscious human being.

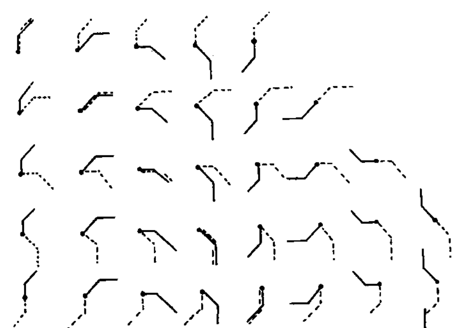
To sum it up, the theory of plasticity (or kinetics) regards the body as a "moving phantom" consisting of lines (so-called body units) and points of rotation, whose possible movements, limited by anatomy and environment, create a "motosphere." Relative kinetics analyzes the possible movements occurring within the motosphere, while absolute kinetics investigates the units and elements involved in changing location (walking, running, jumping elements) and their various combinations.

Biomorphy covers the relationship of the theory and practice of movements based on the natural system of human motion. Its components are the following: symmetry, which ensures static and dynamic balance; holistics, which deals with the body as a whole and its natural proportions; ergonomy, which ensures the economical expenditure of power; ecology, which examines the interaction of body and environment; biometry, which analyzes the difference between geometric and chronometrical rules and the natural execution of movements; and psychosomatics, which examines movement with regard to the relationship of matter and spirit. Valéria Dienes died in 1978 in Budapest.

Gedeon Dienes

Valéria Dienes in the 1920s

Arms and legs in acute angles



Leg scales in obtuse angle

The First Young Shoots and the Growth, 1933
Parable play on sowing

1

Trude Fleischmann

Trude Fleischmann was born in 1895 in Vienna. The daughter of a Jewish businessman, she represented the third generation of a Jewish bourgeoisie whose mission was to culturally integrate their families into the context of the ruling class. Many women struggled to find a position in the Modern era, contending with what was expected of them and what they wanted for themselves.[1] As a result, many Jewish women, including Trude Fleischmann, dedicated themselves to the new field of photography, as well as to classic artistic fields such as singing and poetry.

Trude Fleischmann's portraits seem to arise from a chiaroscuro that lends them sculptural qualities. Her works show that she had an enormous sensitivity for group portraits — the most difficult field in the studio and portrait business.[2] Even the more expressive part of her œuvre remains within a conventional framework, always making the finest distinctions and thus remaining on the highest level of contemporary taste. Just a few protagonists — Claire Bauroff and two or three dance companies — helped Trude Fleischmann gain worldwide fame as a dance photographer. Her dance images developed into nude studies, intended to further refine the representation of body language. Their diffuse lighting and finely outlined contours place them in the tradition of art photography as it was practiced around 1900.

Trude Fleischmann, *Hermann and Helene Thiming as Truffaldino and Smeraldina in Goldoni's "Diener zweier Herren,"* 1924

Trude Fleischmann
***Claire Bauroff*, 1925**

In the mid 1930s, those working in the arts felt threatened from various sides by the political climate. Their work was attacked in newspapers and radio.[3] Although the right-wing regimes of the 1930s were highly interested in photographic propaganda, their emphasis was on technical knowledge.[4] When Austria was annexed by Hitler's National Socialist regime in March 1938, Fleischmann's life grew difficult and unbearable. She had to close down her studio 5 and emigrate, first to Paris, then to London. In 1939, she went to New York, where her former pupil, Helen Post, who had meanwhile become a very well known photojournalist, aided her in many ways. Emily Price Post, a distant aunt, was editor of various home and garden magazines,[6] and it was probably she who gave Fleischmann her first opportunity at Home Stories, taking pictures of prominent people in their own homes. Fleischmann was granted U.S. citizenship as early as 1942; in 1940, she opened a photo studio in Manhattan. The immigrants from Central Europe changed their identities with greater ease than those from Western Europe, shaping new identities that made them more successful — at least economically — than they ever had been in their old countries.[7] Fleischmann's many portraits of the upper class demonstrate her tremendous skill as a photographer. Her finesse with lighting is every bit as good as that of Hollywood photographers; the way she models heads as volumes is absolutely comparable to the work of Yousuf Karsh, who enjoyed enormous recognition in Germany after the war.[8] In 1969, Fleischmann closed her studio in New York, moved to the Italian part of Switzerland, and, as long as it was possible, she lived an independent and self-determined life among people from the theater, music, and cultural scenes. As an old woman, she had to return to the care of her family in the U.S.A. in 1988. She died in Brewster, New York, on January 21, 1990.

Rolf Sachsse
***Camera Austria International*, 54 (Graz: 1996) 41-55.**

Trude Fleischmann
***Berta Reidinger*, 1929**

1. Marion Beckers, "Trude Fleischmann," *Jüdische Frauen im 19. und 20. Jahrhundert*, Jutta Dick, Marina Sassenberg, eds. (Reinbeck: 1993) pp. 116-119. When leafing through the lexicon, one will notice that photography was the fine arts profession most frequently practiced by Jewish women; in general, it is fourth in the list of preferred artistic professions, after dancer, singer, and poet.
2. Rolf Sachsse, *Hermann Claasen, Portraits, Werkverzeichnis*, vol. 1 (Cologne: 1993) pp. 30-34.
3. Christian Cargnelli, Michael Omasta, eds., *Aufbruch ins Ungewisse. Österreichische Filmschaffende in der Emigration vor 1945*, vol. 2 (Vienna 1993). Trude Fleischmann is mentioned in the lexicon.
4. *Fotografieren verboten! Historische Aufnahmen von der Zerstörung Kölns*, exhibition catalogue (Cologne: 1995).
5. Wilhelm Dost, "50 Jahre CV," *Photo-Presse*, 9:1954 (3-17).
6. Emily Price Post (1873-1960), *Current Biography*, 2:1941, (548) and ibid. 21:1960 (114), obituary. Her obituary mentions that she authored "several books on manners and interior decoration," the best known being *Etiquette* (New York 1922), which went through more than twenty editions up until the 1970s.
7. Doron Rabinovici, "Gedenken ist Vergessen. Versuch einer Würdigung," *Das Magazin Österreich-Schwerpunkt zur Frankfurter Buchmesse* 1995, Rüdiger Wischenbart, ed. (Vienna: 1995) 23-24.
8. Leo Fritz Gruber, "Yousuf Karsh," *Foto-Spiegel*, 3:1948 (19-24). This first text was followed by many others up until the 1970s.

Éva Bajkay

Viennese Kineticism and the Hungarian Avant-Garde

After more than half-a-century, Austrian research has at last raised the Cizek School out of obscurity. According to Marietta Mautner-Markhof, one of the most avid experts on Modernist art, the reason for this is not just the dismissive attitude toward the avant-garde historical period propagated by official cultural policy, but also that Kineticism[1] has remained ineffectual.[2] Austrian Expressionism did in fact lead to abstraction and later to Actionism. In Hungary, Constructivist experiments by Kassák, Bortnyik, and Uitz influenced practical design in the 1930s and visual arts in the 1960s. The more theoretical Viennese school did not have such an emanation. The works were mostly lost before their place could be defined within the Central European context.[3] It is therefore no wonder that researchers did not pay attention to possible Hungarian links, especially to those who had been active in Vienna in the first part of the 1920s.

Only a few Hungarians registered for Cizek's class at the Arts and Crafts School: Tibor Gergely (1920-1921), Gertrúd Moiret (1920), Mária Szántó (interior designer, 1920), and Erzsébet Hegedüs (1921).[4] As we see, the majority were women who did not carry on as artists afterward. However, both the annual exhibitions, which took place at the Museum of Art and Industry, and as the opportunity to visit classes made the so-called Viennese Kineticism practiced by Cizek and his pupils widely known. In addition, L. W. Rochowanski, a writer, dancer, and visual artist of Russian origin, published a book on their works in 1922.[5] From 1920 on, immigrant Hungarian artists in Vienna had direct or indirect contact to the art of Cizek and his pupils. They were mesmerized and attracted by the Czech professor's novel approach to the work of art via ornament and composition, which allowed the representation of movement to be the main focus. Cizek's aim was apparently "to awaken the eye." It is certain that he had no intention of any kind of social mobilization. Rather, he endeavored to give a rhythmical expression to everyday experiences, to connect object and environment, to interpret and explore the motion of a person or an object. Seeing the works reminds us more of the relationship between human being and life energy rather than that between power and action. During the period of 1920-21, social outbursts were growing weaker, but Hungarians were still working with the energy of the revolutionary activity of 1919. Uitz turned toward more abstract, more personal themes: *Debaters, Abstract Portrait of a Group, Abstract Portrait*.[6] More strongly influenced by Cubist decomposition, Bortnyik took a more general path in his drawings *Marchers, The Poet*, and *The Railway Station*. The movement of the image and the interventions in selected sections suggested the rhythm of the universe. E. G. Klien, G. Neuwirth, E. Karlinsky, and O. E. Wagner concentrated on the cult of decorative line in their early works, while the intention to improve man and the world manifested itself in the activity of the Hungarians. Vienna was and is a city of dreamers and intellectuals. In particular cases, what seemed to be self-obsessed virtuosity of form can also be regarded as the upswing of early twentieth-century occultism and the natural sciences. The use of electromagnetic rays and radioactive radiation opened up new dimensions for human beings. Ethereal forces were depicted in ways that resembled the illustration of mechanical movements. This can be seen clearly in Uitz's lithography, *Two Heads in Space*,[7] where we not only see the arbitrary rhythm of acute angles and extended arches, but the spiritual force field around the figures as well. In Uitz's case, dramatic presentation plays an important role, as it did with the other Hungarian artists. The same thing can be seen in some of the later works by the Tyrolian Erika Giovanna Klien, Cizek's most talented pupil, which are very different from her earlier works.[8] One of her pieces, entitled *Struggle*, clearly shows Uitz's influence.[9] It has a direct connection with Béla Uitz's large 1922 oil painting of the same name, a harmonic Viennese composition merging Russian iconographic painting and Modernist tendencies.[10] Uitz exhibited his so-called "Icon Analyses" in the museum at Stubenring 6, where the Cizek school had its annual exhibitions. The influences are obvious. Cizek's students did not seek out drama or revolution, but a better, utopian future, as Kassák said about Uitz, reflecting his own creed as well.[11] However, the apolitical Viennese artists (among them, many from the Czech Republic and other parts of the former Austro-Hungarian empire) began with ornamental studies of form, and transformed both outer and inner movements into a new, distorted type of image. So many Hungarian and Austrian artists — all with different approaches — came together in Vienna to experiment with form. Most of the Hungarians came into contact with Kineticism through Uitz, and he was also the one who exposed Klien to Hungarian Actionism. In 1923-24, Cizek's students made three-dimensional sculptures constructed of cheap materials such as paper, cardboard, and wood. Today, similar works by Tibor Gergely or Béla Uitz are only documented in written sources.[12]

Rochowanski named the spatial sculptures of the Cizek circle "the ornament of our age," referring to these works' lack of practical function. However, Kassák's projects were directed towards productivism and were continued in modern design as well as in the Bauhaus. Besides the Cizek School, the "Freie Bewegung" (Free Movement), under the guidance of Adolf Loos, was known as Vienna's most independent artists' group. It should be mentioned that Hungarian events took place in the Kärntner Strasse venue, such as Bela Uitz's first exhibition in autumn 1920. As modest as the bands of avant-garde Austrian and Hungarian artists were, it can be seen on the evidence presented above that they deserve our attention.

1. Oswald Oberhuber, Peter Weibel, *Österreichs Avantgarde 1900-1938. Ein unbekannter Aspekt* (Vienna: Galerie nächst St. Stephan, 1976).
2. Marietta Mautner-Markhof, "Franz Cizek und die 'moderne Kunst' – Ornamentale Formlehre an der Kunstgewerbeschule in Wien," *Franz Cizek. Pionier der Kunsterziehung (1865-1946)*, cat. (Vienna: Hist. Museum of Vienna, 1985) pp. 15-22; *"Konstruktive Tendenzen," Die ungewisse Hoffnung. Österreichische Malerei und Graphik zwischen 1918 und 1938* (Salzburg/ Vienna: 1993) pp. 188-201.
3. These pieces were not available from either the Historical Museum of Vienna or the Vienna City Library. Exhibitions: *Franz Cizek. Pionier der Kunsterziehung (1865-1946)*, cat. (Vienna: Hist. Museum of Vienna, 1985).
4. Archive of the University of Applied Arts. My thanks to Erika Patka for her help.
5. L. W. Rochowanski, *Formwille der Zeit* (Vienna: 1922); *Aquarelle - Zeichnungen 1919-1921*, cat. (Vienna: University of Applied Arts, 1987).
6. For more on his works known only through photos, see Éva Bajkay, *Uitz Béla*, œuvre cat. (Budapest: 1987) nos. 308 - 311.
7. Bajkay, 1987, pp. 48-50.
8. E.G. Klien, *Head, Awaking*, after 1920. *Skizzen, Studien, Meisterblätter*, cat. (Vienna: Hist. Museum of Vienna, 1995), 73.
9. E. G. Klien, *Struggle*, 1925-1926. Collection of Bernhard and Despina Leitner, *Von Schiele bis Wotruba. Arbeiten auf Papier 1908 bis 1938*, cat. (Albertina - Kunstforum Bank Austria: 1996) no. 110.
10. Béla Uitz, *Struggle*, 1922, Hungarian National Gallery.
11. Lajos Kassák, *Uitz Béla kiállítása*, master's thesis, Vienna, 15 November, 1920.
12. "A magyar grafika külföldön, Bécs 1919-1938," cat. (Budapest: Hungarian National Gallery, 1982-83).

Erika Giovanna Klien
***Struggle*, 1925-1926**

1

Peter Weibel

Viennese Kineticism and Hungarian Constructivism

Béla Uitz, born 1887 in Mehala-Temesvár (Romania). Studied at the University of Applied Arts, Budapest, 1907. First exhibition in Budapest, 1914. From 1916 publisher of the magazine *MA* together with L. Kassák. Director of the Arts School for Workers, 1919. After the fall of the Soviet Republic he emigrated to Vienna. Journey to Moscow, participed at the III Congress of the Comintern, 1921. Encountered the Russian avant-garde and their constructivist manifesto. End of friendship with L. Kassák, 1922. Uitz founded the magazine *Egység (Unity)* together with Aládar Comját in Vienna. 1922-1924 he was living in Paris, writing under the pseudonym W. U. Martel for various magazines. Worked as a poster artist and set designer. From 1926 he lived in the Soviet Union and taught composition at WChUTEMAS/ WChUTEIN. Director of planning of decorative works in public places. Organizer of the International Bureau of Revolutionary Artists, 1930-1934. From 1950 commissions for monumental frescos together with a collective. In 1970 he returned to Budapest, where he died in 1972.

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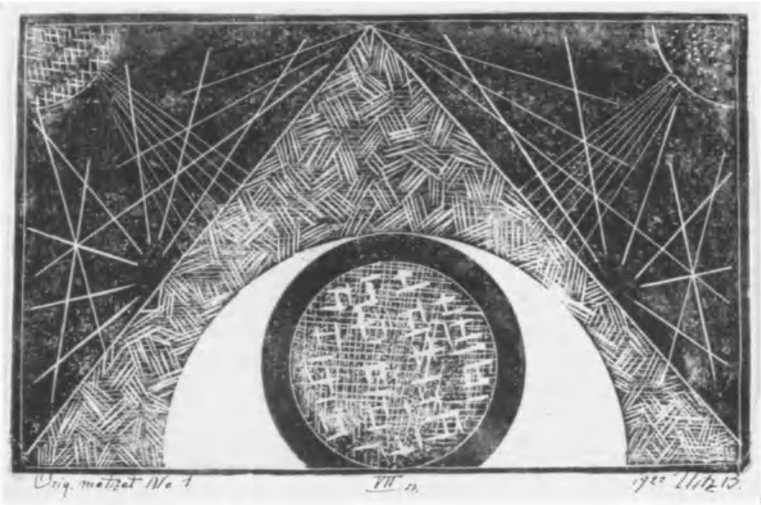
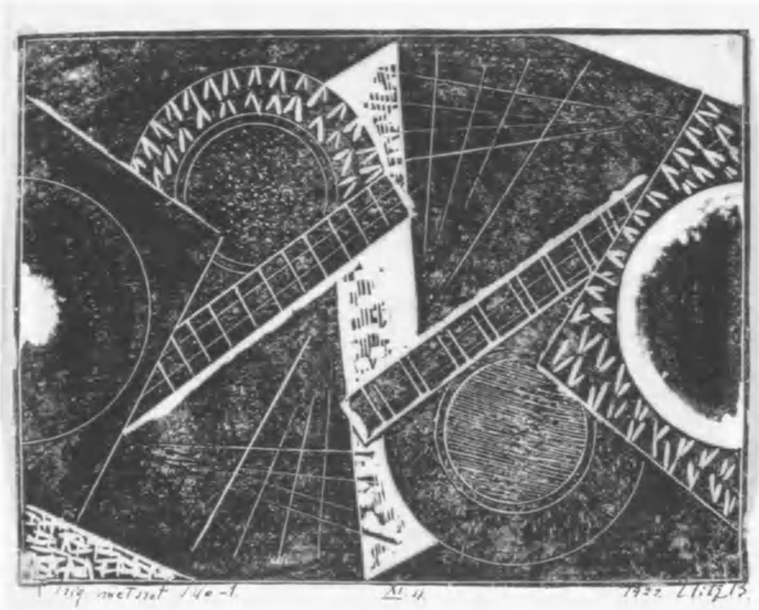
Éva Bajkay, *Béla Uitz. Arbeiten auf Papier aus den Jahren 1913-25* (Budapest-Vienna: Graphische Sammlung Albertina, 1991).


Béla Uitz, *Analysis VII*, 1922
Linocut, 20 × 32.2 cm
© VBK, Vienna, 2005


Béla Uitz, *Analysis XI*, 1922
Linocut, 20.5 × 26.1 cm
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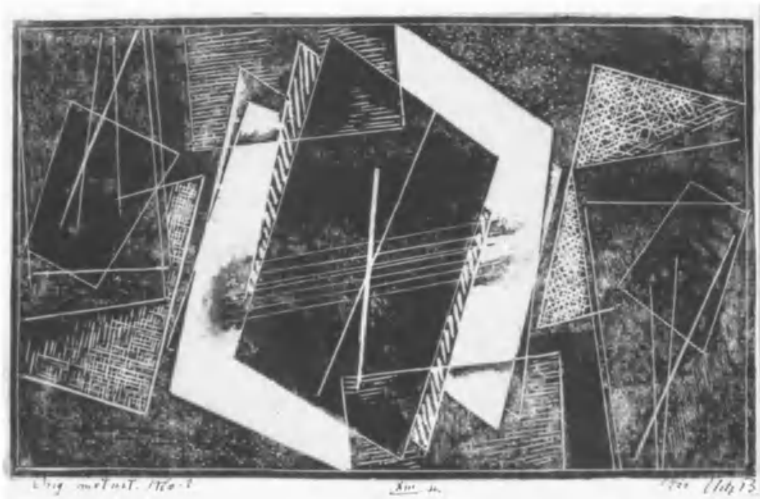
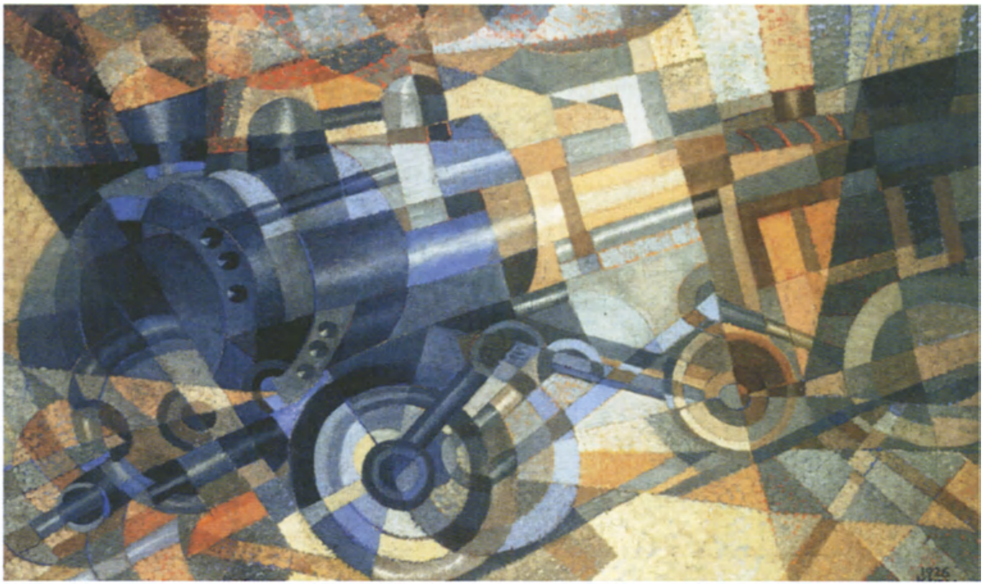
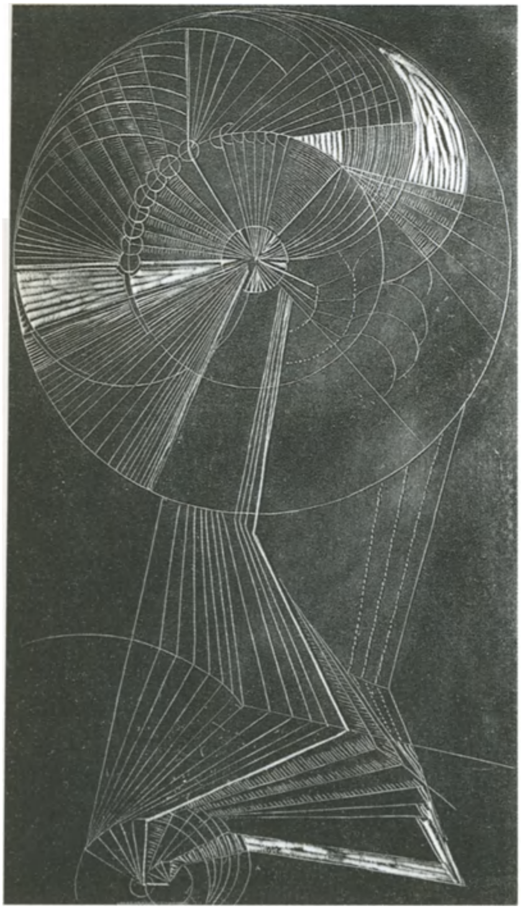

Béla Uitz, *Analysis XIII*, 1922
Linocut, 20 × 32.4 cm
© VBK, Vienna, 2005

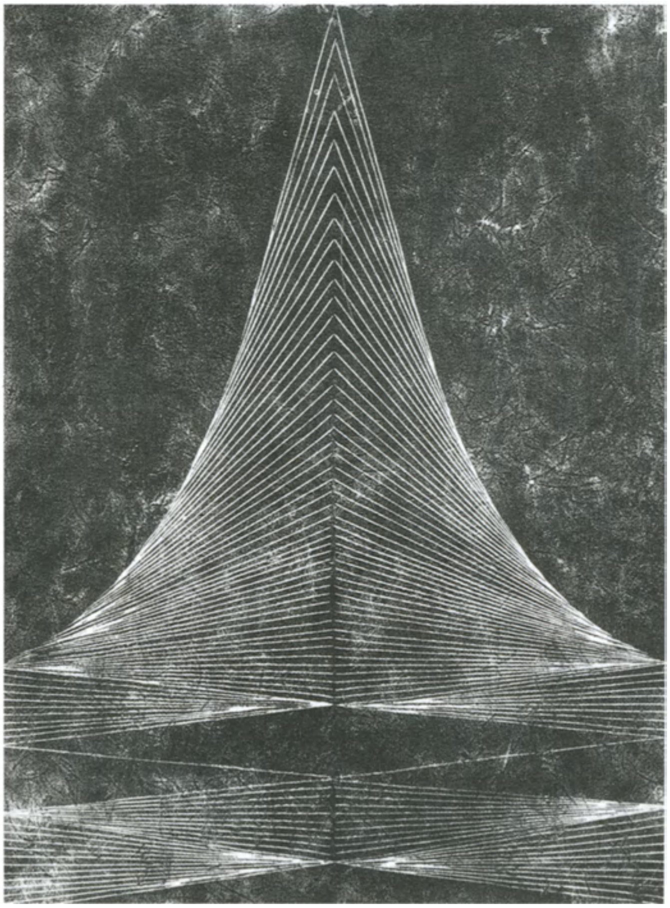
Erika Giovanna Klien
Composition with Circles, c. 1923



Erika Giovanna Klien, *Engine,* 1926
Oil, tempera on canvas, 59.5 × 100 cm



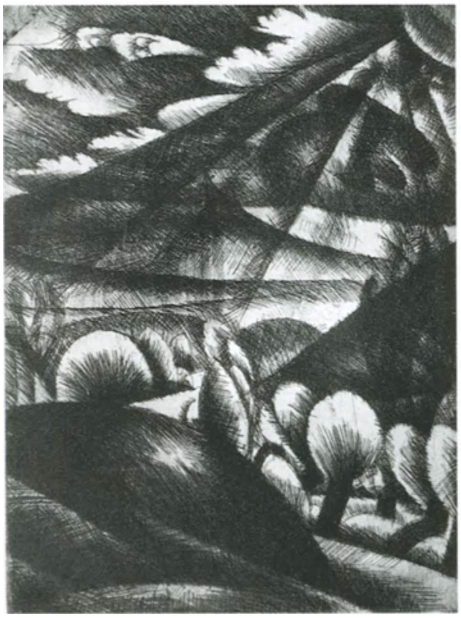
Erika Giovanna Klien, *Figure in Motion*, c. 1933-35
Original Linocut plate



Erika Giovanna Klien, *Bird Flight II,* c. 1935
Linocut

Oskar Donau
Sun Wheel, 1918
Linocut, 26 × 36 cm

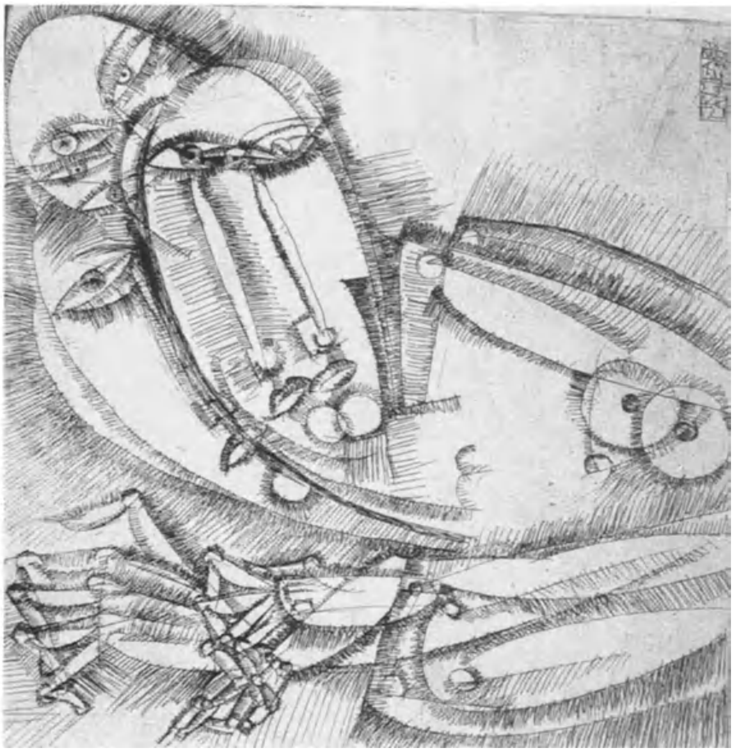
János Mattis-Teutsch
Rhythm (Landscape), 1917
Linocut, 23.3 × 33 cm



Béla Uitz, *Landscape in Hietzing Under Cloudy Sky*, 1920, Etching, 65.5 × 50 cm
© VBK, Vienna, 2005

Béla Uitz, *The Fisher*, 1920
Tempera on cardboard, 90 × 12.6 cm
© VBK, Vienna, 2005

János Mattis-Teutsch, *Man*, 1920
Linocut, 24.7 × 13.3 cm



Irmgard Lang, *Girl* I, 1923
Etching, 35 × 50 cm

Béla Uitz, *Abstract Self-Portrait*, 1920
Colored Chinese ink, 53 × 45.5 cm
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Béla Uitz, *Two Heads in the Space*, 1920
Chinese ink, 53.6 × 45 cm
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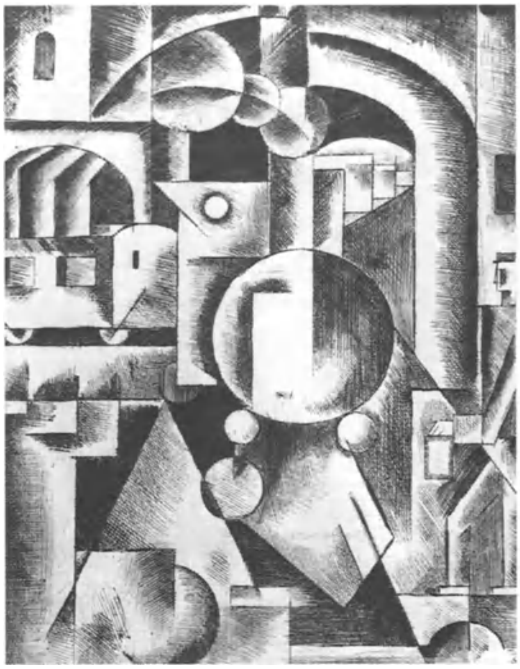
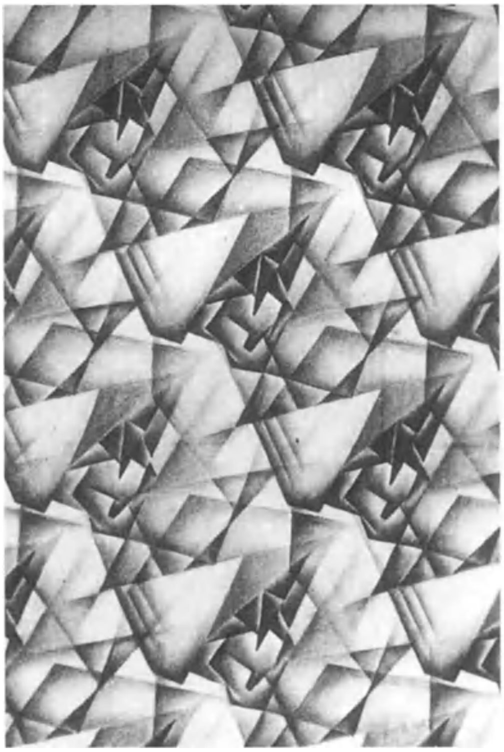
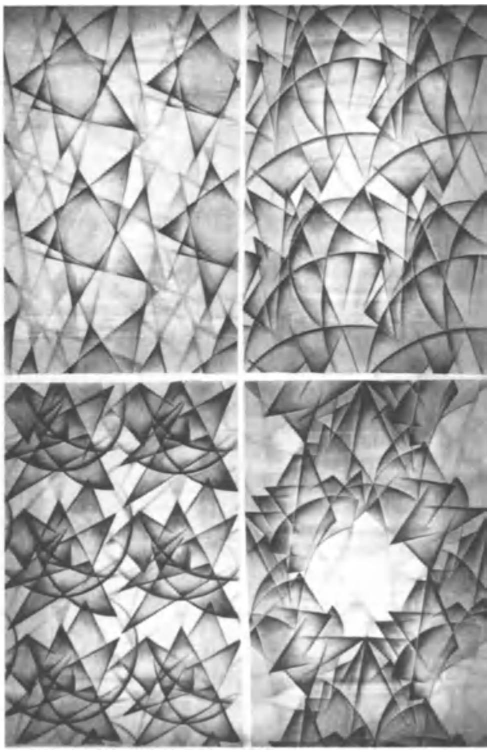


Sándor Bortnyik, *The Train Station,* 1921
Etching, 31.5 × 24.5 cm

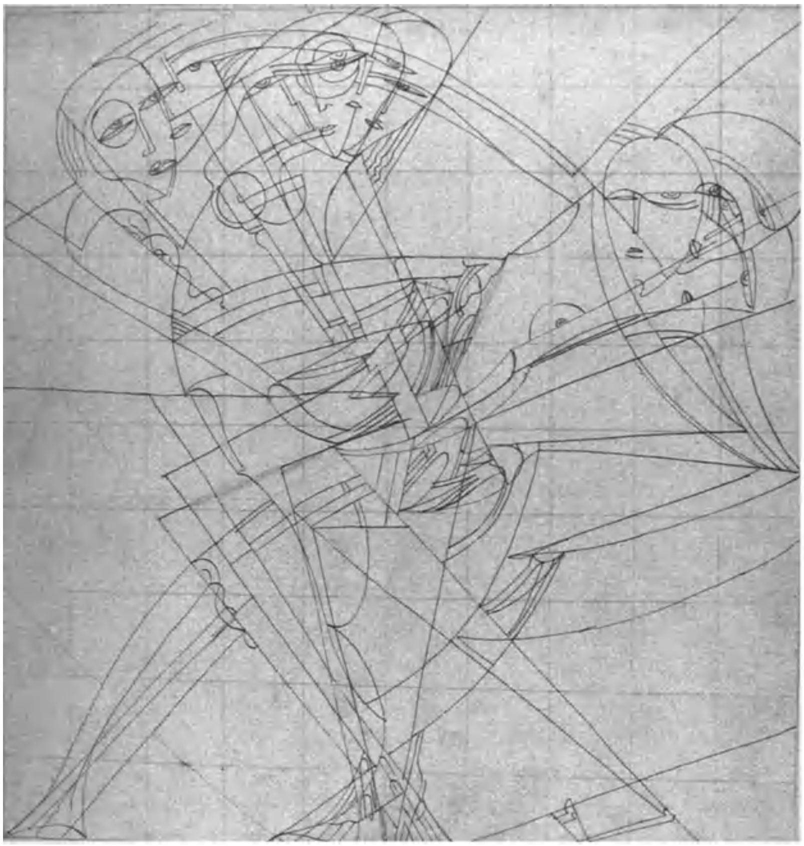
Sándor Bortnyik, *The Marching,* 1921
Watercolor, 27 × 19 cm



Gertrude Fischel, *Kinetic Ornament,* 1921
Sketches for tapestry



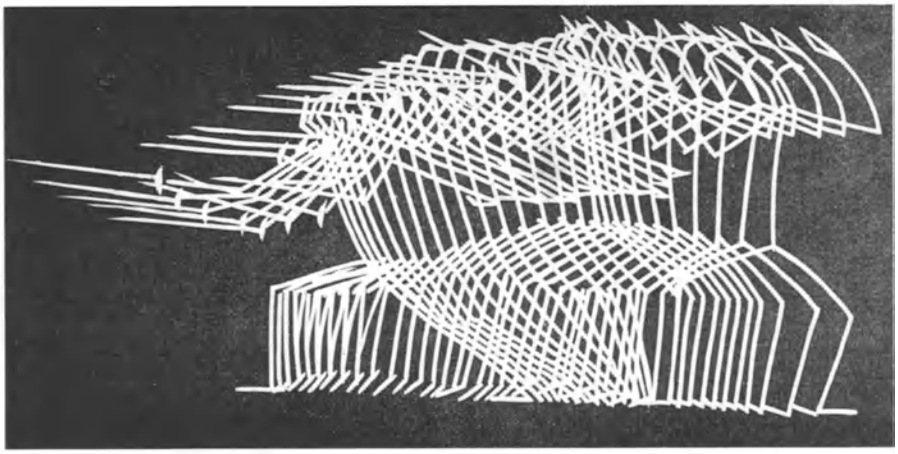
Fritzi Nechansky, *4 Abstract Compositions,* 1922
Charcoal, paper on cardboard, 22.98 × 63 cm



Otto Erich Wagner, *Dancers,* c. 1922
Chinese ink, cardboard, pencilled grid
31 × 30 cm

Gerta Hammerschmied, *Rhythmic Figure,* 1923
Linocut
42.5 × 34.5 cm

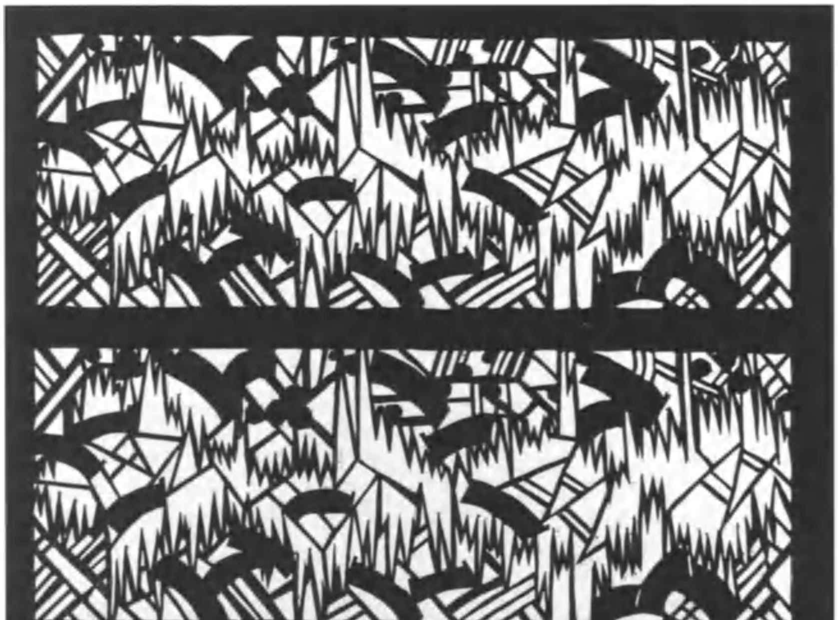
Heinz Reichenfelser, *Rhythms of Dance,* 1921
Charcoal on paper



Hans Hofmann, *Foil Fencer,* 1924
Linocut, 15.8 × 31 cm, © VBK, Vienna, 2005

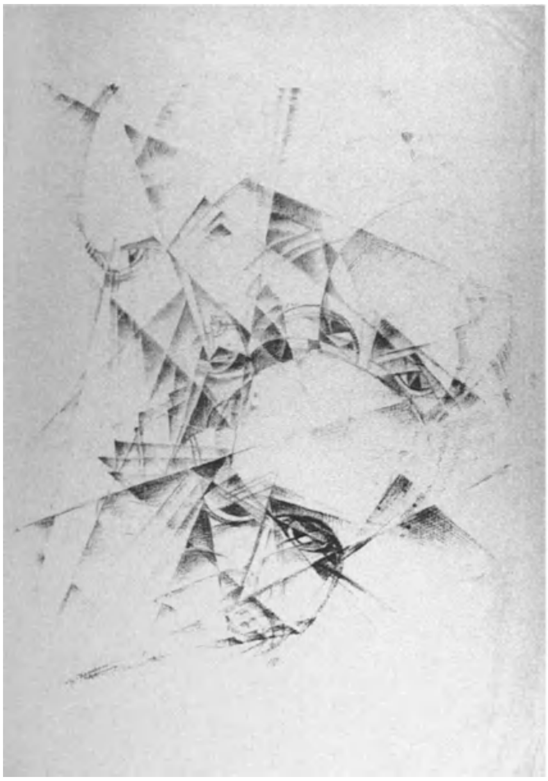
Oskar Donau, *Shelled Town,* 1918
Woodcut in black and brown

Sylvia Penther, *Town and Figures,* c. 1921/22
Woodcut, water-colored, 25 × 32 cm



Hans Pitsch, *Abstract Composition,* 1918
Linocut, 26.5 × 35.5 cm

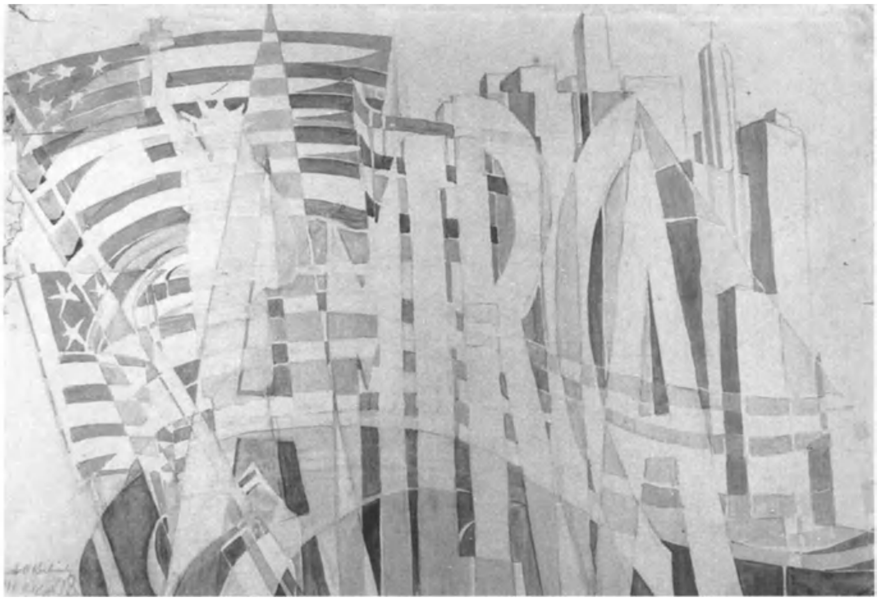
Johanna Reismayer-Fritsche, *Abstract Composition, c.* 1922, 25.8 × 20.4 cm



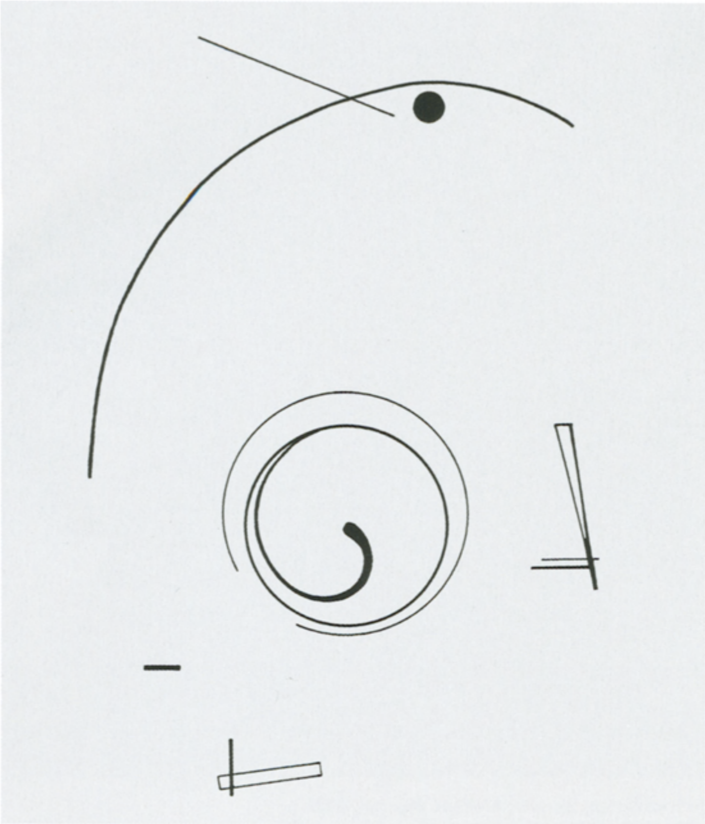
Gertrude Tomaschek, *Head*, 1926
Lithography, 63 × 47.5 cm

Gertrude Tomaschek, *Growth, Motion, Rhythm*, 1927
Lithography, 47.5 × 31.3 cm

Elisabeth Karlinsky, *Motion of a Dancer*, c. 1927
Lithography, 59 × 44 cm, © VBK, Vienna, 2005



Elisabeth Karlinsky, *America*, 1928
Water-color on cardboard, 72.5 × 51 cm, © VBK, Vienna, 2005



Raoul Hausmann, *Abstract Picture Idea*, 1921
Chinese ink on paper, 20.7 × 35.5 cm
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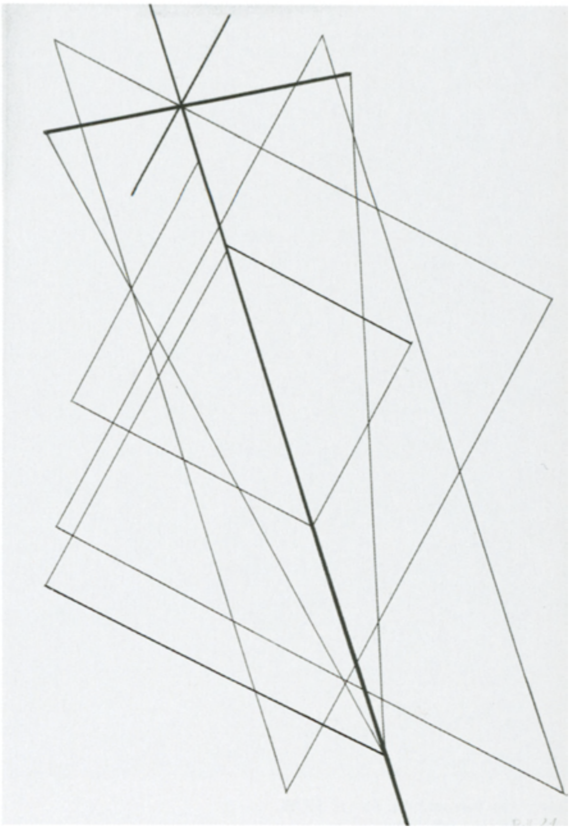

Raoul Hausmann, *Abstract Picture Idea*, 1925
Chinese ink on paper, 28.6 × 38.1 cm
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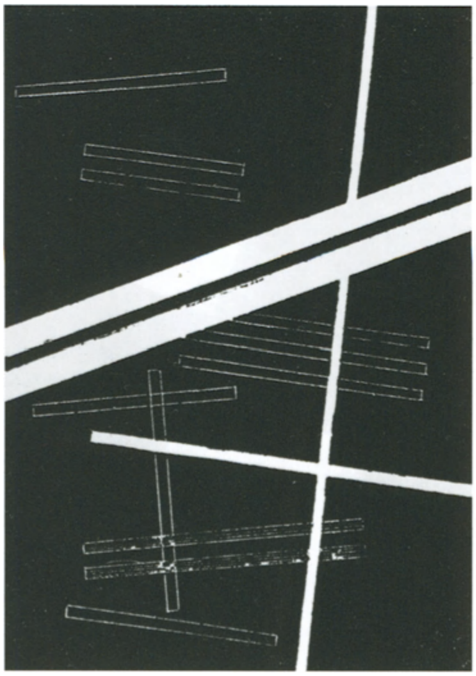
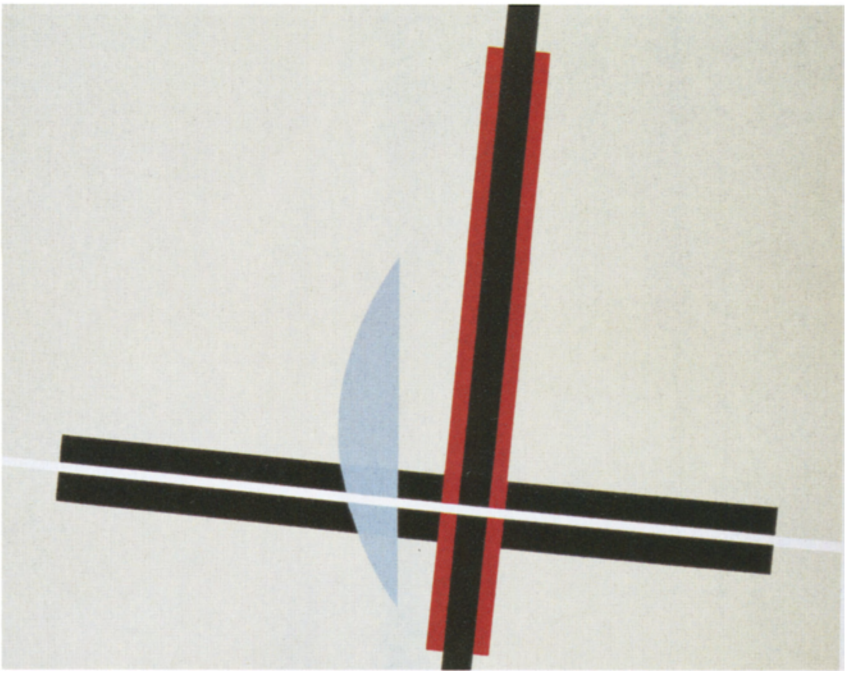
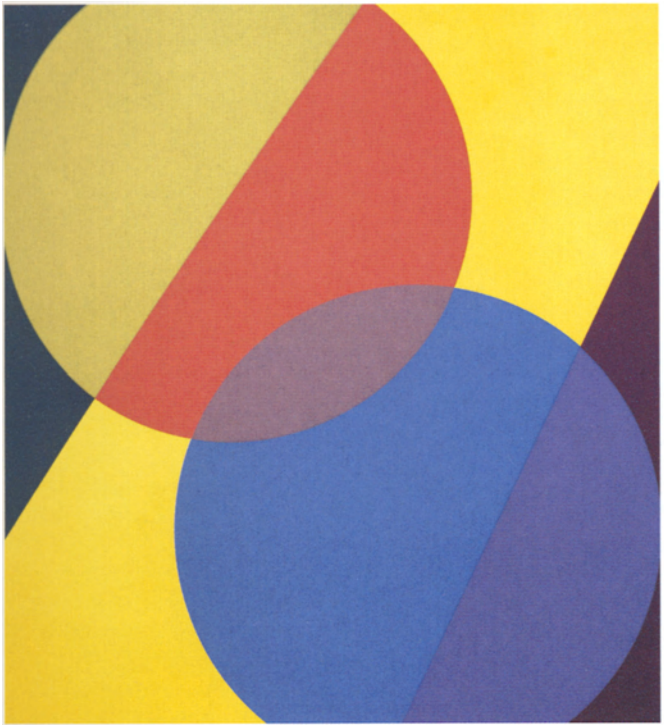


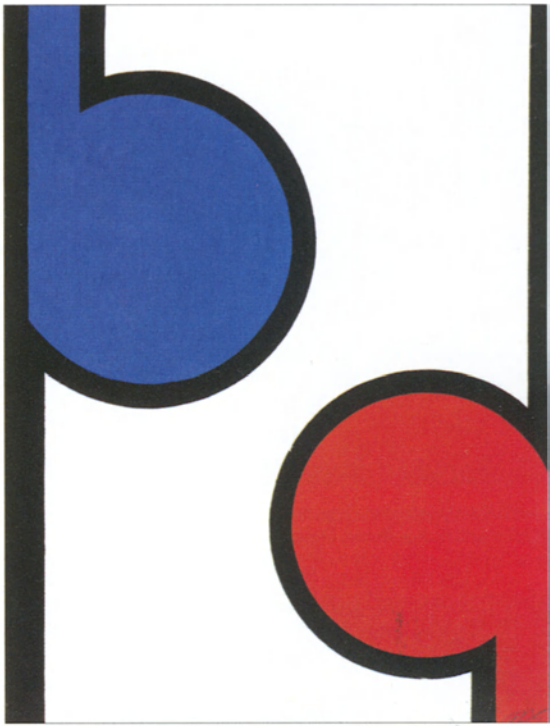
László Moholy-Nagy, *Floating Lines*, 1924
Woodcut, © VBK, Vienna, 2005



László Moholy-Nagy, *Composition IV*, 1922
Reprint 1970, 66.4 × 51 cm, © VBK, Vienna, 2005



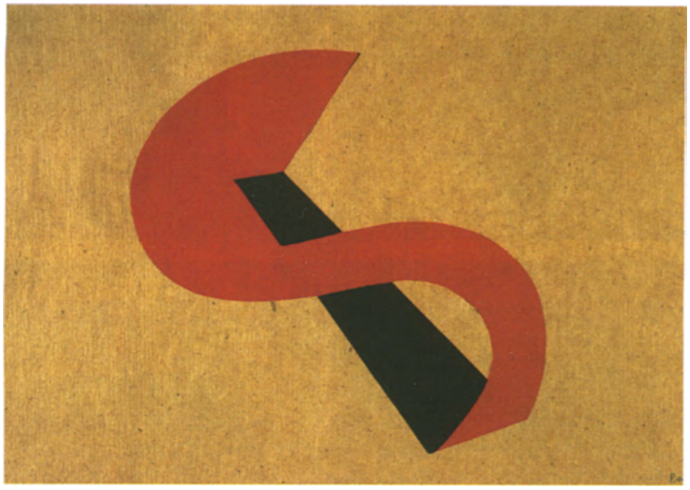
Anna Béothy-Steiner, *Two Circles,* 1930
Reprint 1972, 52.4 × 48.4 cm



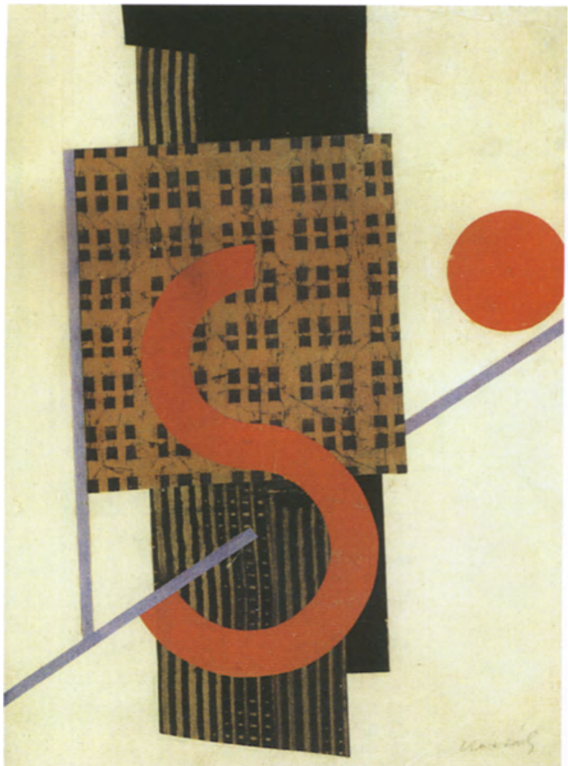
Anna Béothy-Steiner, *Geometrical Composition,* c. 1930
Gouache, 32 × 25 cm

Étienne Béothy, *Composition,* 1930
Chinese ink on paper, 63.5 × 39.5 cm, © VBK, Vienna, 2005

Lajos Tihanyi, *Blue-Yellow Composition,* 1934
Oil on canvas, 45.5 × 38 cm

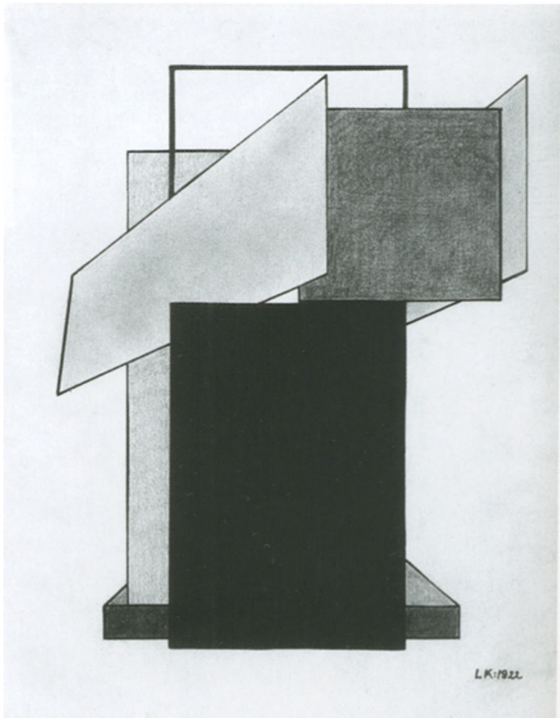


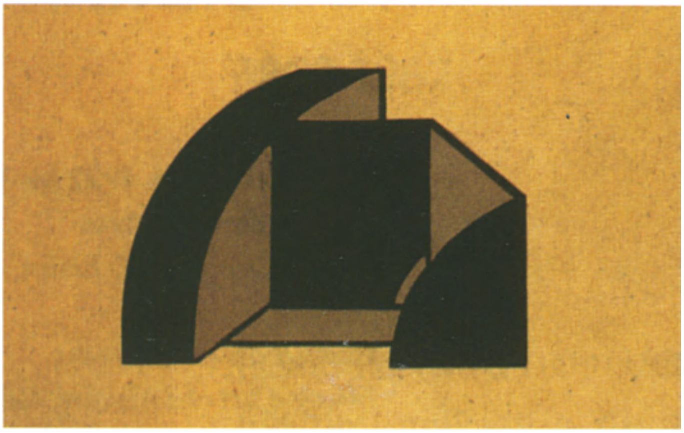
László Péri, *Linoleum Cuts, No. 12*, 1922-1923, portfolio of 12 prints
Published by *Der Sturm*, Berlin, 24.1 × 25 cm



Lajos Kassák, *The Red "S,"* 1923
Collage, 40 × 30 cm

László Péri, *Linoleum Cuts, No. 1*, 1922-1923, portfolio 12 prints
Published by *Der Sturm*, Berlin, 15.9 × 21.5 cm





László Péri, *Linoleum Cuts, No. 8*, 1922-1923, portfolio of 12 prints
Published by *Der Sturm*, Berlin, 21.4 × 28.1 cm

Lajos Kassák, *Image Architecture*, 1922
Pencil, Chinese ink, 28.3 × 22.8 cm

Peter Weibel

On the Origins of Hungarian Constructivism in Vienna: MA 1920-25 The Only Instance of Modernism Between the Wars

Hungary and Austria have in common not only many film stereotypes left over from the Habsburg monarchy, but they also share the question of their artistic avant-garde and the function of exile. As in Hungary, Austria's avant-garde, at the time it existed, had to fight bitterly for survival and was then buried in official history. Emigration, at the time, all too often appeared as the only way to resolve the conflict. For Hungary and Austria, the role of exile in the development of their avant-garde is thus related. Even more interesting, then, is the historical case of Hungary's avant-garde going to Austria for exile.

The intention of this essay is, first, to point out the highly interesting and informative fact that, in the first half of the century, Hungary's avant-garde — leading twentieth-century artists such as Vasarely, Moholy-Nagy, Kepes, Béothy, Breuer, and Kassák — brought forth an independent movement, the *MA* movement, which flourished most successfully in exile — namely in Vienna of the 1920s (of all places). Second, I intend to place the development of Hungarian Constructivism in the general context of logical Constructivist contributions in Vienna. It is interesting to note that, in both Hungary and Austria, the decade from 1910 to 1920 was considered Expressionist. However, under the influence of revolutionary Russian art, the exiled Hungarian avant-garde turned from Expressionism and Activism to Constructivism, while in Austria, Expressionist Activism developed further, leading to the Actionism of the 1960s.

Hungary's Avant-Garde, 1909-1930

According to Éva Körner, Hungary's avant-garde between 1909 and 1930 can be subdivided into four phases: 1909–1912, 1915–1919, 1920–1925, and 1926–1930. The two most important phases, the decade from 1915 to 1925, are tied together in the magazine *MA*, published primarily by Lajos Kassák. Kassák himself appeared to be a central figure of the avant-garde movement in the years 1915 to 1930, due to his artistic as well as theoretical and organizational activities.

Phase 1: Nyolcak, 1909–1912

The Nyolcak [or Group of Eight] consisted of painters Károly Kernstok, Róbert Berëny, Dezső Czigány, Béla Czóbel, Ödön Márffy, Dezső Orbán, Bertalan Pór, and Lajos Tihanyi. The group combined a social, proletarian mission with Cézanne's early Cubist experiences. The tendency toward formalization led to the abandonment of themes and an Expressionistic focus that aimed at the essential. In addition to still-lifes, nudes, portraits, and landscapes, they were also the first urban artists to turn cityscapes into abstract monumental compositions that could have been borrowed from the Renaissance.

Phase 2: Activist Avant-Garde, 1915–1919

The writer and later painter Lajos Kassák (1887–1967), who, stimulated by the writer and later painter, Emil Szittya (1886–1964), had discovered German Expressionism. Inspired by Franz Pfemfert's magazine, *Die Aktion*, which began publication in 1910, Kassák also founded the activist group and magazine, *A Tett* [The action], in 1915. The magazine combined internationalism, socialism, and Expressionism with futuristic dynamics, publishing Apollinaire, Ivan Goll, Marinetti, and others. The October 1916 issue of *A Tett*, with contributions from Emil Verhaeren, George Duhamel, George Bernard Shaw, and Wassily Kandinsky, was banned because of its antiwar position. Kassák initiated a new journal, *MA* [Today], whose first issue appeared one month later in November 1916.

In Vienna in 1924, Kassák began to write his six-volume, two-part autobiography, *Egy Ember Elete* [One man's life]. Kassák, who came from a poor family, was a workman until the age of twenty-two. In Budapest he made contact with the worker's movement early on. At twenty-two he left Hungary and wandered through Europe with his friend, Gödrös, a wood carver. It was then that he met Szittya. Kassák was in Paris in 1909, but in 1910 he returned to Budapest. Familiar with all the "-isms" — particularly with Picasso, Modigliani, Apollinaire, and Cendrars, who was a friend of Szittya — he became their proponent in Hungary.

In the beginning, *MA* had the subtitle *Magazine for Activistic Art* (later *Activistic Magazine*). The painter Béla Uitz was long-time co-editor with Kassák. As the subtitle indicates, in the beginning *MA* still had Expressionist-Activist tendencies, and it developed slowly at first, but quickly in Vienna it became a forum for Constructivism, which to a great degree would become synonymous with the Hungarian avant-garde. But like German Expressionism, *MA's* program for liberating the human being had developed in Hungary in the direction of abstract forms under the influence of Futurism and Cubism. In addition to the new avant-garde — Sándor Bortnyik, József Nemes Lampérth, János Mattis-Teutsch, László Péri, György Ruttkay, Ferenc Spangher, János Schadl, János Kmetty — *MA* also had contact with the Nyolcak and published or exhibited its members: Tihanyi, Berény, and Kernstok. Between 1916 and 1919 it also published Dezső Szabó, Sandor Galimberti, Valéria G. Dénes, Sándor Gergely, Karl Otten, Rubiner, Goll, Walt Whitman, Paul Hatvani, János

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Emil Szittya, *Das Kuriositätenkabinett*. 1923; reprint (Mendeln: Kraus, 1973).

Walter Vitt, ed. *Hommage à Dexel* (Starnberg: Keller, 1980).

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Mattis-Teutsch held the first *MA* exhibition in October 1917. He was also one of the painters most frequently published in *MA*, in addition to Uitz and Bortnyik. Still, in a 1971 catalogue from the Galerie im Taxispalais (Innsbruck), below his name (which is listed with the rest of those artists who tended toward Constructivism between the World Wars) one reads: "unknown German painter" — so heavily had the iron curtain of time descended. Bortnyik, who from 1918 to 1922 numbered among Kassák's closest colleagues, had an *MA* exhibition in July 1919.

The increasing politicization of *MA* can be seen in a special edition about Lenin (1919), and in *MA* contributor János Lékay's assassination of the Hungarian minister of defense, Count István Tisza, in 1918. After that, *MA* ran into conflict with the revolutionary Hungarian Soviet Republic (which began on 21 March 1919) and its commissioner of education, György Lukács. For the cultural political ideology, the *MA* group's expressiveness and tendency to use abstract forms was an expression of a bourgeois decadence incomprehensible to the masses.

Legend has it that Lukács wanted to force his resolutions on Kassák with the help of a revolver. In a special edition of *MA*, Kassák published a letter to Béla Kun in the name of art, in which he rejected art's function as direct propaganda — as was desired by Lukács and the Soviet leader, Kun — and instead established an artistic independence. "Progressive artists are obliged to decide for themselves about the specific issues of artistic creation." Due to these divergent ideas concerning the mission of art, the Soviet Republic discontinued *MA* even though the *MA* movement had supported the Republic's existence and, in its own way, had helped to bring it about. Lukács's sad reactionary role, which began here, ended, in my opinion, in the state-sponsored art of Social Realism, an erroneous adaptation of nineteenth-century bourgeois realism (Balzac, Zola, etc.). Toward the end of the Soviet Republic, in August 1919, Kassák was arrested; he spent five months in prison and then fled to Vienna. The Hungarian Soviet revolution had raised hopes in the progressive intellectual and artistic circles that a similar event might occur in Vienna. Radical Expressionist poet Georg Kulka, part of the circle of friends around Carl Ehrenstein, was obviously in Hungary himself, when he wrote a poem entitled "Budapest, 1 May 1919":

Vielleicht hast du, der das Felsige fällt, du, der die Erde rundet,
Deine Entsagung bizarr an Formerfülltes gehängt –
Buhlten Bäume unzertrennlich, haben Blüthen uns gemundet,
Blieb die Zukunft vor ihnen, ewige Zukunft, gesenkt.

[Maybe you, who cut down rocky cliffs, you, who circle the earth / Have hung your renunciation bizarrely on things filled with form — As trees courted inseparably, we have savored blossoms / the future, endless future, remained low before them.]

Kulka also had contact to other Eastern European avant-garde circles, such as the Yugoslavian group around Miroslav Krleza's journal *Zenit* [Zenith] (1918–1921), in which he was published along with Ivan Goll, Max Jacob, Schiele, Prampolini, André Salomon, Marcel Sauvage, Florent Fels, Alexis Brown, A. Blok, Fritz Reichsfeld, and others. (Incidentally, a report about *Zenit* and "Zenitism" appeared in *MA* in June 1921.) Kulka also dedicated a poem to another Soviet Republic loyalist, namely Gustav Landauer from the German Soviet Republic.

Dem Geiste Landauers
Ein Aufruf goss sich aus. Ein Tod erwacht.
Schrick auf zum Requiem der Jesusmacht!
Springt mancher Brunn ins Gras mit rotem Schein —
Der Freiheit letzter Sieg wird trocken sein.
Durch die Antique deines Alphabets
Schien das verlernte sanfteste Gesetz.
Pflügtest du auch mit altem Apparat —
Es wuchs des Nichtsstaats geistergebne Saat.

[To the Ghost of Landauer: / A cry poured forth. A death awakes. / Rouse to the requiem of Jesus's might! / Some fountain spouts red into the grass — / freedom's final victory will be sear. / Through the antiquity of your alphabet

János Mattis-Teutsch, born 1884 in Breslau. Attended the carpentry school in Kronstadt, and the art school in Budapest 1901-02. Studied sculpture at the Bayerische Akademie der bildenden Künste in Munich, 1902-05. Became a teacher at the Industrial Gymnasium in Kronstadt in 1908. Between 1908 and 1915 he gradually shifted from naturalistic painting with religious and ethical themes to an abstract form of representation. In 1913, he exhibited in the Sturm show in Budapest, and had his first MA exhibition in 1917. Some of his pictures were printed in MA. In 1917, MA published an album of prints featuring twelve of his linocuts. His second show, in 1918, also took place in the MA building in Budapest. He had shows in Berlin and Vienna in 1921. After World War I, he returned to his hometown. In 1918 he joined Der Sturm. Began working with sculpture in 1920. Took part in the 1921 Der Sturm exhibition. Shows in Paris, Chicago, Rome, and Berlin. Visited the Bauhaus in 1925. Editor of *Integral* magazine. His theoretical writings were published in 1931. From 1944 to 1949, taught at the Kronstadt Section of the Romainian Society of Visual Artists, where he was also director from 1957-59. Died in 1960 in Brasov.

/ shone the forgotten, gentlest law. / Even though you plowed with an old machine — / the seed of the non-state, devoted to the spirit, grew.]

We should note here that Landauer proofread Fritz Mauthner's work, *Beiträge zu einer Kritik der Sprache* [Contributions to a critique of language, 1901–1902], a work that influenced the Dadaist Johannes Baader, Jorge Luis Borges, and Wittgenstein, as they themselves attested. Taking this into consideration, it seems that a new image of formal avant-garde art appears, which had been concealed up until then from literary history: namely, that in many cases the artists understood themselves to be part of the socialist revolution. Landauer wrote, "certainly language critique is inseparable from that which belongs to what I consider anarchy and socialism." Unfortunately, Landauer took a negative view of psychoanalysis, especially Otto Gross. The philosophy of language critique also had socialist utopian tendencies, as can be recognized in the position of Otto Neurath, cofounder and promoter of the positivist Vienna Circle: he was head of the central economic bureau of Munich's Soviet Republic in 1919. Neurath also held lectures about his international pictorial language, ISOTYPE, at the Bauhaus in Dessau. From 1915 to 1919, the *MA* movement also belonged to this suppressed and concealed tradition of cooperation among socialism, language critique, progressive art, and poetry in the name of the revolution.

Also connected with this was the story of the previously mentioned Emil Szittya (1886–1964), who in 1906 emigrated to Paris and traveled through Germany, France, and Switzerland (Zurich, Ascona). In 1909 he published a magazine with Blaise Cendrars, *Les Hommes nouveaux* [The new men]. In 1908 he and Voyticky published *Über die Literatur der Neuen* [On the literature of the new] in Budapest. He and Dunajec also published *Die Haschischfilme des Zöllners Henri Rousseau* [The hashish films of customs officer Henri Rousseau] in Budapest. From 1914–1918 Szittya was active in the Dada circle in Zurich. He published the journal *The Mistral* with Hugo Kersten, of which only three issues appeared. The editor of the third number (1915) was Walter Serner, the great Austrian Dadaist and author of the Dada manifesto, *Letzte Lockerung: Ein Handbrevier für Hochstapler* [The final slackening: a manual for con men], written in 1918 in Locarno and published in 1920. Szittya's novel *Ecce homo ulkt* [Ecce Homo is joking, 1911] was an early Dada work. His *Spaziergang mit manchmal Unnützen* [Walk with occasionally useless things] appeared in 1920 with the Austrian Expressionist publisher Strache. *Klaps*, his reckoning with Ascona and the Monte Veritá circle — this melting pot of social utopia, life reform, mythology, and art — was published in 1924 by Kiepenheuer. Szittya came to Ascona through his friend Johannes Nohl (1882–1963), who had worked with Erich Mühsam in the Munich group Tat [Deed] and had studied psychoanalysis in Vienna; in 1916 he had analyzed Hesse. Nohl, who was published in Landauer's journal *Sozialist* [Socialist] between 1910 and 1913, was a friend of Austrian social and sexual revolutionary psychiatrist Dr. Otto Gross, and was often taken into police custody for his so-called "anarchist activities." For Erich Mühsam, he was a "typical bohemian"; for Szittya, a man "to whom fate probably has bound me for the rest of my life." The life and impact of Otto Gross, who was close to the Ascona circle as well as the Berliner Aktion group, was of importance to Expressionist literature in Vienna, Munich, Prague, and Berlin. They also had far-reaching effects (such as on the works of D. H. Lawrence) and deserve closer investigation. Gross's best friend was probably Expressionist poet Franz Jung. Jung also published in *MA*, in the April 1921 edition.

The circle comes back around again. Just as Nohl and Szittya described themselves as good friends, so too were Nohl and Gross. Naturally Gross and Szittya also knew each other, but they didn't get along. Landauer and Szittya also knew each other. Erich Mühsam, who also wrote a book about Ascona, also published in the April 1921 *MA*, as did Jorge Luis Borges in September 1921.

In Szittya's most famous work, 1923's *Das Kuriositäten-Kabinett. Begegnungen mit seltsamen Begebenheiten, Landstreichern, Verbrechern, Artisten, religiös Wahnsinnigen, sexuellen Merkwürdigkeiten, Sozialdemokraten, Syndikalisten, Kommunisten, Anarchisten, Politikern und Künstlern* [The curiosity chamber: encounters with strange incidents, tramps, criminals, acrobats, religious fanatics, sexual oddities, social democrats, syndicalists, communists, anarchists, politicians, and artists], there are elaborate chapters on the art scene in Vienna and Budapest, naturally including Gross, but, as the subtitle "Café Größenwahn" [Café megalomania] shows, the book maintains an ironic distance and often functions on the level of gossip. Also on the list of Szittya's most important and influential books are *Das Selbstmörderbuch. Ein Beitrag zur Kulturgeschichte aller Zeiten und Völker* [The suicide's book: a contribution to the cultural history of all eras and peoples, 1924], *Malerschicksale* [The fates of painters, 1924], and *Ausgedachte Dichterschicksale* [Invented fates of poets, 1927]. Gerhard Rühm, a well-known member of the Vienna Group, certainly knew Szittya and probably owes much to the *Selbstmörderbuch* and *Kuriositätenkabinett* for the motivation for his poetry collection, *Selbstmörderkranz* [Suicide wreath, Rainer Verlag, 1966]. Like Kassák, Szittya was not only

Lajos Kassák, born 1887 in Érsekújvár. Finished an apprenticeship as a locksmith and worked in various types of metal-related job between 1899 and 1908. In 1909, he finished his first autodidactic drawings and established contacts in Paris with Appolinaire, Delaunay, Picasso, Modigliani, etc. In 1912 he began writing poems and plays, and became acquainted with Marinetti. In 1915 he became editor of *A Tett* (The action) and *MA*; founded the Activist group. Immigrated to Vienna in 1920. Developed the theory of image architecture. Published a portfolio of linocuts along with a manifesto in both German and Hungarian. In 1922, he and Moholy-Nagy published the *Book of New Artists*. Shows in 1922 and 1924 at the Galerie der Sturm, Berlin, and in 1924 at the Galerie Würthle, Vienna. Editor of *Dokumentum* magazine. He, Schwitters, and Tschibold founded the *Neuer Werbegestalter* (New advertising designers). Editor of *Munka* (Work) magazine between 1928 and 1938. Organized a group of young intellectuals and workers under the same name. Until the end of the 1940s, he published various writings on art, literature, and society. Starting in 1956, he published several volumes of poetry, collages, pictures, and made films. Died in 1967 in Budapest.

Lajos Kassák

Lajos Kassák
Cover for the January edition of *MA*, 1921
Collage

a writer, but also a painter. Based on his example, we can see in the many entanglements of his person and his work that — abstractly speaking — art history is more complicated than the simple black-and-white that academic school wisdom tries to make of it. We can also see how close the connection was between Vienna and Budapest in the 1920s, which culminated in the exile of the Hungarian avant-garde to Vienna. This third phase was the high point of the Hungarian avant-garde before World War II. It is characteristic of a nation that has been suppressed time and again by a foreign regime (be it the Hapsburgs or the Russians) for its primary creative achievements to have been achieved abroad: in Austria, Germany, France, England, and the U.S.A. This is the paradoxical theory of our essay: that between the two wars, Hungary's avant-garde was in its prime in exile, and that the place of exile was the city of Vienna — a city that drove many of its own artists into internal or external exile, a city of which Theo van Doesburg had written to Walter Dexel in 1924 during his visit to Vienna: "Oh, Vienna is completely hopeless and backward."

Phase 3: MA 1920–1925 in Vienna

The first Viennese issue of *MA*, which now had its editorial headquarters in Vienna's thirteenth district at Amalienstrasse 26, appeared on May 1, 1920. Although in Hungary *MA* had remained part of the Expressionist tradition, when rhythm was liberated by Expressionism and dynamic Futurism, as evidenced by the works of Mattis-Teutsch, Uitz, Bortnyik, Nemes-Lampérth, it was in Vienna that *MA* aspired to pure Constructivism, done in reference to Cubism. It was only in exile in Vienna that the Hungarian avant-garde gained a 'trademark' that has remained connected to it up to the present time (through artists such as Vasarely, Kepes, etc.) — namely, that of Constructivism. Tibor Déry, Andor Németh, László Moholy-Nagy, Lászlo Péri, Farkas Molnár, and the critic Ernö Kállai were the initial Hungarian contributors.

The first Viennese *MA* number began with an appeal by Kassák, "On the Artists from Every Country," in both Hungarian and German. As of this point, *MA* no longer appeared exclusively in Hungarian, but also occasionally in German. In his appeal, Kassák wrote: "The watchword is: the human. Along with liberating the actual powers, the abstract concepts must also be reevaluated." The first four numbers were each about sixteen to twenty pages long; they all appeared in 1920. In the spring of 1920, Kassák began to paint. The first *MA* edition of 1921 (1 January) had a title page from Kassák that combined Constructivist, Dadaist, and Futurist picture poetry elements with the Expressionistic. It was concerned with the outcast and ridiculed wanderer, his experience in exile. This number also contained many images and text contributions from Kurt Schwitters and his "Merz Manifesto." After this initial turn to Dada, the February edition followed with lengthy excerpts from the book, *Wiederkehr zur Kunst* [Return to art], by Adolf Rehne. The March 1921 edition contained *MA's* first reproductions by Moholy-Nagy, in which both Constructivist and Expressionist elements are still united. The title page was by Kassák and at that point had an entirely Constructivist style. The rest of the contents were poems from Blaise Cendrars, Huelsenbeck, and Hans Arp. The April edition, sixteen pages long like all the previous ones, mentioned Moholy-Nagy as a contributor in Berlin. It was primarily dedicated to the work of Archipenko. In addition were texts by I. K. Bonser (Doesburg's pseudonym), Franz Jung, and Erich Mühsam. The June edition, with a title page by George Grosz, contained a contribution from Marinetti about Tactilism, a number of reproductions from Grosz, and texts by Huelsenbeck, Sauvage, Goll, and others.

Cover design by Lajos Kassák and Ernő Kallai for a planned Bauhaus book on *MA* (never realized).

The August 1921 edition, sixteen pages long, was legendary and spoke for *MA's* unique level of quality. It contained Viking Eggeling's manifesto on film, the new art of motion, entitled *Über die Verzeitlichung der visuellen Wahrnehmung* [On the temporalization of visual perception]. Accompanying his text and also on the title page were numerous stills from his films, *Horizontal-Vertical Orchestra* and *Diagonal Symphony*. Also included were drafts for film images by his colleague, Hans Richter. The fact that *MA* recognized the historical and generative significance of Eggeling, as well as abstract film in general, speaks for its timely awareness.

The September 1921 edition was ornamented by a work by Moholy-Nagy, who was the source for most of the reproductions, now in Constructivist style, but still containing machine-like elements. He was also the subject of an article by Péter Mátyás (a.k.a. Ernö Kállai). In addition, there were texts by Majakovsky, Sándor Barta, Jorge Luis Borges, János Mácza, and Christoph Spengemann. The November 1921 edition was dedicated to Kassák himself (the title page, and numerous reproductions whose Constructivism was purer than that of Moholy-Nagy's; he was also the subject of an essay by Péter Mátyás). In addition, there were texts by Schwitters, Cocteau, Alexander Lázsló, Luciano Folgore, and Reverdy. The first edition of 1922, with a typo-poem by Kassák, was dedicated to the dialogue with Cubism (pictures by Picasso, Léger, Gleizes, and an essay by Ernö Kállai). The February 1922 edition was dedicated to Ivan Puni, and included poems by Kassák as well as the manifesto "Präsentismus" [Presentism] by Raoul Hausmann. The March edition belonged to Hans Arp. It also contained Kassák's influential programmatic essay, "Bildarchitektur" [Image architecture] and a report on Dadaism by Huelsenbeck. The May anniversary edition, a double number of thirty-two pages with a now

Lajos Kassák
Picture Book, 1921
Watercolor

purely Constructivist title page by Moholy-Nagy, contained a manifesto by Kassák and reproductions by Hausmann, Oskar Schlemmer, Lipschitz, Kassák, Picabia, Oskár Fischer, J. J. P. Oud, Aurél Bernáth, W. Baumeister, Doesburg, El Lissitzky, Mondrian, Man Ray, Gleizes, Vilmos Huszár, and texts from Tzara, Huidobro, Arp, Gorham B. Munson, Cendrars, Andor Adám, Gleizes, a typo-poem from Kassák, an essay about Constructivism and technique from Kállai, N. Punin's essay on Tatlin, and, in between, photographs of industrial plants. This anniversary edition anticipated one of the most important achievements of *MA*, namely the *MA* anthology that appeared in 1922, *Buch neuer Künstler* [Book of new artists]. The July 1921 edition was almost entirely dedicated to Theo van Doesburg; the August edition had a title page by El Lissitzky, an essay by Kállai about Constructivism, one by János Mácza on the proletarian cult, and numerous manifestos from the Dusseldorf Congress (29–31 May 1922) from Lissitzky/Ehrenburg, Van Doesburg, Richter/Eggeling/Janco/Braumann, and Lissitzky/Richter). The edition thus summarized the increasingly Constructivist direction of *MA*.

Correspondingly, the October 1922 edition contained not only Hausmann's manifesto "Optophonetics" (a further development of Eggelingian thought), Schwitter's "Zahlengedicht" [Numbers poem], and Kassák's German version of "Image Architecture" with excellent reproductions, but first and foremost El Lissitzky's manifesto, "Proun." The December 1922 edition, logically, is dedicated to the Russians. It contained reproductions from Lissitzky, Roszanova, Sterenberg, Drewin, Medunetzky, Altmann, Malevich, Gabo, Tatlin, and Rodchenko, in addition to poems by Malcolm Cowley and William Carlos Williams! The twelve-page February 1923 edition contained, in addition to the film-poem "Chaplin" by Ivan Goll and reproductions by Ozenfant and Jeanneret, which were characteristic of the *MA* members' then-current discussion, and a manifesto about their purist aesthetic. After the influence of Dada, De Stijl, and Suprematism, strong ideological confrontations arose within the *MA* circle, so that certain members such as Uitz left the *MA* circle and went on to Weimar, Paris, or Moscow.

The *MA* circle worked on the revolutionary art of Russia in particular, which was transported in part to Germany and the Bauhaus, where Kállai, Moholy-Nagy, Péri, Molnár, and Bortnyik later worked. After his first encounter with German art, El Lissitzky praised Moholy-Nagy and Péri, whose clear geometry sharply contrasted it. In praising them, he actually praised himself, deservedly so: "Conceived by the revolution in Russia, with us, the Hungarians have become fertile in their art. Moholy-Nagy overcame German Expressionism and is striving for order."

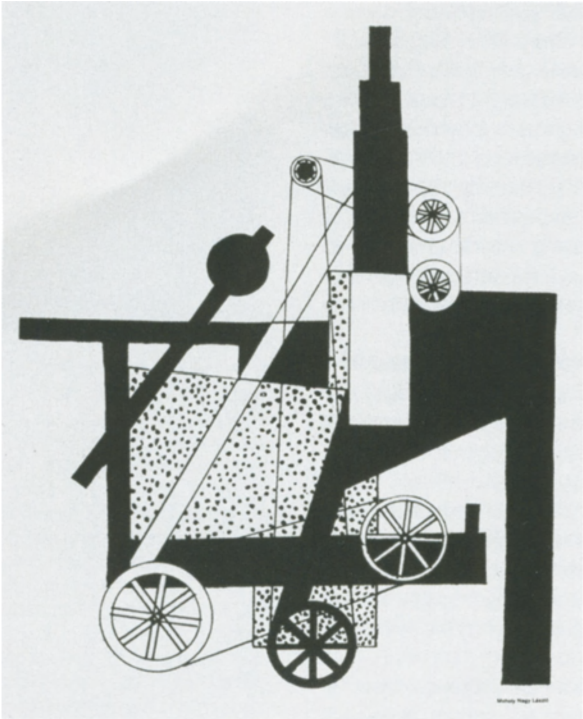
Among other things, Alfréd Kemény was a regular contributor to the German journal *Der Sturm*, and one of the foremost experts on the Soviet avant-garde, along with János Mácza, who wrote about Russia's revolutionary theater. In particular, his illegal trip to Russia, where he heard Arvatov, Malevich, and Ossip Brik lecture on productive art, put him in a position to conduct the theoretical dialogue between the Western and Eastern European avant-garde through in a dialectic article that appeared in both *Der Sturm* and *MA*. For example, he lectured on the tendencies of German Art at the famous Inchuk conference of 1921.

The development of Constructivism flourished at a rapid pace in Vienna. This can be seen in Moholy-Nagy's work, an artist who joined the *MA* group in 1918 with Bortnyik and Péri. In spring 1919, he showed a purely Expressionist painting at the "Exhibition of War Victims" in Budapest. Moholy-Nagy went to Vienna in December 1919. How long he was there is unclear; according to his own accounts, it was only six weeks. In any case, he wrote letters from Berlin in 1920 and had his first Berlin exhibition in 1920 at Fritz Gurlitt's gallery with Nemes Lampért. In 1921 his book appeared as part of the series, *Horizont* [Horizon], in Vienna.

Although Moholy-Nagy had painted an Expressionist portrait of his benefactor, Reinhold Schairer, practically in Schiele's style, during his months in Vienna in 1920 and in Berlin from 1920 to 1921, he was fully taken with pure color and form. Since *MA* was involved in active discourse with other avant-garde magazines, Moholy-Nagy was perfectly up-to-date within a year. In Vienna, on 21 March 1920, he dismissed the communist party as "part of the bourgeois world," unable to accept nonrepresentative art as a revolutionary weapon. He discovered composition as the arrangement of relationships between color, form, and position, which he most closely approached through non-perspective geometry. In 1921 he met El Lissitzky. In a 1921 exploration, in which he attempted to free his pictures "from all elements recalling nature," he joined sides with the Russian Abstractionists. Although Kassák and Kállai, in accordance with the nature of their Expressionist development, initially saw abstraction as a continuation of Expressionism, they soon rejected Kandinsky, as had El Lissitzky and Moholy-Nagy, who said that his pictures reminded him of an underwater world. Moholy-Nagy saw in Constructivism the logical continuation of Cubism, which had made considerable headway in uncovering the constructive elements of an image. In May 1922 Moholy-Nagy published his essay "Konstruktivismus und Proletariat" [Constructivism and the proletariat] in *MA*, in which he defined Constructivism as neither capitalist nor proletarian, but rather as an expression "of the direct color of spatial rhythm, the equilibrium of form."

Sándor Bortnyik, born 1893 in Siebenbürgen. Studied at the Budapest Free School under Kernstock and Rippl-Rónai, 1910. In 1918, joined the MA group and became one of its most important members. Immigrated to Vienna in 1920. Developed image architecture with Lajos Kassák. In 1922 published in various magazines put out by Hungarian emigrants in Vienna. Lived in Weimar between 1922 and 1924, was interested in the Bauhaus and O. Schlemmer's theater workshop, and attended Van Doesburg's De Stijl classes. Exhibited at the Galerie Der Sturm in 1922 in Berlin. Participated in the Congress of Dadaists and Constructivists in Weimar. Returned to Budapest in 1925 and founded the avant-garde theater, Zöld Szamár (Green donkey). In 1927, art editor for *Uj Föld* (New earth) magazine. Founded and directed the school for advertising design (Mühely, or little Bauhaus) from 1928-38. Edited *Plakat* magazine in 1933. Taught at the college of applied arts in 1948-49. Director at the college of fine arts in Budapest between 1949 and 1956. Died in 1976 in Budapest.

Sándor Bortnyik



László Moholy-Nagy, *MA cover*, 1921
Reproduction 1970
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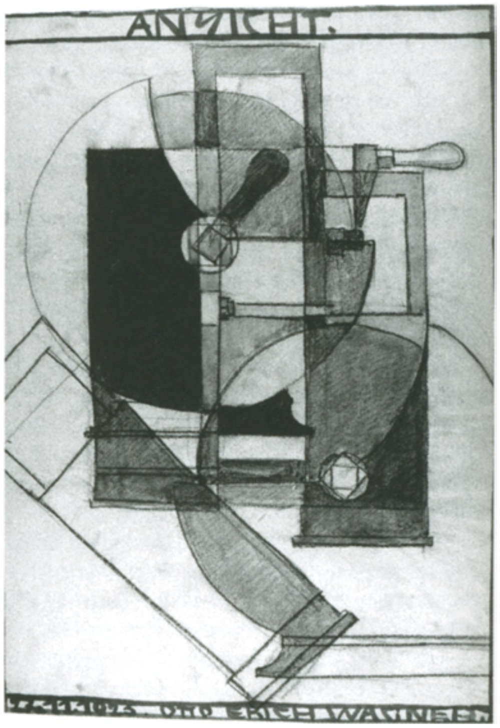
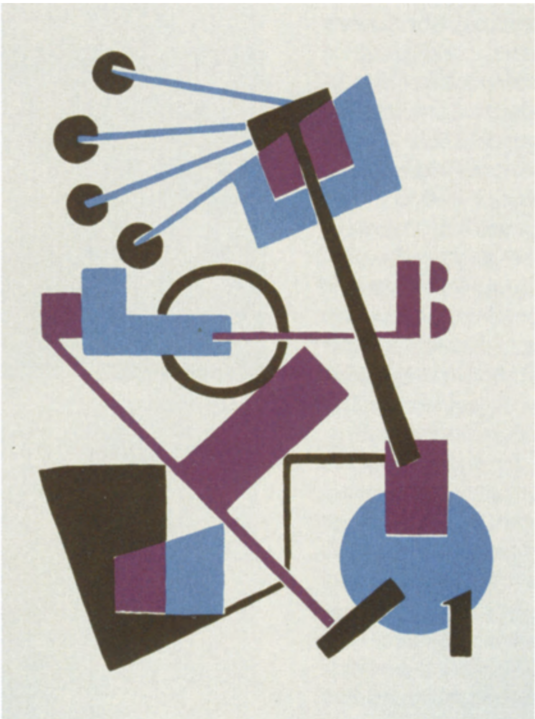


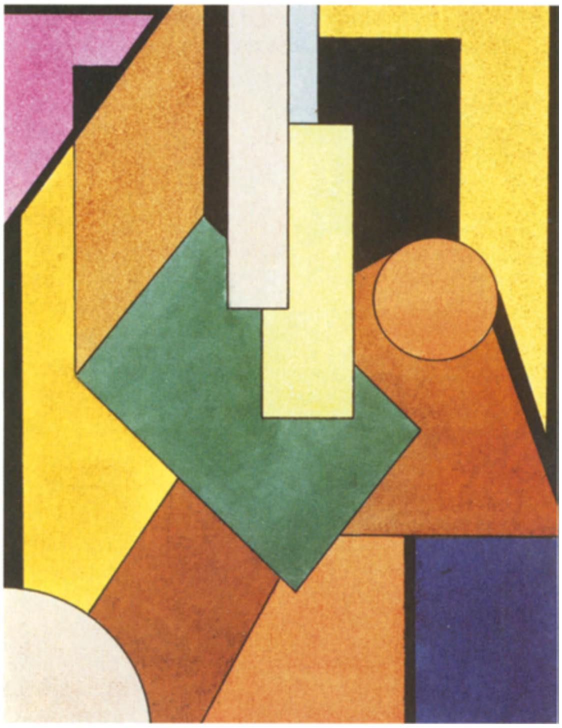
Otto Erich Wagner, *View*, 1923
Charcoal, Indian ink on wrapping paper, 45 × 31 cm



Sándor Bortnyik, *Image Architecture, MA Album II*, 1921
Reproduction 1970

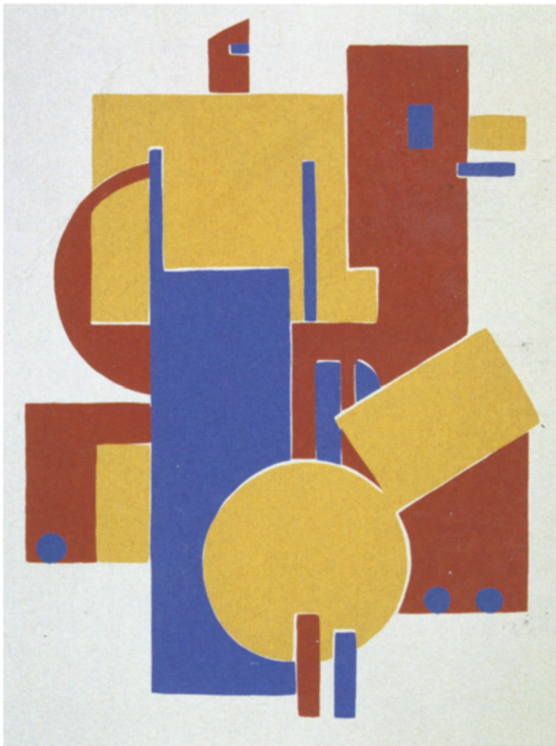
Lajos Kassák, *Steyer Car (poster design)*, c. 1924
Collage, 29.8 × 21.8 cm

Lajos Kassák, *Composition,* 1921
Gouache, 39 × 32.3 cm



Lajos Kassák, *Untitled,* 1921
Colored Indian ink, 26.2 × 20 cm

Sándor Bortnyik, *Image Architecture, MA Album IV,* 1921
Reproduction 1970



Sándor Bortnyik, *Image Architecture, MA Album III,* 1921
Reproduction 1970

László Péri, born 1899 in Budapest. Finished an apprenticeship as a bricklayer and became a student at the workshops for proletariat fine arts in 1919. He was in contact with Kassák and the Activists. In 1917 he began his career as an actor at the MA theater school, studying with János Mácsza. Studied architecture in 1919-20 in Budapest and Berlin. Moved to Berlin in 1921, where he created his first abstract geometric reliefs. In 1922 his portfolio containing twelve linocuts was published by Der Sturm Verlag. Showed at the 1923 Grosse Berliner Kunstausstellung and the November Group's exhibition. Constructivist design for a Lenin tribune for the German art exhibition in Moscow. Worked for the Berlin city building office from 1924 to 1928. Member of Die Abstrakten and Die Rote Gruppe. Shifted to realist sculpture and agitprop art. Immigrated to London in 1934. Moved to Camden in 1934. Co-founder of the Association of Artists for Revolutionary Proletarian Art. Contact with J. Heartfield. Died in 1967 in London.

In the 1920s the divisions between the diverse aspects of abstraction were not as clear as they were, for example, in 1950. Among the Expressionist-influenced abstraction of Kandinsky, the Cubist-influenced abstraction of El Lissitzky or the De Stijl movement-influenced Theo van Doesburg, the similarities were more noticeable than the differences. All published, more or less, in the same journals or taught in the same schools. However, as became evident decades later, secret deep-seated divergences existed between them. For example, in 1920–22, Kassák leaned more in the direction of Ozenfant's and Jeanneret's painterly purism, but also toward Mondrian and De Stijl. (Doesburg, Van der Leck, and Vilmos Huszár, a Hungarian who had immigrated to Holland in 1905, co-founded De Stijl in 1917.)

Constructivism, which would also one day split, had, in its formulation as pictorial, painterly problematic, led to Constructivist painting. Its formulation as architectonic problematic, for example, by Malevich and Rodchenko, led to concrete art. The Viennese *MA* circle took a middle position and developed "Image Architecture," as the title of Kassák's manifesto called it, and to which Bortnyik, L. Kundlák and Moholy-Nagy, were obliged for a time. In these two years, 1920 to 1922, Moholy-Nagy quickly worked out a great number of avant-garde ideas and jumped on the right train — namely that of Russian Suprematism and Productivism. This brought him an exhibition in winter 1922 at Herwarth Walden's famous Sturm Gallery in Berlin. Typically for him, Kassák first exhibited in 1924 (or in 1922, as he claims). However, this move also caused people to accuse Moholy-Nagy of eclecticism, as well as of plagiarizing Lissitzky's later works and those by Alfréd Kemény (alias Durus), a former friend, with whom he wrote a manifesto called *Dynamisch-konstruktives Kraftsystem* [Dynamic-constructive system of forces]. In a 1924 edition of *Kunstblatt* (Art magazine), Kemény accused Moholy-Nagy of promoting himself under false creative premises, as his "sterile work did not contribute to the task of finding a visual expression for our era." Gropius obviously had another opinion: in spring, 1923, he called the twenty-eight-year-old Moholy-Nagy to the Bauhaus, to lead the metal workshop. This was a rapid advancement, occurring as it did two years after his arrival in Vienna in December 1919. A crucial factor was that he had left Vienna after about two months, as he said in a letter on 5 April 1920: "I was decaying actually; as I see it, you can't do anything else there." His career was also helped by a book that he and Kassák had prepared in Berlin: *Buch neuer Künstler* [Book of new artists], which portrayed the peak *MA* activity in Vienna. It was published in Hungarian and German in September 1922 by the *MA* press in Vienna.

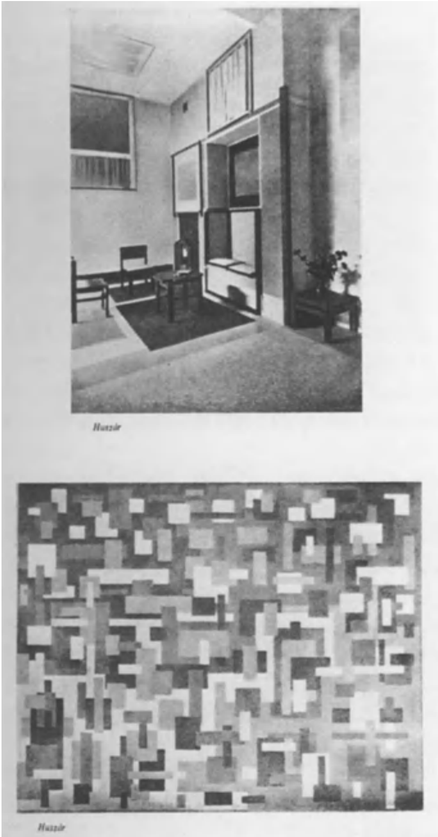
Kassák wrote the story of the origins of this legendary book, which was probably the first great anthology of the avant-garde, as follows:

> *Back then in 1921 I lived in Vienna. Moholy-Nagy was in Berlin, which had become a focal point for art undergoing a process of fermentation. He had access to a larger circle of personal acquaintances, had more opportunity to correspond with people, which is why he took over the task of collecting pictures for the book. We took care of the journalistic work together. I wrote the foreword, designed the typography and the title page. It was the first attempt to show the close, mutually supportive connections among painting, sculpture, architecture, and technology.*

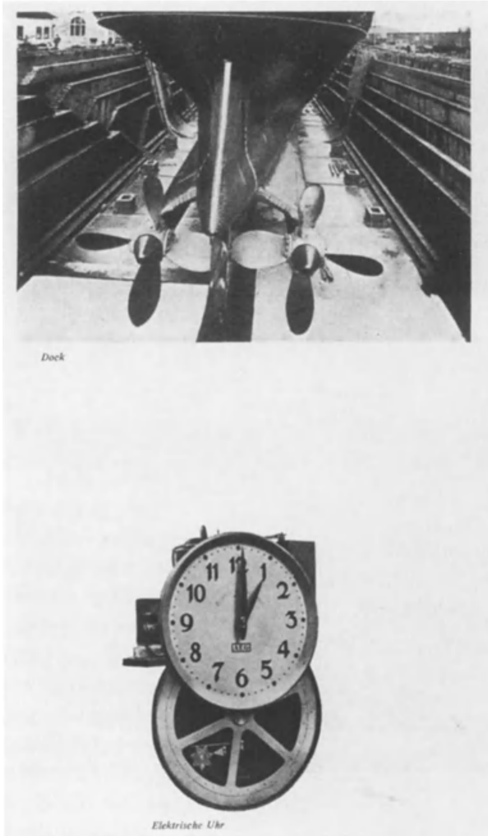
Endré Gáspár, *Lajos Kassák. Az ember es munkája (Man and His Work)* Vienna: Julius Fischer, 1924.

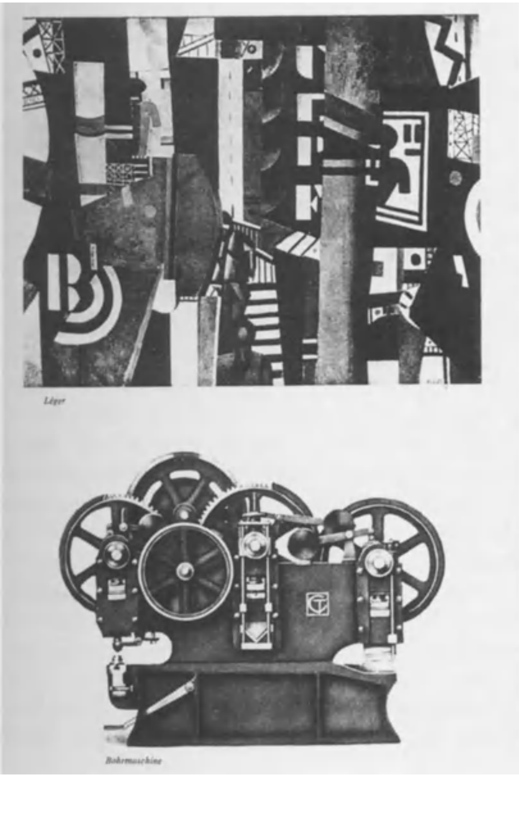
In a letter dated 22 February 1922, Moholy-Nagy urged Kassák on: "When will the anthology appear?" The main work had been finished in 1921. In the spirit of the Machine Age, Kassák and Moholy-Nagy included reproductions of pictures from the most diverse magazines (from Dada to Mecano), which were listed in an index, to provide an overview of modern artistic efforts and their complicated development and references. The choice of pictures is indeed remarkable, and we can certainly thank Moholy-Nagy for their subtly differentiated placement and depth. The anthology contains several excellent pictures of what were then relatively little-known artists, but it is also a very pure visualization of thought about the connections of art movements, in which pictures from industry, daily life, and the world of machines allow for important comparisons and stimuli. This approach to design — comparing and contrasting photographs from the world of machines and pictures or sculptures from the art world — was also found in the journal, *L'Esprit Nouveau* [New spirit], co-published by Le Corbusier and the painter, Amédée Ozenfant, starting in 1920. (In 1923 Le Corbusier published a collection of his articles as the book, *Vers une architecture nouvelle* [Towards a New Architecture].)

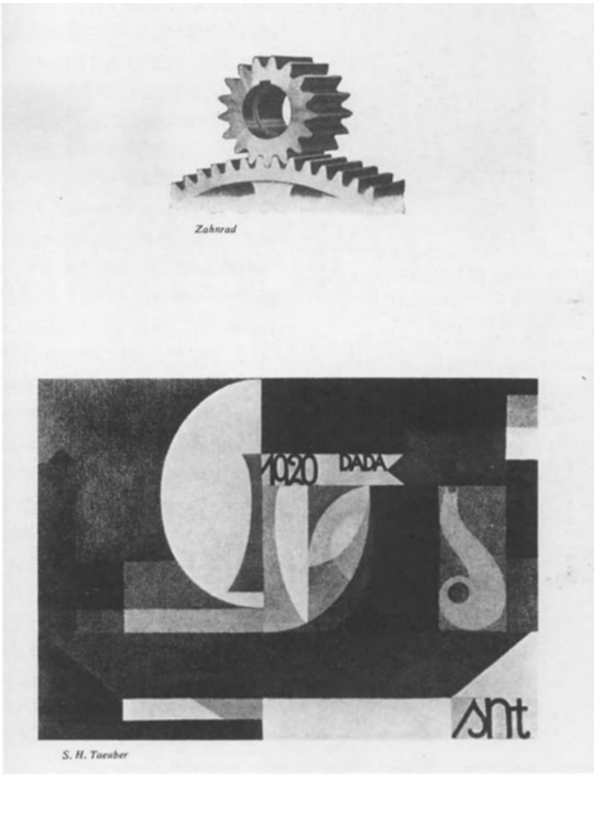
In addition to *Buch neuer Künstler* and *L'Esprit Nouveau*, I must mention yet a third significant book from the epoch, *Die Kunstismen 1914–1924* [literally, The artisms], by El Lissitzky and Hans Arp (Zurich 1925). Also, the series of Bauhaus books from 1923 must certainly be considered a further development of Kassákian typography and the style of the *Buch neuer Künstler*. Gropius and Moholy-Nagy were the co-editors, and Moholy-Nagy also served as typographer; Kállai was also occasionally involved. Most especially, there were Moholy-Nagy's own books, *Malerei, Fotografie, Film* [Painting, Photography, Film, 1925] and *Von Material zu Architektur* [From material to architecture, 1929].



Lajos Kassák, László Moholy-Nagy, *Book of New Artists*, (Vienna 1922), reprint: Lars Muller Publishers, 2002







Alfréd Forbáth, born 1897 in Pécs. Studied architecture at the technical university in Budapest, 1914. Member of the Galilei Circle, 1918. Moved to Munich; finished his studies with Theodor Fischer in 1920. Worked at Gropius's studio at the Bauhaus, 1920. In 1923, he and Bortnyik founded the Neue Reklame Gestaltung company (New advertising design). Chief architect for the Sommerfeld concern between 1925 and 1928. Exhibited at the Weimar Bauhaus in 1926. Started his own office in Berlin in 1928. Taught urban and suburban architecture at the Itten school between 1929 and 1932. In 1932-33, he and Ernst May went to the Soviet Union as city planners. Returned to Hungary in 1933. Immigrated to Sweden in 1938. City architect in Lund between 1938 and 1942. Took over city planning tasks in Stockholm in 1942. Professor at the technical university in Stockholm from 1949 to 1950. Worked at the Institute for Space Exploration in Bonn in 1950. Retrospective of his work was shown at the Bauhaus Archive in Darmstadt, 1969. Died in 1972 in Stockholm.

I am amazed that this unique work met with no resonance in Vienna. In the years 1920 to 1924, thanks to the activities of *MA*, the Expressionist poets, and Friedrich Kiesler's theater exhibitions in 1924, Vienna took a prime position in the contemporary avant-garde. It would be well worth a more specific investigation to find out why this epoch fell into such disregard and why these efforts remained so isolated that each one knew little about the activities of the other. For example, in Kiesler's International Exhibition of New Theater Techniques in the Great Concert Hall and in the corresponding catalogue (copy deadline, September 19, 1924), no *MA* members except Moholy-Nagy were present. Doesburg wrote to Walter Dexel on 11 November 1924,

> *In Vienna there was an excellent exhibition organized by Kiesler. A lot of people met there: Marinetti, Léger, Prampolini, etc. Marinetti ate holes in the Viennese mentality.*

Kiesler's theater exhibition only appeared indirectly in *MA*, namely in the plagiarism battle between Jakob Levy Moreno and Kiesler concerning the precedence of the round stage form. Moreno had been one of the most important Austrian Expressionist poets since 1914. In 1918 he published a monthly called *Daimon*, on which Brod, Wassermann, Weiss, Béla Balázs, Werfel, and Goll also worked. From 1919 the *Neue Daimon* was published by the cooperative publishing house of Alfred Adler, Ehrenstein, Moreno, Sonnenschein, Werfel, and Lampl. In 1923 Kiesler's *Stegreiftheater* [Spontaneity theater] was published by the Kiepenheuer Press. In this work, he evaluated his experience with the stand-up improvisational theater that he founded in 1922, a "theater without spectators." Together with the architect Hönigsfeld, Kiesler designed a model for a theater with a round central stage, where the borders between actor, audience, and director become blurred. Although Moreno's name was mentioned in Kiesler's catalogue, in a quote at the beginning, his *Stegreiftheater* was only mentioned in connection with Honigfeld, not Moreno. At the same time, however, Kiesler was exhibiting a model for a theater with a central circular stage. A battle over plagiarism developed.

Xanti Schawinski pointed out that Moreno's experiments also had an influence on the Bauhaus stage. Moreno immigrated to America in 1925, where he developed his spontaneity theater — which was known as theater ad absurdum by 1923, used for psychodrama and group psychotherapy.

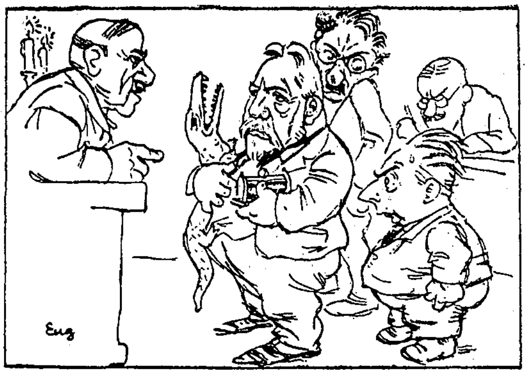
The connections of *MA* to the Viennese Kineticism of Franz Cizek, who taught at the Viennese School of Arts and Crafts, remain uninvestigated. L. W. Rochowanski's book, *Formwille der Zeit* [The current will to create, 1922], features illustrations of works by Cizek's students from his department for ornamental forms. In striving for form and their high degree of abstraction, these works were more radical than some of the *MA* works. Cizek's work, although it had an influence on people such as Roller, Hoffmann, Koloman Moser, Peche, and Loeffler, was, however, rejected and pushed aside by his school, so that his class' yearly exhibition scarcely penetrated the public consciousness. In 1924 Cizek had to accept a new class for form theory, as approved by the administration. Marianne Ullman, Erika Giovanna Klien, R. L. Reutterer, Paul Kirnig, Heinz Reichenfelser, Gertrude Neuwirth, Franz Molnár, Ernst Plischke, Hansi Reismayer, Johanna Reismayer-Fritsche, and Georg Teltscher were among Cizek's students of Kineticism (1920–1924). It was very likely that, at the time, Rochovanski's book identified Franz Molnár as Farkas Molnár, who left Hungary in 1920 and who, in all probability, also lived in Vienna. In 1921, he joined Gropius's Bauhaus. The well-known architect Plischke also learned his vocabulary of form from Cizek, before studying with Oscar Strand (1921–1923) and Peter Behrens (1923–26). Georg Teltscher also studied at the School for Arts and Crafts (1919–1920), before going to the Bauhaus (1921–1923) and then later to England. In Vienna for Kiesler's theater exhibition in October 1924, Marinetti, Prampolini, and Doesburg visited Cizek's class with Rochowanski, and were deeply impressed.

All the more amazing, then, is the absence of a direct connection between *MA* and the progressive Austrian artists in Vienna, with the exception of indirect relationships and awareness, or direct contributions from artists such as musician J. M. Hauer (1925) and Georg Teltscher (1925), of the Bauhaus. Tihanyi had an exhibition in 1920 in the Moderne Galerie in Vienna. The tenth *MA* exhibition, featuring Béla Uitz, also took place in Vienna in 1920. At the premises of the Freie Bewegung [Free movement], the artist's group led by A. Loos, which was located in Vienna's first district at Kärntner Strasse 4, the *MA* circle offered an evening about Russian art on 13 November 1920. About the Russians, Kassák said,

> *our painting was also shown the path it had to take if we wanted to realize our ideals and achieve a constructive form of life. They are the sons of the future.*

On 16 October, there was an *MA* evening in the concert hall, featuring poems by Schwitters, Arp, Tzara, and some young Hungarian authors. The conversion of

Caricature depicting the plagarism trial against Kiesler, printed in *Die Stunde* on 25 January 1925



Kassák's theories into pictorial praxis, begun in the spring of 1920, led to the first exhibition of his paintings, gouaches, sculptures, collages, typographies, and picture poems in the Viennese Würthle Gallery in 1921. On 15 September 1921, the *MA* circle gave a matinee on Activism, Expressionism, and Dadaism, with contributions from Arp, Moholy-Nagy, Sándor Barta, János Kudlák, and Jorge Luis Borges. In 1921 Kassák also met Marinetti at the Hotel Erzherzog Josef.

From left to right: Kiesler, Marinetti, Van Doesburg, Prampolini, and Rathe in Vienna, 1924

Horizont proposed a series of books on Archipenko, Huelsenbeck, Schwitters, Grosz, Klee, and Marinetti. The first, on Archipenko, was published, followed by one on Moholy-Nagy in 1921. In the September 1921 issue of *MA*, six future editions of *MA* were announced: the poet Sándor Barta, Kassák's image architecture, János Kudlák, János Mácza, Simon Andor, and thirteen reproductions from Moholy-Nagy. The Viennese Bán Publishers published a verse and novel series by Kassák in 1921, as well as an *MA* portfolio of image architectures by Bortnyik. Published in 1922: an Aurél Bernáth print portfolio, and the famous *Buch neuer Künstler* by Kassák/Moholy-Nagy in September. In 1923 Kassák's poems were published as the first *MA* book, then a second volume of poetry and Tristan Tzara's "Gas-Coeur." A special German edition of *MA* also appeared in 1923, with contributions from Karl Peter Röhl, Adolf Behne, Werner Gräff, and Hans Richter. Eggeling/ Hausmann's "2. präsentistische Deklaration" [Second presentistic declaration] addressed the international Constructivists. Also featured were Ludwig Hilberseimer (*Über die Bewegungskunst von Eggeling/Richter* [On the motion art of Eggeling/Richter]) and Gert Caden, among others. In addition to Constructivist works by Egon Engelien, Josef Peeters, and Röhl, the March *MA* presented a new Viennese colleague, the painter and poet Hans Suschny, who painted interesting variations of "image architecture." The July 1923 *MA* contained contributions from Léger, Baumeister, Richter, Farkas Molnár, Henrik Glauber, M. Brommer, Cocteau, Suschny, and Kállai. The September *MA* contained contributions from Tibor Déry, Kassák, Doesburg, Herwarth Walden, Schwitters, Huidobro and another Austrian, R. N. Coudenhove-Kalérgi. In 1924, contributions and/or reprints by Lenin and Trotsky appeared, as well as a great many architectural essays and reproductions, primarily by A. Korn and Gropius; in April 1924 there was a first-time contribution from Josef Matthias Hauer, the founder of twelve-tone music. In 1924, Kassák had a Sturm exhibition in Berlin. On 22 March 1924, *MA* also hosted their first German propaganda evening in the Schwarzwaldsaal (Herrengasse 10, Vienna 1) on the subject of Hungarian art, with the aid of Miriam Schnalbel-Höfflich, Paul Emerich, Hadank, Zyperowitch, Leo Halpern, Max Kuhn, and Hans Suschny. In September 1924, before Kiesler's theater exhibition, a music and theater volume of *MA* appeared with contributions from N. Altmann, A. Vesnin, Kassák, Stepanova, Marinetti, Kamardionko, H. Walden, Schwitters, G. Caden, Léger, El Lissitzky, Tairoff, Suschny, Moholy-Nagy, Coop, Grosz, Chagall, Prampolini, Picasso, Stuckenschmidt, Georg Teltscher, Josef Nádass, Günter Hirschel-Protsch, and Josef M. Hauer. The anniversary edition of 15 January 1925 contained a contribution from Moreno-Lévy about the *Théatre Immediate*, and a French anthology on Surrealism (with Max Jacob, Paul Eluard, Philippe Soupault, Tzara, Picabia, and Pierre Reverdy). On the last page, in capital letters, was printed, "propagate the art of the avant-garde." On 15 June 1925, the last *MA* number was published, "Das Junge Schlesien" [Young Silesia], with contributions from G. Hirschel-Protsch, Hans Leistikow, Max Berg, and others. Kassák most likely met Marinetti once again, either in 1925, or at the Kiesler's 1924 theater exhibition, where Marinetti was also present. On 8 May 1926, *MA* presented a retrospective of 1925-26, once again in the Schwarzwaldsaal, with the title "Konstruktive Kunst" [Constructive art]. Works included poems (Kassák, Nádass, Suschny, Surrealists, Dada), music (Bartók, Milhaud), dance (Gertrud Krauss), and the event included such participants as Jolán Kassák, Krauss, Ernst Bachrich, H. Rodenberg, Franz Wrangler, and Josef Kalmer. Kassák and Kemény published their "Manifesto of Kineticism" (1924) in the magazine *Der Sturm*, in which they proposed dynamic constructivism as a solution to the problem of time in pure painting: the unity of material, movement, and space. On 14 June 1926, there was an *MA* matinee in Paris, opened by Paul Dermée, with Ivan Goll, Phillip Soupault, and Michel Seuphor in attendance.

Competition entry from the "Workshop for Mass Form" for *The Chicago Tribune*, 1922

In Paris, Kassák got to know Léger, Arp, and Le Corbusier personally. There was also finally a bit of international recognition, for example, the eighteenth Bauhaus book, *MA Ungarische Gruppe* [MA Hungarian group], by Kassák and Kállai was announced, although it was never completed. However, Kassák, who, unlike Moholy-Nagy, did not follow the trail leading to an international career, went back to Hungary after the end of the counter-revolution in the autumn of 1926. In 1926 he received a postcard from Paris upon which was

Lajos Kassák
Image Poem, 1924-26

Lajos Kassák (middle) and his circle

written, "Nos amitiés internationales à Kassák," [our international friendship to Kassák]; it was signed by Mondrian, Seuphor, and Prampolini.

As we can see, there was active international cooperation on a personal as well as a professional level. There were also several *MA* activities in Vienna, but basically only a small amount of necessary collaboration with Viennese artists. The success abroad was much greater, as shown in a late greeting by Arp:

Dearest Kassák, the news that Kassák will soon come to Paris in person surprised me more than if I had heard that Santa Claus himself wanted to come here. I received the first news of you in Zurich — that was a long time ago — from Sophie Taeuber, after her return from Vienna. She brought one of your works with her, which we carried around with us like an icon. Sophie also brought your publication, "Das Buch der neuen Kunst." She was so excited that she designed a project, "Monument à Kassák."

It was through *MA* and the Hungarian exile avant-garde artists, who had more contact with international artists than with local artists, that Vienna became a center of the Constructivist avant-garde, despite the strong attraction of Paris, Weimar, and Moscow — and the corresponding departure of the Hungarians. For in turning *MA* into a forum for Constructivism, Kassák lost many old comrades. His co-editor from 1920, Béla Uitz, broke with Kassák in 1922, and after a stay in Moscow in 1921, became a co-worker for the Hungarian communist monthly, *Unity*. In 1923, Uitz had an exhibition at the Vienna Austrian Museum, before he moved on to Paris and Moscow. The poet Sándor Barta also went with Uitz.

Lajos Kassák, poster for the Galerie Der Sturm, Berlin, 1924

János Mácza also immigrated to Russia for ideological reasons. Inspired by Farkas Molnár, whom he met in Vienna, Bortnyik left as well. He had been one of the most active *MA* members since 1917/1918; he came to Vienna in 1919 but left in September 1922 and went to Weimar, where he stayed until 1924. In Weimer, although he didn't work at the Bauhaus, he was in close contact with Bauhaus people, living in Doesburg's studio when he was abroad. In 1925 Bortnyik went back to Budapest. While in Weimar, Bortnyik visited Mattis-Teutsch, who had been an *MA* member from 1917 to 1925 before going back to Romania around 1930. Between 1921 and 1930, Bortnyik was present at a number of avant-garde group exhibitions in Rome, Berlin, Chicago, and Paris.

As will be seen by the example of the younger generation of Hungarian avant-garde artists, the Bauhaus (and to a lesser degree, Moscow) drew the Hungarian Constructivists out of Vienna. Many still worked on *MA* from Weimar. Vienna was also a springboard for exhibitions and careers in Berlin and Weimar — a destiny that others have encountered to this day. Doesburg was also interested in *MA* early on, but by the winter of 1921, he had turned more to the Bauhaus.

A particularly interesting case of being lured from Vienna by the Weimar Bauhaus is that of Johannes Itten, who from 1916 to 1919 worked in Vienna as a painter as well as in his own private art school. Represented by Alma Mahler (at the time Alma Mahler-Gropius, later Alma Mahler-Werfel), who was interested in Itten's painting, he became acquainted with Gropius in the summer of 1919 and at Gropius's urging, moved to Weimar that autumn. Itten's students followed him: Carl Auböck, Josef Breuer, Max Bronstein, Friedl Dicker, Vally Neumann, Franz Probst, Franz Scala, Naum Slutzki, Margit Téry-Adler, Walter Heller, Anni Wottitz, and Gyula Pap. Pap already had his first group exhibition behind him, in the Haus der jungen Künstlerschaft [House of young artists], but Itten's departure and Gropius's Manifesto led him to move to Weimar, where he remained from 1920 to 1924. Between 1926 and 1933, he was a teacher at the Itten School in Berlin. In 1934 he opened a private art school in Budapest, where ErnőKállai, the long-standing *MA* and Bauhaus collaborator who had returned home, also worked. In 1947 Pap founded a painting school for poor but talented children of workers and farmers.

Lajos Kassák, *Constructive Art*, 1926, poster design

Bauhaus drew numerous Hungarians into its fold: Moholy-Nagy, Farkas Molnár (1921–1925 with Gropius, returned to Hungary in 1925); Marcel Breuer (1920–1924 Bauhaus in Weimar, 1925–1928 Master at Bauhaus in Dessau); Andor Weininger (1921, in Weimar with Itten; 1925 at the theater workshop in Dessau); Gyula Pap, and Bortnyik. In short-term residence were artists such as Mattis-Teutsch, Alfréd Forbáth (1921–1922 with Gropius; a freelance architect from 1923 on, later in Sweden), Kállai, Berger, Téry, Henrik Stefán, and Lászlo Péri (1920 Vienna, 1921 Berlin, where he made the first cement reliefs, architect as of 1924, 1933 London). The following members of the Hungarian avant-garde either lived in Vienna or had a connection with the Viennese *MA* circle: János Mattis-Teutsch, Moholy-Nagy (1919–1920), Aurél Bernáth (1921–1922 in Vienna, where his graphic portfolio appeared in 1922, Sturm exhibition, 1924; 1923–1926 Berlin; returned to Hungary in 1926); Sándor Bortnyik (1919–1922); Alfréd Forbáth (*MA* reproduced his Constructivist drawings); Vilmos Huszár (co-founder of De Stijl, left in 1923, in contact with *MA* from 1920–1925); Farkas Molnár (1919, 1920, spring 1922 in Vienna); Nemes-Lampért (*MA* member as of 1918; 1919 in Berlin, 1920 exhibition with Moholy-Nagy in Berlin at Gurlitt; died in a sanatorium in1924); Lászlo Péri (*MA* member as of 1918; 1920 Vienna, 1921 Düsseldorf, later Berlin); György Ruttkay (MA member as of 1918; 1920 Vienna, 1922–1923 Berlin); Ernő Kállai, Alfréd Kemény, Andor Németh, Sándor Barta, Béla Uitz (1919–1923), Kassák (1920–1926), Tibor Déry, János Mácza, Andor Weininger, Gyula Pap (1919), János Kmetty, the two excellent and unfairly forgotten futurist Expressionists, Hugó Scheiber and Béla Kádár, who exhibited together in Budapest in 1921, and afterward often at Sturm and elsewhere; János Kudlák, Bertalan Pór (from the Nyolcak, which was in Vienna for a short time after the counter-revolution; 1928–1948 Paris, then Budapest); Gyula Derkovits (student of Kernstok 1919, 1923–1926 in Vienna, then again in Budapest); Károly Kernstok (1920–1926 in Berlin, returned to Hungary in 1927); Lajos Tihanyi (1919–1921), Robert Reiter, Gáspár Endre, and others. Lajos Tihanyi moved to Berlin (1922) and Paris (1923) after his exhibition at the Moderne Galerie in Vienna in 1920; he thus belonged to that group of avant-garde artists who chose exile in Paris instead of Vienna, Moscow, or Berlin. In Paris, Tihanyi became a member of the group, Abstraction-Création, in 1933; the Surrealist Robert Desnos published a book about him in 1936. Important Hungarian founders or members of Abstraction-Création, which Van Doesburg also later joined, were notably István (Étienne) Béothy (from 1920 in Paris, where he and Herbin founded Abstraction-Création in 1925); Henri Nouveau alias Henrik Neugeboren (1927–29 Bauhaus in Dessau with Klee; 1929 Paris) and Alfred Reth (1905 Paris, 1913 Sturm exhibition, 1932 Abstraction-Création).

The inner *MA* circle was most solid between 1920 and 1922; after this the migration began. However, *MA* still moved on to become a center for the international avant-garde, thanks to the collaboration of its members from outside Vienna. After *MA* opened up to Berlin Dada, Futurism, Russian Constructivism, and finally even early Surrealism, it mainly helped to lead the first phase of International Constructivism to its peak in 1925. According to his biographer, Tomas Straus, Kassák discovered himself while in exile in Vienna, but I would add that he also founded Hungarian Constructivism. The Hungarian path, from Expressionism to objectlessness, to geometric and optic abstraction, maintained a worldwide reputation, thanks to the work of Moholy-Nagy, Béothy, Kassák, Huszár, Kepes, Schöffer, Vasarely, and Marcel Breuer (in architecture). Perhaps painters and architects Mattis-Teutsch, Bortnyik, Péri, Tihanyi, Molnár, Weininger, Antoine Prinner, Béla Uitz, and Henri Nouveau deserve the same acknowledgement. A collection of prints by Kassák (six serigraphs from 1920–1923) and Vasarely (likewise six serigraphs), which appeared in 1961 at Denise René's in Paris, clarified the arc of Hungarian Constructivism's international reputation and affirmed the *MA* circle's exile in Vienna from 1920 to 1925 as its most important source.

MA is indebted to Vienna for exile only. Vienna is indebted to *MA* for making it one of the centers of the international avant-garde. The *MA* epoch in Vienna between 1920 and 1925 was possibly the only moment of the modern fine arts between the wars — and, typically, Austria passed that up as well.

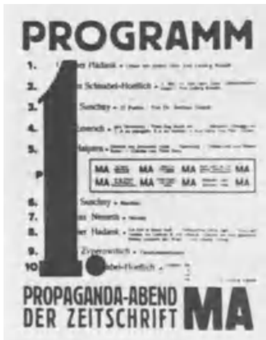
Gyula Pap, born 1899 in Orosháza. Attended the Imperial Graphic Teaching and Experimental Institute. Military service, 1917. In 1918 he returned with the Hungarian revolution to Budapest. Studied at the Budapest school of arts and crafts. Immigrated to Vienna in 1919, moved on to Berlin. Studied at the Bauhaus under J. Itten, 1920. Worked at the metal workshop at the Bauhaus from 1921 to 1923. Lithographer between 1924 and 1926. Edited *Élettudomány* (Science of life) magazine as part of the pacifist movement. Taught painting at the Itten school in Berlin between 1928 and 1933. Returned to Budapest in 1934. Designer at the Goldberger textile factory between 1937 and 1940. Civil service at the Hungarian steelworks, 1944. Founded the János-Nagy-Balogh painting school for the children of workers and farmers, 1946-47. Professor at the college of fine arts in Budapest from 1949 to 1962. Died in 1983 in Budapest.

Poster by Hans Suschny, 1925

Epilogue
Phase 4: 1926–1930

During the period following the end of the counter-revolution, it seemed possible to many artists that a continuation of the Hungarian Soviet Republic of 1919 could provide consolidated freedom; therefore, many returned to Hungary. Farkas Molnár had already returned to Hungary in 1925, where he died in 1945. Károly Kernstok (1927), Alfréd Forbáth (1933–1938), Róbert Berény (1926), Moholy-Nagy (for one week in 1930), Sándor Bortnyik, Gyula Pap (1934), and Aurél Bernáth (1926) also went back to Hungary.

Bortnyik, who had gone to Budapest in 1925, founded a private school named Mühely [Workshop] or Kis Bauhaus [Little Bauhaus], which he led for ten years, until 1938. The most famous student at this school was Vàsàrhelyi, world-famous under the name Vasarely — who, after he learned Constructivism from Bortnyik, carried on the trends created by Hungarian Constructivism and the Hungarian representatives of Abstraction-Création (Nouveau, Béothy, Reth) to Op Art. The worldwide experiments conducted by Hungarian Constructivists in Vienna, Weimar, and Paris culminated in a victory over time with the omnipresent popularity of Vasarely. Where this victory comes from, which source can be thanked for it, on which geographic and cultural background it is constructed, is clarified by the history of *MA*. In a foreword for a 1961 catalogue published in Paris by Denise René, Jean Cassou wrote about the prints of Kassák and Vasarely, "It is actually Kassák who leads us to a better understanding of the real sources of abstraction."



Poster by Lajos Kassák, 1924

In December 1926 in Budapest, Kassák started a journal called *Dokumentum*. The articles, which appeared alternately in German, French, and Hungarian, were about architecture, the Russian avant-garde, Surrealism,

Lajos Tihanyi, born 1885 in Budapest. Attended the school of arts and crafts in Budapest, 1904-05. Co-founder of the Nyolcak avant-garde group in 1909, which presented an exhibition at the Berliner Secession in 1910. Exhibitions in 1914 in Vienna, and in 1918 at the MA Galerie. Emigrated to Vienna in 1920. Exhibited at the Moderne Galerie, Vienna. Lived in Berlin from 1920 to 1923 and painted Expressionist portraits. Shows in Berlin and Paris, where he finally settled in 1923. Went to America in 1929. Member of the Abstraction-Création group. Died 1938 in Paris.

Lajos Tihanyi

and film aesthetics; they included an article by Walter Benjamin, "Über die neue russische Filmkunst" [On the new Russian cinematography], written in Moscow. In May 1927 the magazine ceased publication due to a lack of interest. Under more difficult conditions involving police and censorship, Kassák published *Munka* [Work] from 1928 to 1938. Throughout the years, Kassák fought for his communist convictions, enduring court cases, the impoundment of his publications, imprisonment, and confiscation. Until 1930, the artistic emphasis of *Munka* was photography. Photocollages and montages led to a social photography movement in Hungary. Among the young new avant-garde, for whom photo and film was their actual medium, the most important were Sándor (Alexandre) Trauner, Lajos Vajda, Gábor Peterdi, and the later world-famous György Kepes. Under the influence of Russian film, they created brutal photomontages, a unity of Constructivist and social elements, which were in accordance with the new demands of the period. The contact with artist colleagues abroad remained intact — for example, Moholy-Nagy published his essay "Über das totale Theater" [On total theater] in *Dokumentum*. However, the rising fascist activities made free artistic endeavors more difficult — for example, the Hungarian chamber of engineers denied membership, based on the race principle, to Marcel Breuer, who wanted to return home.

After 1930 these young avant-garde artists also left Hungary — Vasarely, Kepes, Trauner, Sándor Vajda, and Peterdi. Vajda returned to Hungary from Paris in 1933. Trauner first went with Kepes to Berlin and then, around 1930, to Paris. He became an excellent film set designer, working with Marcel Carné, Howard Hawks, and Billy Wilder (*The Apartment*). Gábor Peterdi, who was a member of the Munka circle from 1930 to 1933, moved to Paris in 1933 and then in 1939 to the United States, where he later became a professor at Yale University. Kepes went to Berlin, where he became a colleague of Moholy-Nagy's. Later, he and Moholy-Nagy worked together the New Bauhaus in Chicago in 1937, where the semiotician Charles W. Morris, Xanti Schawinsky, Herbert Bayer, and Archipenko all taught. He was also at its successor school, the School of Design in Chicago, from 1939 to 1946. Afterward he became a professor for visual design at the Massachusetts Institute of Technology in Cambridge, where, in 1947, he founded the world-famous Center for Advanced Visual Studies, which he led until 1974. His successor was Otto Piene. As an author (*Language of Vision* [Chicago, 1944]) and publisher (*vision + value*, 6 vols. [New York, 1966]), as an artist and teacher, Kepes — next to Moholy-Nagy, Breuer, and Vasarely — represents a further international triumph of the *MA* circle's efforts.

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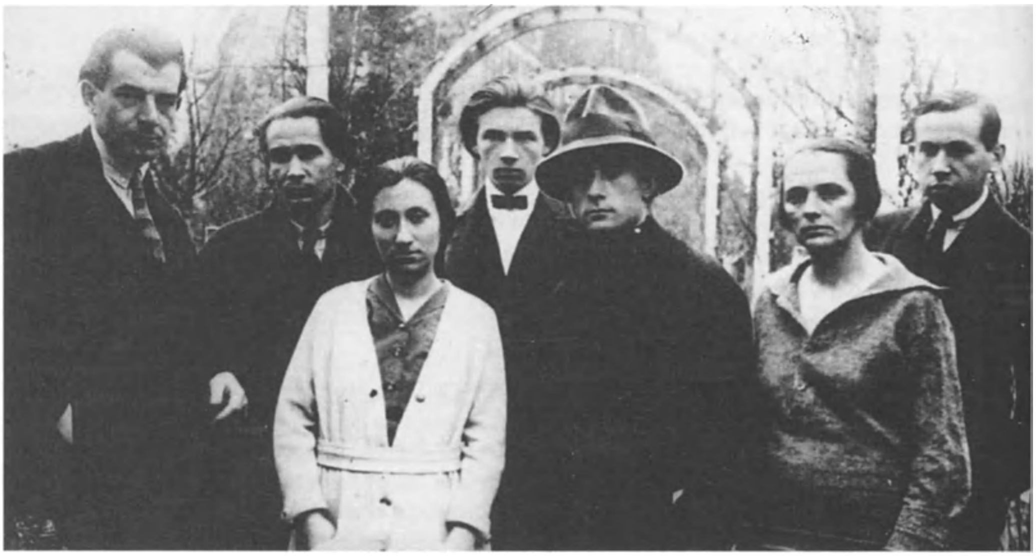


The Hungarian avant-garde group, *MA*, in Vienna, 1920. From left to right: Sándor Bortnyik, Béla Uitz, Erzsébet Újvári, Andor Simon, Lajos Kassák, Jolán Simon, and Sándor Barta

Éva Bajkay

Hungarians at the Bauhaus

During the second half of the nineteenth century in Hungary, opportunities for education in the arts were still limited, and so many students of painting went to Munich. There, at one of the strongholds of conservative academics, their professors were (paradoxically) Hungarians such as Benczur, Liezen-Mayer, and Wagner. One hundred and ten years ago, in 1886, another Hungarian, Hollosy, opened an independent painting school in Munich, where students were taught to value individual intuition and to strive for an ideal union with the modern zeitgeist. This explains why, in the early twentieth century, Hungarians looked upon Germany as the place for advanced art education. It should be noted, too, that German art schools had always seemed especially appealing to Central and Eastern Europeans. After World War I and the revolutions, their importance was reinforced by the Weimar Republic's democratic system, where foreigners were welcome. Moreover, the inflated German Mark made life relatively cheap.

In 1919, when new conditions prevailed, the successor to the Saxon Imperial Academy, the Bauhaus of Weimar, was opened as a contemporary, small, utopian cultural model of the young German Republic. It is worth mentioning, however, that neither the authorities, nor the artistic world, nor the general public were as yet prepared to accept the principles of a progressive, open, international, and creative educational community, as proclaimed by this academy.[1] This situation had its obvious impact on the history of the Bauhaus: its critical moments clearly indicate the historical changes and the gradual shift toward the right. Thus, unlike the academies, which were well adjusted to the outdated nineteenth-century social system, the Bauhaus, endeavoring to create art for a modern industrial civilization, remained in utopian isolation during the 1920s. For that reason, the school had a special appeal to the young talents from less industrially advanced countries with a more conservative political system, which explains why it attracted so many Hungarians.

With the exception of Breuer and Moholy-Nagy (instructors), little is known about the activities of the other Hungarians at the Bauhaus: Bánki, Berger, Fodor, Frölich, Hollós, Johann, Kárász, Lichtenthal, Markor-Ney, Molnár, Müller, Pap, Schwarz, Stefán, Téry-Adler, Thal, Weiner, and Weininger (students) Kallai (aesthetician), Forbát (architect), and Neugeboren (sculptor, painter, musician). The activities of the whole group are grossly neglected by Leo Kohut.[2] Only in the past few years have there been exhibitions of these artists.[3]

The Hungarian students of the Weimar Academy were young; they were not political migrants like the majority of artists working in Vienna and Berlin after 1919. The Bauhaus was preferred by German-speaking art students, who were mostly of Jewish origin. On the one hand, this group consisted of students who had finished secondary school in Vienna and were adherents of Itten (Margit Téry-Adler, Gyula Pap), and, on the other hand, students from Saxon, Serbia, and the Hungarian communities of southern Hungary (Marcel Breuer, Farkas Molnár, Henrik Stefán, Johan Hugó, Andor Weininger). The latter went to the school on the advice of Alfréd Forbát, an architect from Pécs, who worked with Gropius. It may be of interest to note that Breuer first attempted to study in Vienna on a scholarship, but he only stayed for a couple of months. "I entered the Academy, but immediately left: I knew that it was not for me," he wrote about his departure from Vienna.[4] He began by studying painting, and his early, dynamic watercolors, containing Dadaist elements, indicate the impact of Itten's and Klee's teaching, which emphasized individual expression.[5]

Margit Téry-Adler, *Untitled,* 1920s

The most obvious example of how the Hungarians of the Viennese Itten School were incorporated into the Bauhaus can be found in Margit Téry-Adler's work. Like several Austrian students, she followed her teacher to Germany in 1919 and spent a year at the Weimar Academy as one of his adherents. Nevertheless, it is important to note that of all possible work, it is hers — from the silhouette experiments with form to her analyses of light and form in Giotto's frescoes — which were to chose to represent Itten's "Vorkurs" (preparatory course) method in the Bauhaus publication.[6] Margit Téry and her husband, art historian Bruno Adler, also worked with Itten and Schlemmer as editors of the journal *Utopia*, reflecting the spirit of Weimar.[7]

Itten's impact, which dominated the first Expressionist period of the Bauhaus up to 1923, can also be seen in the works of another Hungarian student, Gyula Pap.[8] He and Breuer began the Vorkurs in 1920, and there is evidence that, as early as 1921, he substituted for the teacher during his absences, which was certainly a great honor. The biophysiological and emotional effect of the Itten method, which

1. Karl-Heinz Hüter, *Das Bauhaus in Weimar* (Berlin: 1976); John Willett, *Art and Politics in the Weimar Period. The New Sobriety 1917-1933* (New York: 1978); Éva Forgács, *Bauhaus* (Pécs: 1991).
2. Leo Kohut, "Bauhaus. Ungarn – Tschechoslowakei. Zur Bauhaus-Rezeption in Ost-europa," *Bauhaus*, catalogue (Berlin: 1981) pp. 283-287.
3. *A magyar grafika külföldön. Bécs 1919-1933*, Print Collection, Hungarian National Gallery (Budapest 1982); Krisztina Passuth, *A magyar műrészekaz európai avantgarde-ban. 1919-1925* (Budapest: Corvina,: 1974); *Wechsel-wirkungen. Die ungarische Avantgarde in der Weimarer Republik* (Marburg: Jonan Verlag, 1986). *A magyar grafika külföldön. Németország 1919-1933*, Print Collection, Hungarian National Gallery (Budapest: 1989); *Wille zur Form in Österreich, Tschechoslowakei und Ungarn* (Vienna: Academy for Applied Arts, 1993); *Hungarian Constructivism 1918-1936* (Tokyo: Watari-um, 1994).
4. Peter Blake, *Marcel Breuer – Architect and Designer* (New York: 1949); *Utak árkádiából Utópiába*, cat. (Pécs: Múzeum Galéria, 1997).
5. *Staatliches Bauhaus in Weimar 1919-1923* (1923; reprint Munich, 1980) p. 204.
6. Ibid., pp. 48, 49, 54, 55.
7. Éva Bajkay, "From Medieval Cathedral to the Modern Mechanical Stage," *Annales de la Galerie Nationale Hongroise 1989-1990* (Budapest: 1993/94) pp. 33-47.
8. "Documents of the correspondence between Gyula Pap and Johannes Itten," Ars Hungarica, nr. 2 (Buda-pest:1988,) pp. 201-211.

Margit Téry-Adler, *Dynamic Composition,* 1920

9. Eva Badura-Triska, "Zu Ittens Wiener Jahren 1916-1919," *Johannes Itten. Künstler und Lehrer* (Krefeld/Stuttgart: Kunstmuseum Bern, 1984/85) pp. 69-88; Eva Badura-Triska, "Margit Téry," *Wechselwirkungen*, 1986, p. 292, see **3**.
10. *Die Metallwerkstatt am Bauhaus*, cat. (Berlin: Bauhaus-Archiv, 1992); Lenke Haulisch, Gyula Pap (Budapest: 1974).
11. Éva Bajkay, "Ember vagy kocka," "A korai Bauhaus magyar rajzairól," Művészet (Aug. 6-7, 1988) pp. 36-39.
12. Walter Gropius, "Memorial to the March Dead, Weimar May 1, 1922," Copper Engravings Collection at the Staatlichen Kunstsammlungen Dresden, Inv.: B 1972-26.
13. Ex Sjarel, "De Stijl und Deutschland 1918-1922. Die ersten Kontakte," K.I. Konstruktivistische Internationale schöpferische Arbeitsgemeinschaft, 1922-1927; *Utopien für eine europäische Kultur* (Düsseldorf: 1992) pp. 73-80.
14. Ernö Schubert, "Képkiállitás", Krónika (Pécs: 1921) pp. 92-93, see also **7** and **11**.

emphasized a variety of material, many different forms, and — most especially — contrasting colors, remained a lifelong inspiration for the first two Hungarian students, Margit Téry-Adler, and Gyula Pap.[9] They both remained loyal to their associative, expressive beginnings, not only as teachers (Téry in Karlsbad, 1923-1926; Gyula Pap at the Itten School in Berlin, 1926-1933), but also as independent artists (Téry in film, photography, and advertising design from 1962 to 1977; Pap in his Berlin period and after 1960). In 1923, after Itten's departure, they, too, left Weimar. Initially, Pap had been interested in craftsmanship, in accordance with the Bauhaus principles. His design of simple, everyday objects, lighting devices, lamps, candlesticks, pots and bowls (reproduced by Technolumen, Bremen) show his belief in the synthesis of the traditional and the modern, in the spiritual clarity of form. Nevertheless, Pap did not remain in the metal workshop, even though it cost him the position of head of the workshop. He replaced rigid forms with essential clarity and devoted himself to a kind of painting focused on the human being.[10]

During the first Bauhaus period there was no training in architecture. Above and beyond this well-known fact, Gropius's private office, which had been started under the direction of his long-time partner, Adolf Meyer, received little attention. Alfréd Forbát, an architect from Pécs, was an active member of the team from September 1920 until May 1922. After his studies at the Technical University of Budapest (1917-1918), he received a diploma in Munich, after studying under Fischer. He was then offered a studio at the Bauhaus, and his architectural activities were closely linked to Gropius's program. He was also busy with issues such as contemporary single family housing, low-cost dwellings, and mass production, even if his projects, though simple, could not be implemented on account of the costs involved. At that time, Germany was facing the dual problem of an enormous housing shortage caused by the last war, and large-scale inflation resulting from industrialization, which hindered such projects. Under this double pressure, Forbát's plans did not come to fruition. As far as his career is concerned, Forbát was a building engineer in 1921 in Berlin-Zehlendorf; in 1922, in partnership with Gropius, he designed standardized dwellings and housing estates. In considering Hungarian participation in the Bauhaus movement (beyond from his periodical lectures), his influence on the young generation of Pécs is even more important to us today. His information through letters, and his advice given Weimar were of great significance. Without his influence, Marcel Breuer would not have become a world-famous architect and furniture designer. And what would Farkas Molnár have achieved in his search for inspiration in Italy?[11] He had been Forbát's fellow student at the Technical University, and so, in 1921, Molnár turned to Forbát for advice. On Forbát's invitation, he went to Germany in the autumn of 1921, along with his artist friends from Pécs with whom he was travelling through Italy: Henrik Stefán and Hugó Johann. Andor Weininger joined them afterward. Later on, Molnár joined Gropius's architectural firm on Forbát's recommendation, where he worked until 1925. Thus there was always an important Hungarian member in the team (Forbát, then Molnár, then Sebök).

The periodical build-up and disruption of partnerships, characteristic for the avant-garde, is well illustrated by the Hungarians working with Gropius. By leaving Gropius early, Forbát broke away from the influence of this overpowering personality. There is no doubt that Gropius exploited his young partners. It becomes flagrantly obvious when one knows that Forbát was deeply involved in making the plaster model for the memorial to the March Dead, and it was Molnár who made the expressive lithograph of it, which was later included in the *Rotes Heft*, published for the inauguration of the memorial.[12]

Their link with Theo van Doesburg of Holland sustained the illusion that they were maintaining their identities apart from Gropius.[13] Forbát and Gropius first met the apostle of Neoplasticism at Taut's home, in November 1920. Forbát's chalk drawings and his participation in the De Stijl group exhibitions (Paris, 1923, and Weimar, 1924) are evidence of their strong relationship. During his stay in Weimar in 1921, Van Doesburg's lectures left a lasting impression on the Bauhaus students. The young artists from Pécs, foremost among them Molnár, were among his admirers. Molnár, Johann, Stefán, and Weininger joined the Bauhaus in October 1921. They had exhibited together previously in Pécs, and discussed the various "isms."[14] The influence of early Cubism can be detected in their Italian townscapes; Molnár and Stéfan each published six of them as part of the set of lithographs produced under Feininger's leadership at the Bauhaus print workshop. Unfortunately, this Italian collection has received little attention, in comparison with other Bauhaus print collections. Though rather akin to Feininger's style, it lagged behind the bold experiments of contemporary European graphic art. From April 1922 on, the young Hungarians sought to develop as artists at the Bauhaus: Molnár in wood sculpture, Stefán in stone sculpture, and Weininger in mural painting. All of these studios worked with Gropius's principle of the *Gesamtkunstwerk*, which the architect had perfected in his buildings. Kandinsky's influence is less palpable in the works; instead, they show traces of Schlemmer, who did not actually work in the workshop, and of Van Doesburg's theories. Molnár and his friends attended the De Stijl courses held by Van Doesburg in Weimar from March to July 1922 and, impressed by this experience, adopted Neoplastic principles. The compositions

Gyula Pap, *The Drawer,* 1923
Ink on paper, 43,5 × 29 cm
© VBK, Vienna, 2005

seen in Van Doesburg's studio had an obvious effect on Weininger's window pane-like work, in which colored squares are assembled into a dynamically contrasting pattern.[15] Molnàr's transition project, designed in collaboration with Keler for the 1923 exhibition, also attempts to enhance spatial effect by means of color. In Molnár's interpretation, the analytic process of the "isms" is as follows:

> *The regular replaces the accidental. Instead of the decorative and the strongly expressive, we have the constructive, the utilitarian, the rational, the international...*

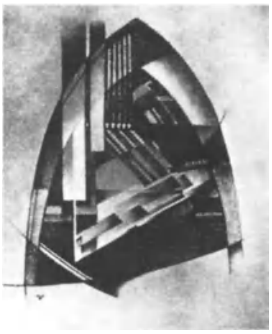
In German, the initial letters of these principles make up the word KURI, and this word became the name of a new group of artists. In contrast to Gropius's manifesto of 1919, they emphasized Constructivism, which they said would construct a new, dynamic world out of clarified elements. The principles in the KURI manifesto clearly delineated a certain period at the Bauhaus: the end of 1992, after the international Constructivist meeting in Weimar, the time in which the influence of Van Doesburg and that of another colleague of his, Vilmos Huszár, was strongly felt. Another founding member of De Stijl, Huszár was also present in Weimar at that time, and as a Hungarian, he is of special interest to this investigation. The Expressionist phase of the Bauhaus had obviously come to an end.

In an article published in the *De Stijl magazine*,[17] Huszár sharply attacked the Bauhaus, condemning the school for promoting subjectivism. He demanded a type of art that was both original and suited to the new technical civilization. The external criticism, internal disquiet, and the organization of the KURI group might have induced Gropius to propose inviting an unknown Hungarian Constructivist master, after Itten had departed. This is how Moholy-Nagy came to the Bauhaus. Thanks to his earlier work and his connections to architects from the Sturm circle in Berlin, he arrived to take the teaching post that Theo van Doesburg had hoped for. Apart from Schreyer, nobody voted against Moholy-Nagy, since Van Doesburg's dogmatic Constructivism and the competitive atmosphere caused by his strong personality had the effect of putting others at a distance.[18]

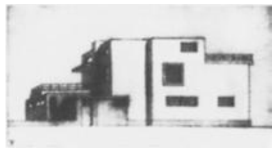
The KURI movement had performed its role in moving the Bauhaus towards Constructivism, yet it soon dissolved. As a matter of fact, it was no more than a loose group of friends, an "abstract union under Molnár's leadership," as Kurt Schmidt, an Bauhaus ex-student living in Gera, described it.[19] Their manifesto, mentioned above, was published in Hungarian.[20] This little-known document contains a list of the KURI members. Of the sixteen who signed it, the first names are, significantly enough, Hungarian ones: Farkas Molnár, Henrik Stefán, Hugó Johann, and Andor Weininger; it was the group from Vienna, whose most recent member, Ludwig Cacinovič, a Croatian artist from Pécs who had exhibited with them before. (During the autumn of 1922 Johann, Stefán, and Cačinovic returned to Hungary, where Johann opened a glass painting workshop; sculptor Stefán returned in 1925 to the Bauhaus sculpture studio in Dessau, where he stayed until 1928.) Breuer, a consistent follower of Gropius, did not take part in the movement, but seven Germans joined. Kurt Schmidt, Breuer's neighbor in the studio, came from the mural painting workshop with his companions, Walter Herzger, Paul Heberer, Otto Kahler, and Franz Hessler, as well as Walter Menzel and Otto Umbehr, who later became photographers. The other members of the group, representing seven nationalities, came for the most part from the mural painting workshop: Czechs Heinrich Koch and R. Kossnik; the only Austrian, Georg Teltscher, who later worked in England; Estonian Rudolf Paris, and Semich Rüstem of Turkey. This theoretical fraternity was something of an exception in the history of the Bauhaus; it was quickly forgotten, and has remained in obscurity until today. An essential feature of this academy as a social institution (unlike other schools) was to promote a liberal, extraordinarily collective spirit. The high ethical standards and intense intellectual atmosphere at the school had a lifelong impact on the majority of the students. Gropius put great emphasis on developing a real collective, made up of young, liberally minded people who came from various countries, who were concerned with artistic, human, and social renewal. Andor Weininger strongly supported Gropius in these efforts. Weiniger remained at the academy even after the dissolution of the KURI group. From 1923 on, he became interested in abstract set design, and in 1924, he and two other former KURI members helped to found the Bauhaus orchestra. It should be mentioned that Gropius highly appreciated Weininger's skills, among which were his ability to create a cheerful yet elevated tone at their evening meetings, and his constant efforts at maintaining a good collective feeling. Later, Gropius tried hard to bring him back to Dessau, even going so far as to personally release him from workshop obligations.[21]

Collective and experimental work were harmonized on the Bauhaus stage. Weininger joined the mechanical stage experiments initiated by two former KURI members, Kurt Schmidt and Georg Teltscher, in their abstract puppet shows developed from simple, geometrical shapes and figures.[22] The mechanically movable figures, designed by Schmidt and his friends, were geometrically shaped and resembled UFOs. Weininger later

15. Éva Bajkay, "A Hungarian Stage Designer of the Bauhaus," *The New Hungarian Quarterly*, 92 (Budapest: 1983) pp. 199-202; Andor Weininger, *Vom Bauhaus zur konzeptuellen Kunst* (Kunstverein Düsseldorf: 1990).
16. "The Kuri Group," *Wechselwirkungen* (1986) pp.260-275, see also 3; Éva Bajkay, "Gruppenbildung in Weimar. Beiträge der unbekannten ungarischen Bauhäusler," *Wissenschaftliche Zeitschrift* (Hochschule für Architektur und Bauwesen Weimar: 1987) 33: 4-6, pp. 331-332; Monika Wucher, *Weltkuri! Der Beitrag einer Künstlergruppe zum gewaltigen Konzept des Weimarer Bauhauses* (1992) pp. 178-182.
17. Vilmos Huszár, "Das Staatliche Bauhaus in Weimar," *De Stijl* (1922) 9, pp. 135-137.
18. Professors' answers to a questionnaire by Gropius (Weimar: Staatsarchiv) Inv. 000102.
19. Note from Kurt Schmidt to the author (Gera, 1990).
20. *Út* (Novisad: Dec. 1922).
21. Gropius's letter of invitation to Weininger in Pécs, November 29, 1925, printed in *Wechselwirkungen* (Bauhaus Archiv Berlin: 1986) p. 270, see also 3.
22. Kurt Schmidt, "Das Mechanische Ballet – eine Bauhaus-Arbeit," *Bauhaus und Bauhäusler* (Cologne: 1985) pp. 123-128.



Alfréd Forbáth, *Composition*, 1920



Alfréd Forbáth, 1923

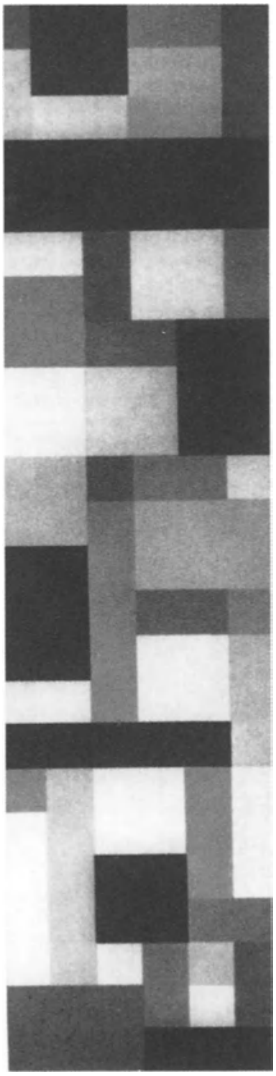
23. Katharina Jánszky-Michaelsen, *Andor Weininger* (Düsseldorf: 1990).
24. Kurt Schmidt, "Akte," Weimar Archiv – Staatliches Bauhaus.
25. *MA* (Vienna, November 15, 1923; September 1, 1924).
26. Oskar Schlemmer, László Moholy-Nagy, Farkas Molnár, *Die Bühne am Bauhaus* (Munich: Bauhaus Books 1925) no. 4.

produced similar figures using much the same method, which are now at the Theatermuseum in Cologne. Schmidt's figures were meant to help demonstrate Bauhaus ideas at the 1923 exhibition. However, this primarily visually based presentation did not contribute to popularizing the Bauhaus. Used to more conventional styles, the public found the presentation overly primitive, even though these mechanical stage experiments were not new outside of Germany. All over the world the possibilities inherent in the direct translation of Constructivist principles to the stage had already been recognized: their sources were Léger's, Malevich's, and Huszár's mechanical, optical, and acoustic "puppet shows." The Russian exhibition in Berlin (1922), the Kinetic programs (Moholy-Nagy, Péri, *Manifesto of the Constructive-Dynamic Power-System*, Berlin: 1922) and the 1922 Constructivist meeting in Weimar must have had a powerful effect on the young artists. Weininger's watercolor sketches for *Mechanical Revue* should not really be interpreted from the perspective of invention, but have more to do with his continual work in this style which also influenced Kandinsky.[23] These stage experiments by former KURI members combined De Stijl's construction of space, based on pure colors and geometrical shapes, with the theatrical concept of the Bauhaus, which increasingly gained importance from 1923 on under the strong influence of Oskar Schlemmer. The relationships among the impersonal, masked, figures as they moved mechanically across the stage, not only served as an abstract visual element, but also represented direct experience for Schlemmer and his students. Although it may have provoked sarcastic criticism among the public, it did not remain ineffective. Also affected was Sandor Bortnyik, a talented Hungarian painter and member of Kassák's group in Vienna, whom Molnár had called to Weimar, too. Bortnyik remained an outsider at the Bauhaus, although he took an active part in their parties and meetings. As a painter, he planned to write a book on Schmidt's set designs from an outsider's point of view.[24] Although his plan never came to fruition, his critical view of the combined effects of De Stijl and Bauhaus in Weimar was clearly expressed in one of his (later destroyed) paintings. Van Doesburg, leaning out from the "prison" of Neoplasticism, stares at a female Bauhaus student who is balancing on a rope, with a ball in her hand. This sarcastic criticism finishes with a view of the new row houses then being planned: a sharp contradiction between what is desirable and rational on the one hand and what is left over and can be experienced. This dilemma could not be solved in the Weimar Republic, either, due to the increasing pressure of the right-wing municipality.

Farkas Molnár, the influential, ambitious, self-appointed leader, also turned toward the theater. Besides his architectural and administrative obligations, he also made lithographs that prove that he never banished landscape, nature, or humanity from his art. He did not become an orthodox proponent of geometrical forms like most of the De Stijl followers. He also had the specific Hungarian avant-garde characteristic, mentioned before in connection with Gyula Pap: a willingness to preserve classical heritage while adopting the contemporary approach. One of his virtually unknown multi-figure compositions may be regarded as the modern version of Michelangelo's *Last Judgement*, and, at the same time, it is an illustration of Schlemmer's manifesto written for the Bauhaus exhibition in 1923. The centrally arranged nude figures represent a community (the Bauhaus) relying on the past, challenging heaven with a firm belief in the future.

After Van Doesburg's influence receded, Schlemmer's influence became dominant for the KURI members left in Weimar. The "Bauhaus Dances" were biomechanical experiments that attempted to transform living figures into mechanical ones. In the *Mechanical Revue*, with its cut-out figures, as well as the puppets, which were more difficult to move, the Bauhaus artists (including Weininger, who appeared among the dancers) explored the effects of color, form, space, and rhythm.

Molnár wrote about the new theatrical experiments for *MA*, the Viennese journal of the Hungarian avant-garde, illustrating his article with photos of Teltscher's and Schmidt's figures.[25] Onstage, he wrote, where space and color both have an architectural dimension, the mechanical figures mediate the relationship between formulated space and man.



Andor Weininger, *Composition*, 1922/1962 © VBK, Vienna, 2005

By 1923, the KURI members had decreased in number. After an effective but brief theoretical involvement they joined in the theatrical experiments at the school. They were not unique: the theater attracted everyone, including all Hungarians. For the first and last time in his life, Marcel Breuer created a set design, the *ABC Hippodrome*. He also designed a poster for *Bauhaus Dance*, which reflected his growing technocratic approach, since it advertised the hard rubber floor and the electrifying, rhythm-generating elements. It is worth noting that even Guyla Pap, whose ambitions lay elsewhere, also designed for the stage. Hungarians made significant contributions to the Bauhaus theatrical experiments, from stage design to innovative architectural solutions.

Besides Schlemmer's, contributions by Moholy-Nagy and Molnár were also outstanding examples of the search for new ways of handling the relationships between the human figure and space, and between the spectators and the stage.[26] Molnár adopted the idea of the open theater, interpreting it from an architect's point of view. In his plan for a "U Theater," the spectators, sitting in a U-shaped auditorium, can follow the performance on three fixed stages, one suspended stage, and various suspended bridges or drawbridges. However, his design was overcomplicated and could not be implemented. The same is true for Moholy-Nagy's mechanical, eccentric script, which aimed for a new synthesis of color, form, movement, sound, and light. Molnár, who retreated into architecture, and Moholy-Nagy, whose bright, creative ideas spread everywhere, from the material experiments of the Vorkurs to photography, film, and theater — appear together in a book, which also documented the final phase of Molnár's Bauhaus activity. Moholy-Nagy, the editor of the Bauhaus books, commissioned Molnár to design the frontispiece for the first volume of the *International Architecture* series. Molnár's design, which resembled the frontispiece of the November 1923 issue of *MA*, reflected a kind of restrained Constructivist design. Moholy-Nagy designed most of the other frontispieces himself. He wrote two whole volumes of the series himself;[27] they testify to his diverse and innovative personality, which Gropius also highly appreciated.

Farkas Molnár, editor of a manifesto, architect, painter, graphic artist, essayist, and propagandist, was a typical representative of the idealistic enthusiasm of the first Bauhaus phase. He was one of those who believed that their attractive, clever plans, detached from reality, were sufficient means unto themselves. Moholy-Nagy, in contrast, was a technocratic builder who embodied the Constructivist period at the Bauhaus. His most representative product was the *Lichtrequisit (Light Requisite)*, designed for an electric stage. Its mechanism, which produced color and light effects, demanded engineering expertise.

The latter was provided by Istvan Sebők, an unknown Hungarian engineer who floated between Dessau, Vienna, and Budapest. He was one of the Hungarians who continued on with the cooperation during the second Bauhaus period. In 1926, after graduating in Vienna, Sebők did not come to Germany to undertake formal studies, but rather to familiarize himself with modern architecture. In Gropius's firm, he took part in planning projects and competitions, as if he were Molnár's successor. Through his collaboration with Moholy-Nagy, he became an "external" member of the Bauhaus. From 1928 onward, in Berlin, he was a film and set designer with Moholy-Nagy and helped Gropius to organize his studio. By designing three mechanical units for the *Light Requisite* and coordinating the movements performed on a rotating disc, he contributed to the realization of a utopian stage machine.

Like his predecessor Molnár, Sebők was an architect with good design skills, who mainly took part in competitions for theater architecture (Dance Theater of Dresden, 1926-1928; Györ, 1929; Harkov, 1930). His designs were based on dividing a building's volume and coloring its various levels using a combination of primary colors. They were of a character with theaters by Hungarian Bauhaus members (such as Forbát's block theater, which was comprised of a single hall and conceived specifically for Hirschfeld-Mack's spotlight effects). Sebők's designs also reflected Weininger's utopia and continued with Gropius's and Moholy-Nagy's notion of the total theater, culminating in an excessive, spherical building (1926).

Having discussed various activities linked with theater, we now turn our attention to the Hungarian contribution to the low-cost housing program, a special concern of Bauhaus architecture. Forbát was chiefly concerned with designing a suitable ground plan, and used flat roofs and geometrical architectural forms lacking fantasy (Studio, Weimar, 1922; residential units, Berlin-Siemensstadt, 1930). In the first Bauhaus period, Molnár's plans differed little from Forbát's, though they showed greater variety of solutions and a somewhat more individualized architectural form. Following Gropius's principles, Molnár gradually moved from the one-story, single family house to various types of terraced housing, which contained small flats. For the exhibition of 1923, he produced a prototype for a new single family house, which he described as "the first square house produced by the universal KURI." The bright, provocative colors of this house (the "Red Cube") represented a revolutionary symbolism, whereas its ground plan is still successful, despite the inhuman, rigid frame. The next step Molnár intended to take was to design a tower block along the route indicated on his postcard, published by the Bauhaus. Central European reality, however, provided different opportunities. His plans were never implemented in Germany, since he left the country at the time of the economic crash. In Hungary, the architects who returned from the Bauhaus (Molnár, 1925; Forbát, 1933) never got beyond designing single family houses. Molnár's activity in Hungary, which lasted until his early death, remains mostly unexplored.[28] Forbát, however, worked in Sweden after World War I, at a time when the Bauhaus principles were spreading, and Marcel Breuer, who had given up designing furniture in favor of architecture, became world famous in the United States. Breuer had adopted the first Bauhaus program and, on Forbát's advice, began his training in the joinery under Gropius and Brendel. It is a token of his progress and talent that, from May 1922 onward, he was involved in teaching; he became a journeyman in 1924 and was a master craftsman from 1925 until 1928. As a teacher, he soon put his stamp on the workshop: he was responsible for integrating the joinery and the metal workshop. Breuer had a typical Bauhaus career, evolving from the traditional handicraft of eclectic

27. László Moholy-Nagy, *Malerei, Photographie, Film* (Munich: Bauhaus Books 1929) no. 14.
28. Otto Mezei, *Hungarians Related to the Bauhaus: Antecedents, Collaboration, Influence* (Budapest: Institute of Adult Education and Institute of Cultural Research, 1981).

Farkas Molnár, *Boy with Kite*, 1923

Farkas Molnár, *Gépember*, 1923

Marcel Breuer
Wooden chair, 1925

Marcel Breuer
Tubular steel chair, 1926

wooden furniture (1925) to steel tube furniture (developed in response to Thonet's invention), to the serial production of his armchair with a steel tube frame (1928). His consistent loyalty to Gropius was unique among the Hungarians. Breuer's collaboration with the director was fruitful: his relationship to Gropius was almost as close as Molnár's to Moholy-Nagy.

The Constructivist period at the Bauhaus began as attention shifted to manufacturing. Upon Moholy-Nagy's arrival, the search for new media soon produced results. Moholy-Nagy's activities covered the Vorkurs, the metal workshop, photography, film, theater, and typography. For him, the integration of art and technology was a fundamental principle, but he did more than write manifestos. He regarded technical progress as a tool in the collective, productive, and practical work geared toward developing human abilities. A true Hungarian artist, he was never a rigid technocrat. He followed the typical course of the Hungarian avant-garde, becoming a Constructivist after having been an Expressionist. His greatest dream was to achieve complete self-realization. On the basis of his autodidactic experience, he rightly propagated the opinion that everybody is talented, and this view was welcomed at the Bauhaus. Between 1923 and 1928, he realized his educational principles most consistently in the preparatory course. He replaced Itten's expressive training based on intuition with a strict, analytic system. He encouraged experiments with forms and materials, but also with spatial construction, color, light, and the various aspects of transparency.

Apart from his inspiring teaching and organizational work, Moholy-Nagy's amazing energy and Hungarian temperament were manifested in painting, photograms, light performances, films, etc. His achievements cannot be discussed in detail here, since abundant literature is devoted to this subject already.[29] After all, the purpose of this paper is not to analyze the best-known Hungarian figures of the Bauhaus, but to take a look at the minor, forgotten ones.

When, in 1928, Moholy-Nagy, Breuer, and Gropius left the Bauhaus, the second period of the academy came to an end. This, however, did not end the participation of the Hungarian students, teachers, and artists. The switch to left-wing functionalism resulted in even greater variety at the school, ranging from industrial commissions to teaching Marxist theory; however, the previous, unified spirit no longer prevailed.

In this so-called "red Bauhaus" period, a special role was played by Ernö Kállai. A Hungarian theorist, aesthetician, and teacher, Kállai had lived in Germany since 1920 and had gained a reputation with his reviews, published in *Das Kunstblatt* and *Sozialistische Monatshefte*.[30] In the early 1920s, he defended Constructivism, but from 1925 onward, the decline of revolutionary utopias made him turn to craftsmanship and realism. At the beginning of the economic crisis, when left-wing political movements grew in strength, Kállai focused on the social aspects of housing and the function of painting, film, photography, etc. He advocated the notion that production had to meet the real needs of the masses. During his year as editor of the Bauhaus journal (1928-29), he declared — both in his teaching and in many of his articles — that the Bauhaus was scientifically oriented, in accordance with the principles of its new director, Hannes Meyer.

From our nationalistic point of view, Kállai's special merit lay in his promotion of Hungarian contributions — for instance, in the *Bauhaus journal*. The first issue of 1928 featured the *Bach Monument*, a sculptural work by Henrik Neugeboren, a Saxon artist born in Transylvania, who had studied in Budapest and Berlin. Between 1928 and 1930, Neugeboren was in Dessau, where he made this monument. It is the earliest known example of a straightforward — though rather rigid — visual representation of music by means of abstract art. The design concept is based on the musical notation of a fugue from *The Well-Tempered Piano*. An arrangement of square tubes, formally resembling organ pipes, was the result. It also reminds us of the controversial relationship between sculpture (art) and technology at the Bauhaus.[31]

According to Bauhaus principles, not only was sculpture discarded, but independent painting was too. Tapestry was used for interior decoration. Otti Berger, born in Vörösmart, Hungary, was one of the most talented students at the weaving workshop in Dessau. Her colorful, Hungarian temperament was an asset to the multinational community. Berger's creative, innovative imagination was outstanding, especially in her broad variety of plastic fiber textile patterns designed for standardized production (Bauhaus archives). Her long treatise on the methodological aspects of fabric, composition, and textile manufacturing has not been published or reviewed as yet; the manuscript had remained in the hands of Gropius, as was usual.[32] Her ideas harmonized with Meyer's and Kállai's, when, in the politically darkening atmosphere of Germany, she stated that, like religion and art, the home can be opium for the masses. In her opinion, tapestry escapes all danger of comfort: "tapestry is rather like music: flowing, harmonious, undulating, melodic."[33] Ruth Hollós, another weaving student, also experimented with new techniques and materials, especially with artificial silk in her tapestry murals.

Around 1930, more and more women joined the Bauhaus, and among them were many Hungarian women. Masa Baranyai took the preparatory course in 1929, Zsuzsa Bánki in 1930, and Zsuzsa Markos-Ney in 1931. Ethel Fodor (1928-1930) and Judit Kárász (1931-1932) received relatively long and fruitful training in the

29. Krisztina Passuth, *Moholy-Nagy* (Budapest: Corvina, 1981).
30. *Ernst Kallais gesammelte Texte*, preface by Tanja Frank (Berlin: Kiepenheuer Verlag, 1985).
31. *Perspektive und Klang*, (Darmstadt, Bauhaus Archive 1966); *Vom Klang der Bilder. Die Musik in der Kunst des 20. Jahrhunderts*, cat. (Munich: Staatsgalerie Stuttgart, Prestel, 1985).
32. *Bindungslehre* (Berlin: Bauhaus-Archiv) Inv. 1409.
33. Otti Berger, *Stoffe im Raum* (Prague, 1930).

photography department. Their photographs, preserved up to our time, are faithful documents of life at the Bauhaus, as well as examples of "subjective photography," initiated by Moholy-Nagy in the mid-1920s.[34] Its characteristic features were the shift in angle, which provided a view from the top or the bottom; unconventional focusing in the case of portrait photos; arbitrary extracting sections from the portrait; and superimposed pictures. Irén Blüh's photograph of Judit Kárász is a beautiful example of this style.

Kárász's and Fodor's teacher was not Moholy-Nagy, but Peterhans: the photography workshop opened relatively late (1929). Nevertheless, Moholy-Nagy's inspiring influence was undeniable. The students moved beyond technical or compositional innovations to the domain of sociological photography, showing interest in the urban way of life, gigantic building projects, and the humiliating poverty of the increasing numbers of unemployed. After their return to Hungary, they adhered to this critical, documentary approach.

Moholy-Nagy was the only Bauhaus artist to move from photography to film, the most advanced artistic medium. The young people did not receive training in film, even after 1930. Nevertheless, Moholy-Nagy's films (*Marseille*, 1929; *Still Life in Berlin*, 1926; *The City Gypsies*, 1931), demonstrated his visual and social sensitivity and had an obvious impact on the younger generation; they still seem vivid and innovative today. The film's interplay of white, black, and gray might be a reference to the effects in his famous *Light Requisite* of 1930, as if he were compensating for the lost opportunity to use it onstage.

As we have seen, their compatriots often had a direct effect on the younger generation of Hungarian Bauhaus students, who were, at the same time, attracted to the general atmosphere of the school. Wherever they went afterward, they continued to adhere to the Bauhaus principles.

Zsuzsa Markos-Ney, for instance, who studied textile designer under Otti Berger, worked in Paris from 1933 on. Ethel Fodor, a photographer who had visited the weaving workshop at the invitation of friends, became a hand weaver in Cape Town from 1963 on.

Otti Berger, who had been at the experimental weaving workshop since 1932, remained at the school until the bitter end. She was not allowed to work under Nazi rule, and was thus compelled to return to her hometown, Zagreb. From there, she was taken to a concentration camp in Germany, where she died. The others left the school in time and for good, carrying the Bauhaus ideas all over the world. Some of them had to leave because of their communist political opinions. One of them was Judit Kárász; another was the architect, Tibor Weiner, who was expelled from Germany in 1931. Weiner left for the Soviet Union, as a member of Hannes Meyer's brigade. Forbát had also worked in the Soviet Union, in the brigade of Ernst May (1932-33); for the next five years, he stayed in Hungary. He settled in Sweden in 1938, where he gained a reputation in urban planning. Molnár and Moholy-Nagy met for the last time at the CIAM Congress in Athens in 1933. After emigrating first to the Netherlands and then to England, Moholy-Nagy ended up in the United States, where, as a professor, he continued to propagate Bauhaus theory and practice (New Bauhaus of Chicago).

The Bauhaus influence on art education in Hungary was indirect. It had an impact on Jaschik's private school; some of Jaschik's students (Fodor, Schwartz) eventually went to the Bauhaus. However, the most consistent representative of the Bauhaus principles was Sandor Bortnyik's school of applied graphic art, Mühely (The Workshop), which lasted from 1928-38. Bortnyik was never enrolled at the Bauhaus. Nevertheless, he was the founder of one of the most interesting satellite schools of the 1930s, when poster design was the only feasible domain of Constructivism.[35] One of Bortnyik's students was Victor Vasarely, the great Op Art master of Hungarian origin, who gained fame in Paris.

Later on, chances to propagate Bauhaus ideas were limited. In his lectures at the School of Applied Arts in Budapest, Ernö Kállai spoke about the aesthetic design principles of the Bauhaus (1948), and as a professor at the School of Fine Arts (1949-62), Gyula Pap kept the ideas alive. The shift from National Socialist to Socialist Realism art policy did not encourage research until it was almost too late; many documents were lost, and others have been found only with difficulty.

By pointing out their presence in the international community and their contributions to it, this paper has aimed to do justice to the lesser-known Hungarian members of the Bauhaus. Special attention has been paid to the enduring, highly effective interaction between the school and its Hungarian members. In closing, we quote from a statement made by Forbát in 1922:

> *For me, the Bauhaus is not only a theoretical construction that can be interpreted according to taste, and is not fully understood... Neither is it an institution for human development only, although this is the feature that I appreciate the most. For me, it is a combination of energies that necessarily results in the development of form.*

34. *Film und Foto der Zwanziger Jahre*, Uta Eskildsen, J. K. Horak, eds. (Stuttgart: Württembergischer Kunstverein, 1979); Bauhausfotografie (Düsseldorf: Marzona, 1982).
35. *Archiv für Buchgewerbe und Gebrauchsgraphik*, Leipzig 1930; Bortnyik's and Vasarely's posters in vol. 10.

Iren Blüh
Judit Kárász at the Bauhaus, 1931

Éva Bajkay, graduated as an art historian on the Eötvös Loránd University, Faculty of Humanities, Budapest in 1967. Since then she has been the researcher of the Hungarian National Gallery, from 1984 the head of the Department of Graphics. She has performed a stop-gap work in the research and collection of the classical Hungarian Avant-garde. She has organized several exhibitions on this topic in Hungary and abroad. She had scholarships in Austria and Germany. She has published more than 80 studies and 7 books in Hungarian and foreign languages. Among others: *Uitz Béla*, 1974, 1987, *A konstruktivizmus*, 1979, *Huszár Vilmos*, 1983, *Biró Mihály*, 1986, *Dömötör Gizella – Mund Hugó*, 1996 (with Jenö Murádin); Europa im Umbruch. Zeichnungen und Druckgrafik 1900-1930 (Stuttgart-Budapest: Staatsgalerie Stuttgart, 2004).

1

Catherine David

Vision, Motion, Emotion: Moholy-Nagy's Experimental Activity

László Moholy-Nagy, born 1895 in Bácsborsod. In 1919 emigration to Vienna. From 1919 he was living in Berlin and had contact to the Dadaists. In 1921 he became acquainted with the Russian constructivism and was correspondent of the magazine *MA (Today)*. In 1922 exhibition with László Péri in the gallery Der Sturm; first photograms and telephone pictures. He finished the film-script for *Die Dynamik der Großstadt*. From 1923 he taught at the Weimar Bauhaus (metal-class). In 1924 photo-sculptures. From 1925 on publication of Bauhaus books. In 1927 encounter with Malevitch. In 1928 separation from the Bauhaus. Designs for the Berlin State Opera and the Piscator-theater. In 1929 first film *Marseille vieux port*. Publication of the book *Vom Material zur Architektur*. He organized the Stuttgart Werkbund exhibition *Film und Foto*. In 1930 he introduced the *Light Requisite* in Paris. Exhibitions in Stockholm, Amsterdam, Hamburg, Cologne, Paris, and Budapest. In 1931 lectures at the University of Arts and Crafts in Bratislava. In 1934 emigration to Amsterdam. 1935-1936 he lived in London. Worked on films, photo-books, and advertising jobs. In 1937 he moved to Chicago and became the director of the New Bauhaus. In 1939 he founded the School of Design. He died of leukemia in 1946.

I don't really believe in mankind. Every human being reveals himself individually; much of it is art.
(from an interview in *The Little Review*, Chicago 1929)

Experiment in Totality is the biography Sibyl Moholy-Nagy wrote about Moholy in 1950. She records what he said to Robert Jay Wolff, one of his closest collaborators at the Institute of Design in Chicago, when he knew that he was dying of leukemia. "I don't know yet about my paintings, but I'm proud of my life." Moholy was aware that he had lived an unusual, eventful life, that he had been a leading figure of the first order, and that he had shared in the adventures of the avant-garde of the first half of the century. From Hungary, where he was born, to the United States, through World War I, the Soviet Revolution, and the Weimar Republic, Moholy-Nagy also experienced places like Berlin, London, and Chicago. His legendary optimism and extraordinary courage by no means prevented him from clearly recognizing that there were things in his life and complex work that were misunderstood, inexplicable, or shut off from direct, unanimous reception.

It is indeed possible to take the view that the popularity of the man and his œuvre suffered from an early point on (as it still does today) from the extreme diversity of interests and talents of this artist who, at a young age, definitively turned his energies and preferences to two fundamental, complementary areas of work. His teaching, first at the Weimar and Dessau Bauhaus from 1923 to 1928, then at the Institute of Design in Chicago from 1937 until his death in 1946 was augmented by educational activities, which he pursued at all possible, sometimes unexpected, opportunities. Secondly, Moholy-Nagy also adhered to a radical experimental practice, which he successfully applied to a wide variety of expressive forms: painting, typography, books, photography, film, sculpture, commercial and industrial design, stage sets, and trade show architecture.

For theoretical or practical reasons, certain areas of work prevailed at various stages of his life: for instance, painting, photography, and teaching predominated during his time at the Bauhaus and in Chicago. Later (1928-36), after leaving the Bauhaus, he built a life for himself as a freelance designer through film, photography, commercial design and trade show architecture in Berlin, Amsterdam, and London. However, Moholy did not bend his work to any aesthetic hierarchic structure. His definition of design, "Not a profession but an attitude," may be applied equally to his understanding of art and his conception of the role of the artist in contemporary society.

The fact that attention is often exclusively paid to the obvious formal and material eclecticism of his work means that only one medium, or only one particular moment or series is singled out for observation. The original dynamics and inner coherence of his work, which elude the traditional categories of art history (even the history of modern art), are often neglected. In fact, Moholy's thoughts and work bear no academic or orthodox relation to Constructivist ideology and art. After cutting short his law studies, Moholy embarked on a different path than Gabo, Lissitzky, or Rodchenko, for instance, and dispensed with any formal technical or artistic training. His poetic talent and interest in literature are rather those of the autodidact or gifted amateur, which did not, however, prevent him from accumulating scientific and technical knowledge, which is mainly reflected in his articles and books. As in the case of Gropius, the broad diversity of his interests and wide educational horizons conjure up the image of a Renaissance artist, a modern-day Leonardo, rather than the more contemporary figure of the engineer/artist. For a long period of time, there was a certain inscrutability to Moholy's texts and his enlightened notions, including his sudden lyrical outbreaks and descriptions of visions or technical projects that seem to be very well thought-out. We need only recall the light painting he described in a letter to Frantisek Kalivoda in 1934,

> *i dream of light machines that can be used to manually or automatically/mechanically project visions of light into the air, into large spaces, onto screens of unusual texture or fog, gas, and clouds. i have created countless projects; the only thing missing was the client who would commission me to build a light fresco or light architecture consisting of graduated straight and curved walls lined with artificial materials such as galalith, trolith, chrome, or nickel, and which, at the touch of a switch, could be immersed in shining light, fluctuating symphonies of light, while the surfaces slowly shift and dissolve into an infinite number of controlled units. i wish i had a bare room with twelve projectors, which would activate the white void underneath the intersection of colorful bursts of light.*

László Moholy-Nagy
Construction, 1923
© VBK, Vienna, 2005

Many of Moholy's writings and some of his major works — for example, the *Light Requisite* (1922-30) or the *Space Modulators* (1930-1940) — represent a very specific link (or, in less successful instances, a collage) of poetic intuition and theoretical reflection. Indeed, Moholy's objects often appear to be experimental structures: aesthetic and cognitive models rather than works of art. Attention has often been drawn to the qualitative difference between the results of his work and the more or less unfinished appearance of certain works — above all his paintings — that sometimes bear the imperfect traces of the artist's experiments with technique. In the 1930s, on the other hand, Moholy produced unprecedented material and light effects by painting on industrially produced synthetic plastic grounds (celluloid, Bakelite, Trolith, Galalith, and acrylic glass) which he would lightly scratch to make the paint adhere. This constant focus on the material constitution of the work, the search for the appropriate expressive material, has a history that far exceeds the mere desire to translate new technological possibilities into artistic forms. At the beginning of his years in Berlin, Moholy had the opportunity to analyze the concept of "facture" as developed by the Russian Constructivists after Tatlin, which V. Markov defined in factural-theoretical terms in his book, *Schaffensprinzipien in den plastischen Künsten* (Creative Principles in Sculpture), published in 1914. According to the definition proposed by G. Conio in his anthology of texts, manifestos, and documents of Russian Constructivism, "facture" means "... the formal and, at the same time, material quality of a work" and "... thus refers to both matter and manner."[1]

Moholy interpreted and adapted certain Constructivist viewpoints and forms, which he encountered in Berlin in Lissitzky's circle and during the first exhibition of Russian art organized by D. Sterenberg at the Van Diemen gallery in 1922. In the same year, he and Kemény signed the *Dynamic-Constructive System of Forces manifesto* published in *Der Sturm*, while in 1923 his name appeared alongside those of E. Kállai, Kemény, and L. Péri in the Hungarian journal Egység, beneath an explanation for the making of a Russian-style Proletkult organ. However, he felt disappointed at the failure of the Hungarian revolution and was disturbed by the growing turmoil in Europe in the 1920s and 1930s. Consequently, he became increasingly distrustful of politics and specifically of the link between politics and the culture. He evolved a humanist and utopian manner of thinking in which culture, especially visual culture, becomes the driving force behind change.

Beneath their paltry dyed red shell, the revolutionaries forgot the true meaning of the revolution. They forgot to propel life's inner revolution. They forgot culture.[2]

"The Spiritual and Social Aspects of Constructivist Art," a lecture he held for students at the Bauhaus in 1923, contained his definition of Constructivism, which, he asserts, should be compulsory for the School. This definition contains the principles of the New Vision,

Constructivism, our new dimension, has no other aim than to take part in life. It is profoundly connected to the spirit of evolution, which has produced science, civilization, and the system that determines social life. Like all of these, Constructivist art is processual, forever open in all directions. It educates the human ability to perceive, the ability to react emotionally and to draw logical conclusions.[3]

Moholy's experience in the U.S.A., first at the New Bauhaus and later at the Institute of Design in Chicago, did not so much relativize what he had learned in Europe, but radicalized it, in Moholy's opinion at least. His often problematic relations at the Institute of Design, in a system absolutely governed by economic concerns, confirmed his stance. The frequently heard reproach — that Moholy had become estranged from Bauhaus in the United States and betrayed its aesthetic and social program in favor of an increasingly close integration of applied design into industrial production — must countered by pointing out that Moholy constantly endeavored to give priority to training, to developing the students' creative skills. In other words, he devoted much to the experimental search for knowledge with regard to the evolved object or finished product. In his last public statement, a lecture at the Conference on Industrial Design as a New Profession, held in New York in November 1946, he notes:

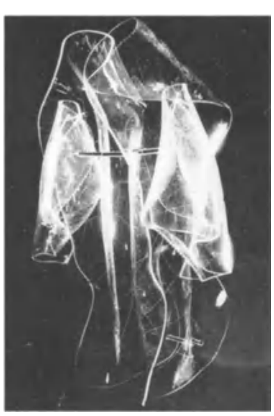
One day we shall fully comprehend the confusion of the industrial revolution. On the one hand, we teach people to read and write, while on the other, we deprive them of this skill by means of advertising, radio, and other propagandistic media, which appeal to the basest of instincts for the sake of profit.[4]

Written twenty years later, in a different context, in the face of different constraints, these words almost seem to echo his letter of resignation from the Bauhaus, submitted after his friend, Gropius, had been replaced by Hannes Meyer, an advocate of a technocratic, utilitarian style of leadership:

We are now in danger of becoming what we had opposed as revolutionaries – a talent factory, where only results count, and the development of the human being as a whole is overlooked.[5]

Moholy's thoughts and work, indeed his entire life, are an exemplary embodiment of the heroic adventure and arduous fate of the avant-garde artist in the first half of the twentieth century. The utopian plan shared

1. Gérard Conio, "Le Constructivisme Russe," *Le Constructivisme dans les Arts Plastiques. Theoretische Texte, Manifeste, Dokumente. L' Age d' Homme*, vol. I (Lausanne 1987).
2. Sibyl Moholy-Nagy, *Moholy-Nagy – Experiment in Totality*, 2. ed. (Cambridge: MIT Press, 1969).
3. Ibid.
4. Sibyl Moholy-Nagy, op.cit.
5. Steven A. Mansbach, *Visions of Totality. László Moholy-Nagy, Theo van Doesburg and El Lissitzky* (Ann Arbor: UMI Research Press, 1980).

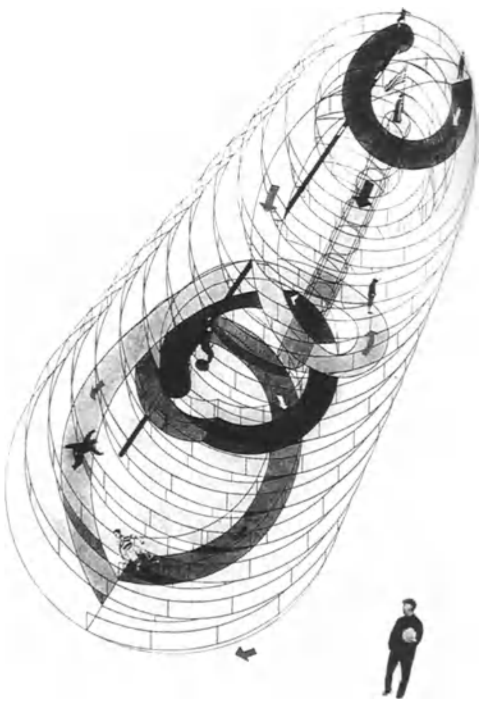


László Moholy-Nagy
***Space Modulator 101*, 1940**
© VBK, Vienna, 2005

by a whole generation of artists — to devise a new type of art and new forms that would suggest and shape a "desirable future order" — would soon be confronted with the harsh realities of the world. In this context, Moholy's steadfast optimism and pragmatism set the standards for what was an immeasurable effort. The bold venture, which began in 1937, of grafting the Bauhaus ideal onto the socially, economically, and culturally different foundation of the United States, was meant to provoke crass contradictions that would stimulate his thoughts. In this respect, *Vision in Motion*, published in 1947, one year after his death, can be regarded as his chief work, a kind of mental *Light Requisite*. Starting with the work performed at the Institute of Design, the book provides a summary of his whole life's experience. *Vision in Motion* is both his ethical and his aesthetic legacy; it is one of the most important books ever to be written on modern art and culture. Reading the brilliant chapters in which Moholy discourses on the possible relations of art and technology, the fundamental yet neglected role of education in modern society, or on the new relations of space and time shaped by James Joyce, it becomes evident that the artistic experiment Moholy proposes is not aimed at creating an ideological vision or constraint, by way of manufacturing the necessary objects and works, but rather to achieve a flexible, curious gaze: the gaze of the subject in the world.

***László Moholy-Nagy* (Kassel Museum Fridericianum Kassel / Verlag Gerd Hatje: 1991) pp. 9-12.**

Catherine David, born in 1954 in Paris. Studied Literature, Linguistics and Art History. 1972-1990 curator at the Musée National d'Art Moderne, Centre Georges Pompidou, Paris. 1989-1991 professor at the École du Louvre. 1990-1993 lecturer at the Institute for Ethnology at the University of Paris X Nanterre. Since 1990 curator at the gallery National du Jeu de Paume, Paris. Artistic director of the documenta X, Kassel, 1997. 2001-2003 guest lecturer for art history at the RWTH Aachen. From 2002 director of Witte de With, center for contemporary art in Rotterdam.



László Moholy-Nagy
***Kinetic Constructiv System*, 1922**
Constructions with paths of movement for play and transport
© VBK, Vienna, 2005

László Moholy-Nagy

Light Requisite for an Electric Stage

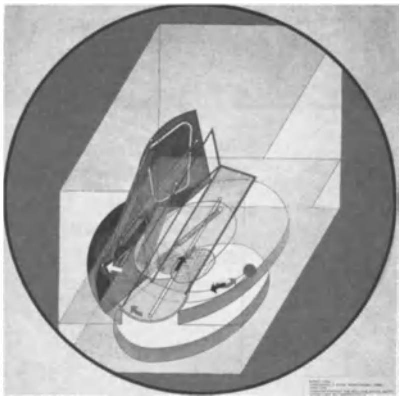
Today, adjustable artificial electric light makes it easy to produce strong lighting effects. With electrical energy, one can carry out different pre-calculated movements, which can be repeated without deviations. Light and motion once again become elements of creation, in accordance with today's system of references. The fountains of the Baroque era, the jets of water and water settings seen in Baroque festivities can be creatively revived with the help of light fountains and mechanical, electric moving images. These methods will probably be used in the near future in advertising, as carnival entertainment, and to heighten suspense in the theater. It is even foreseeable that these and similar "light plays" will be transmitted via radio, partly as television advertising, partly as real light-plays, if receivers are equipped with their own lighting devices containing electric adjustable color filters operated by remote control from the broadcasting company. For instance, shadow plays would also be possible. Stenciled pieces of cardboard, like the art supplements in today's magazines, will be enclosed in the radio magazines, and can be inserted in the machine. The first experiments with these kinds of light plays will have to be confined to very simple light and motion processes, as most people are not even ready to accept these kinds of apparitions, let alone deal with them in an experienced manner. One such initial step is the *Light Requisite for an Electric Stage*, which was sponsored by AEG for the exhibition of the German Werkbund in Paris and constructed by the AEG theater department. The *Light Requisite* is an apparatus for the demonstration of special lighting and motion effects. The model consists of a cubic box (120 x 120 cm) with a circular opening in front, which is open to the stage. A number of electric bulbs — yellow, green, blue, red and white — are mounted around the opening, at the back of the plate (about seventy 15-watt bulbs and five 100-watt searchlight bulbs). Inside the box, parallel to the front side, there is a second plate, which also has a circular opening. It is also provided with electric bulbs of various colors ranged around the opening. Individual bulbs flash up in various places according to a pre-set plan. They illuminate a constantly moving mechanical device, which is made partly of translucent material, partly of transparent material, and partly of perforated material, in order to ensure the best possible linearity of the shadows projected onto the rear wall of the closed box. (If the projection takes place in a darkened room, the rear wall of the box may be removed, and the colors and shadows can be projected onto any size screen behind the box.) The mechanism is built on a circular plate carrying a three-sectioned frame. The dividing walls are made of transparent Zellon, and one wall is of vertical metal staves. Each of the three sections of the frame has a moving image, which goes into action when this section of the revolving plate faces the opening to the stage. The motion play of the first section: three staves gently rock (since the ceiling differs from the floor) along an endless track. Various materials, such as translucent gauze, parallel horizontal staves, and wire are mounted on the three staves.

The motion play of the second section: on three planes, lined up front-to-back, is a large, immobile aluminum plate; in front of this is a smaller, perforated, polished, nickel-plated brass plate, which moves up and down. Meanwhile, between the two, a small ball rolls around on a roller coaster.

The motion play of the third section: a glass spiral is wound around a glass staff. This describes a conical movement in opposition to the large disc. The point of the cone touches the floor made of a slanted, bisected glass plate, which in turn is suspended above another mirrored circular plate.

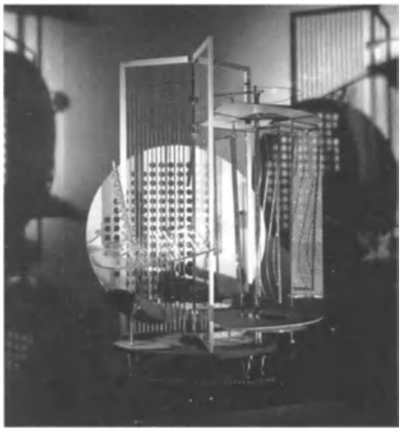
The *Light Requisite* could be used for many optical observations, and it seems important to me to systematically continue with these experiments, as a way to develop light and motion design

Die Form, 5: 11/12 (Berlin: 1930): 297



László Moholy-Nagy
Drawing of the Light Requisite
© VBK, Vienna, 2005

László Moholy-Nagy
Light Requisite for an electric stage, 1922/30
Designer: Moholy-Nagy, Berlin, constructed by Stefan Sebök, cert. Engineer.
© VBK, Vienna, 2005



László Moholy-Nagy, *Light Requisite*, 1930
Replica of 1970, mobile construction with different metals, plastic, wood and electric motor, 151 × 70 × 70 cm
© VBK, Vienna, 2005

1

Raoul Hausmann, Hans Arp, Iwan Puni, László Moholy-Nagy

A Call for an Elementary Art!

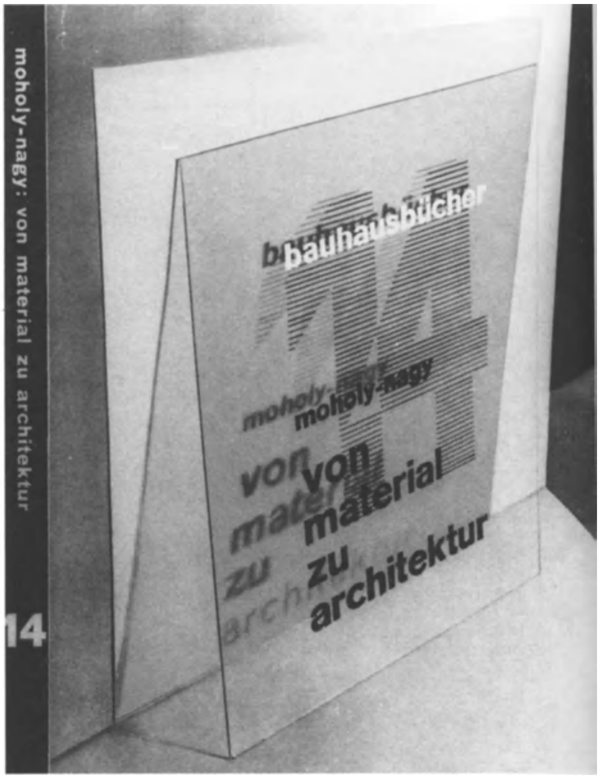
Raoul Hausmann, born 1886 in Vienna. In 1900 he moved to Berlin. In 1912 co-worker on *Der Sturm*. From 1917 on, worked as an author, worked on the magazine *Die Aktion*. 1918 co-signer of the Dadaist manifesto *Synthetisches Cino der Malerei*. Beginning of collage and montage works. Development of the phonetic poem. In 1919 editor of the first number of *Dada* as well as organizer of the first Dada-exhibition, Berlin. In 1920 co-worker on *De Stijl*, contact to Schwitters. In 1926 publication of the psycho-morphological novel *Hyle*. In 1927 intense work with photography. From 1944 on he lived in Limoges. Died in 1971 in Limoges.

References:
Karl Riha (ed.), *Da Dada war, ist Dada da* (Munich: 1980).
Michael Erlhof, *Raoul Hausmann. Dadasoph* (Hannover: 1982).
Franz Josef Czernin, *Sechs tote Dichter* (Vienna: 1992).
Michael Erlhof, *Raoul Hausmann*, 2 vol. (Munich: edition text + kritik, 1982).

To the Artists of the World!
We love the bold invention, the innovation in art. Art is the consequence of all the forces of a certain time. We are living in the present. And so we make a demand for the consequence of our time: an art, which can only come from us, did not exist before us, and will not exist after us — not like a changing fashion, but out of the knowledge that art is eternal and does not stop at past consequences. We call for an Elementary Art. Art is elementary because it does not philosophize: it creates itself exclusively from its own elements. It is said that being an artist means to give way to the elements of creation. Only the artist can find the elements of art. They do not develop through the arbitrary act of the individual. The individual is not separate, and the artist is just an exponent of the forces that shape the worldcs elements. Artists, declare solidarity with art! — Turn away from styles. We demand lack of style in order to attain style! Style never is plagiarism!
We regard this manifesto as an action: captured by the movement of our time, we proclaim that elementary art will renew our point of view, our awareness, of the tirelessly intersecting sources of power that shape the spirit and form of an age, which will allow art to become something pure, released from function and beauty, something elementary inside an individual.
We call for an Elementary Art! Against reactionary art!

Berlin, October 1921
De Stijl, vol. IV, No. 10 (1921).

Raoul Hausmann, Cover of *Material der Malerei, Plastik, Architektur*, 1918
© VBK, Vienna, 2005



László Moholy-Nagy
Cover of *Bauhaus book 14*, 1929
© VBK, Vienna, 2005

Raoul Hausmann

Optophonetics

About Color Pianos

The basic theoretical elements of color pianos have kept me busy since 1921. I sent in five different constructed versions of the piano to the German patent office, the first one in 1927. They were so new, technically speaking, that the patent office had doubts about the possibility of production. Furthermore, in their rejection, they wrote "that nothing agreeable to humans would result." The patent office could have left this worry to the inventor. Based on the uniformity of all processes of transmission and motion, a color piano assumes a basic physical resemblance between sound and color values as the creative means of expression.

a bis z, vol. 3, no. 22 (Cologne: 1932) 88.

Optophonetics

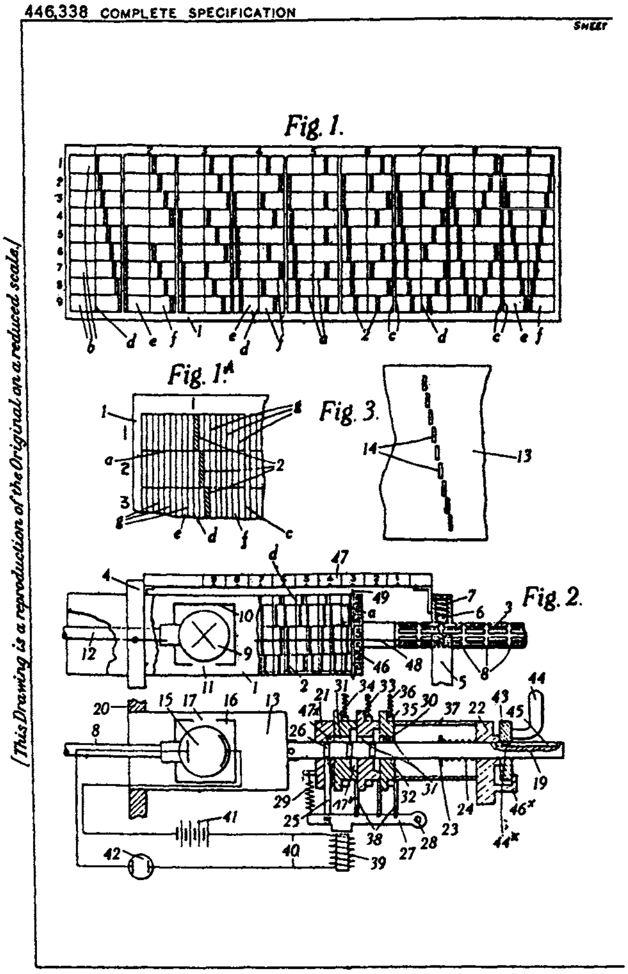
If there is an appropriate technical structure, the optophone has the power, or rather the ability to display the audio equivalent of each optical phenomenon, or in other words, it transforms the differences in the oscillation of light and sound, since light and sound are both oscillating electricity.

MA, vol. 8, no. 1 (Vienna: 1922).

Raoul Hausmann wrote to Paul de Vree regarding the optophonetical apparatus on December 6, 1966:

As the patent office in Berlin did not want to grant me a patent for the optophone, regarding it as "technically realizable" but "lacking utility," I transformed the optophone into a photoelectric-based calculating apparatus. This was the first cybernetic robot, for which I received English patent no. 446338: device to combine numbers on a photoelectric basis. However, I had to sell the patent to escape Nazi persecution in 1938.

Factotum Art, vol. 1, no. 1 (1977) 47.



A page from the patent specification 446338

Hausmann and Daniel Broido applied for the English patent on September 25, 1934; it was deposited on October 25, 1935, and officially registered on April 27, 1936, as number 446338: improvements in and relating to calculating apparatus.

Raoul Hausmann, *Sieg. Triumph. Tabak mit Bohnen, Texte bis 1933* (Victory. Triumph. Tabacco with Beans. Texts Until 1933) edition text + kritik, Michael Erlhof, ed., vol. 2 (Munich; 1982) p. 215.

1

Miklós Peternák

Light and Sound from Hungary

Miklós Peternák, born 1956 in Esztergom. Studied history of arts at the University of Budapest. 1981-1983 he worked at the Hungarian National Gallery in Budapest and 1983-1987 at the department of art history at the Hungarian Academy of Sciences. Since 1991 director of the Intermedia Department at the Academy of Arts in Budapest. From 1997 director of Center for Culture and Communication C3, Budapest (founded in 1996).

Remarks on the History of Intermedia in the 1920s

In this text, I intend to present a system of better- and lesser-known facts and links, where the historical appearance of intermedia and its conceptual system of relations form an integrated unit. Moholy-Nagy left Hungary, along with Sándor Gergely. In Berlin, he met Alfred Kemény, Ernő Kallai, and László Péri, and together, they also composed a public statement. Kállai's ideas move in the direction of a comprehensive concept uniting nature and art; Kemény focuses on participatory politics. Not just their beginnings in the avant-garde, but also the increasing interest in film that they both had are reasons to mention their names here.

Viking Eggeling showed his first finished film, *Diagonal Symphony*, to his friends, at his home, on November 5, 1924.[1] Moholy-Nagy, Kállai, and Kemény were all present, as well as Arthur Segal. I mention him rather than other, perhaps more significant participants, because in 1925, he published *Lichtprobleme in der bildenden Kunst* (Light Problems in the Visual Arts)[2] jointly with Nikolas Braun, one of his students, who was of Hungarian origin. In his essay, *Konkretes Licht* (Concrete Light), Braun mentioned that he used electric light in his reliefs, light sculptures, and illuminated stages. (He published this essay under the title *Changing Light Image*, along with a design for an illuminated stage.) Nikolas Braun's work, *Light Rhythm*, exhibited at the November Group show in 1923, was mentioned by Ludwig Hilbersheimer in the *Sozialistisches Monatsheft* (Socialist Monthly) in company with the works of Vilmos Huszár, László Péri, and Moholy-Nagy, among others, as well as the films of Hans Richter and Werner Graeff.

In the same year that Braun's and Segal's book was published, Sándor (Alexander) László published his book, *Farblichtmusik* (Color Light Music).[3] Whereas Braun includes light as a third element accompanying color and form in picture, sculpture, and stage, László uses light as projected color in the course of his research on the connection between music and colors. The relation between color/light/music and the concept of "expanded cinema," which appeared much later, is acceptable to the extent that it was supported by film expert Oskar Fischinger. Moholy-Nagy also knew and highly appreciated László's work, and mentioned it in his *Painting, Photography, Film*.[4] Without delving further into László's presentations or the characteristics of the color/light/music relation,[5] I would simply like to point out that we are once again faced with a constructed machine — a piece of electric equipment and the theoretical research work connected with it. While László experimented with connections of music and light, Braun did likewise with light and three-dimensional objects. However, in the works of Henrik Neugeboren (Henri Nouveau) we find examples of the connections between sculpture and music, reinforced by theory and text. The *bauhaus journal* (1929:1), contains his explanatory text entitled *eine bachfuge im bild* (a bach fugue in the picture), as well as the score with a graphic transcription and the photo of the sculpture (maquette). Besides Bauhaus associates Moholy-Nagy, Farkas Molnár, and Andor Weiniger, dancer József Ligeti, ballet master and director at the Opera House in Kolozsvár, also worked with experimental dance and theater. Ligeti arrived in Berlin in autumn 1928, and after meeting Herwarth Walden, he performed a work titled *SOS — der europäische Jazz — akustisch-optisches Spiel* (SOS — European Jazz — An Acoustic/Optical Play)[6] at the Sturm Theater. Apart from this work, which he considered a rather unsuccessful experiment, Ligeti is also of interest because he came into contact with both Béla Balász and Moholy-Nagy. Aided by the above-mentioned István Sebök, Moholy happened to be working at the time on the set construction for Mehring's *Der Kaufmann von Berlin* (The Merchant of Berlin). Returning from Britz to his home in Berlin one day, Ligeti obtained Moholy-Nagy's private telephone number from a member of László Dienes's group. Dienes, who founded the journal *Korunkt* (Our Era) in 1926, lived in Britz. The magazine, where Gábor Gáal had been editor-in-chief since 1928, published several texts by Moholy-Nagy.

Parallels to the character of the political, socially committed Piscator Theater can be found in German film production as well. Here, I will mention only one filmmaker who is of extreme importance to us, Ernő Metzner. Alfréd Kemény (Alfred Kern), who was also active as a film critic, wrote an article titled *Filme der SDP* (Films of the Social Democrat Party), in which he discussed two of Metzner's films *Am Anfang war das Wort* (In the Beginning was the Word) and *Freie Fahrt* (Open Road). Metzner's next film, *Überfall* (Attack, 1929), is regarded by all film historians and avant-garde film critics as significant for the epoch. Its theme slightly resembles that of another of his films, *Abenteuer eines Zehnmarkscheins* (The Adventures of a Ten-Mark Note), whose script was written by Béla Balázs.[7] Metzner was the stage designer of several films;[8] moreover, he worked with what we would nowadays call "special effects." His activity in this area is most frequently connected with two of Pabst's films: *Kameradschaft* (Comradeship) and *Westfront* 1918.

When silent film gave way to talking pictures at the end of the 1920s, the first material unification of light and sound was achieved. Technicians, engineers, and theoreticians all prepared for this. An important figure who was relatively unknown on an international basis was Dénes Mihály. I mention him here because of his role in the development of television.[9] By the way, he named his equipment *Telehor*, a name of purely Greek

1. Louise O'Konnor, "Viking Eggeling. Artist and Filmmaker, Life and Work," Acta Universitatis Stockholmiensis (Stockholm, 1971). Eggeling's first article, "Theoretical Statements about Movement Art" was published in Hungarian in *MA*, vol. 1, August 1921.
2. *Lichtprobleme in der bildenden Kunst* (Berlin ,1925). The book is divided into two parts: Arthur Segal, "Das Lichtproblem in der Malerei," and Nikolaus Braun, "Konkretes Licht." Braun (b. 1900 in Berlin , d. 1950 in New York) was a member of the November group, participated in the light reliefs shows of 1923 and 1925-30. In 1924, he had a joint exhibition with Lajos Kassák in the Sturm gallery. Lived in Hungary from 1938 to 1949, later in the United States. See Miklos von Bartha, *Carl Laszlo, Der Sturm. Die ungarischen Künstler am Sturm, Berlin, 1931-32* (Basel: Galerie von Bartha, 1983).
3. Alexander László, *Die Farblichtmusik* (Leipzig, 1925) and *Einführung in die Farblichtmusik* (Leipzig, 1926). The performance took place at the Tonkunstfest in Kiel. See Hans Hildebrand, *Die Kunst des 19. und 20. Janhrhunderts* (Potsdam: Akad. Verlag Atheneum, 1931) pp. 451-452; Max Buttig, *Sozialistische Monatshefte* (1926): 881-882. Reprinted in W. Herzogenrath, *Film als Film, 1910 bis heute* (Kölnischer Kunstverein, 1977) pp. 71-72. The book gives a summary of the whole issue; see also the heading "Lichtkunst" in Scheugl-Schmidt, *Eine Subgeschichte des Films*, 2 vol., Frankfurt am Main.
4. According to Lucia Moholy-Nagy, after an essay by Albert Schröter, published in the *Münchener Illustrierte Presse*. See Lucia Moholy-Nagy, *Marginalien zu Moholy-Nagy* (Krefeld, 1972) p. 57.

origin, not wanting to use a mixture of Latin and Greek (television). Moholy-Nagy was also familiar with this word, as his 1927 article *Typophoto* proves. What is more, he recommended it to Frantisek Kalivoda, an editor in Brno, as the title of a magazine. Later, in 1936; *Telehor* dedicated a special issue to Moholy-Nagy.

In his book about color/light/music, Sándor László attempted to summarize everything connected to this matter; and in his work dealing with the problems of television, Mihály also gave an account of experimental antecedents and achievements. In describing the equipment, he uses expressions such as "dissecting images into elements," "light/signal receiver," "stream of images," "the composition of visual elements," and "image intercepting surface." At the end of the era, the illuminated image, the image as beams of energy, becomes a technological reality. The projected image complements sound — in a uniform, patented form as well.

Miklós Peternák, "Bemerkungen zu der Geschichte der Intermedia in den 20-er Jahren," *Wechselwirkungen. Ungarische Avantgarde in der Weimarer Republik* (Neue Galerie Kassel, Museum Bochum, 1987) pp. 456-470

Special issue of the magazine *telehor*, dedicated to László Moholy-Nagy, 1936

5. For more on its essence and place in the historical context, see also Elemér Gyulai, *A látható zene, Zeneműkiadó* (Budapest, 1965) pp. 19-20.
6. The invitation is published in: *Tempa* (Berlin, March 21, 1929). For more on this and the following see Ligeti's memoir, *Valóság* (1969:4) pp. 99-105.
7. *Die Abenteuer eines Zehnmarkscheins*, 1926. Director: Berthold Viertel, Karl Freund. Hungarian review by Iván Hevesy, *Nyugat*, 1926 II, pp. 889-890. Béla Balázs worked in other films besides his best-known, *Das blaue Licht*, made jointly with Leni Riefenstal. He worked with László Vajda and Lee Lania on Brecht's transcription of Pabst's film, *The Threepenny Opera*. The related press debate and documents (including Balázs's articles) are published in *Photo Cosporius. Filmgeschichte in Bildern*, catalog (Berlin: Staatliche Kunsthalle, 1978).
8. Ernő Metzner (born 1982 in Szabadka, died 1953 in the USA) started as a graphic artist, but his path led to film quite early (in 1913, his drawings were published in magazines such as *Mozi* and *Színházi Élet*. He was active in Berlin between 1920 and 1933, and later worked in France, England, and the United States. He was the set designer for films by Feyder, Pabst, and René Clair, among others. He directed the following films: *Man steigt nach* (1927), *Am Anfang war das Wort* (1928), *Freie Fahrt* (1928), *Überfall* (1929), *Achtung! Liebe! Lebensgefahr! Rivalen im Weltrekord* (1929-30). Hans Casparius, one of the actors, who also did the film's stills, published reviews in his exhibition catalogue.
9. In 1919, Dénes Mihály (1894-1953) used his equipment to broadcast images in Hungary. For more on his sound/film invention, see István Nemeskürty's essays in *Filmkultúra* (1980:2) and *New Hungarian Quarterly* 79, and Dénes Mihály, *A távolbalátás készüléke* (Budapest, 1929). For more on his experiments in Hungary, see *Mozgó képek*, January 1986.

1

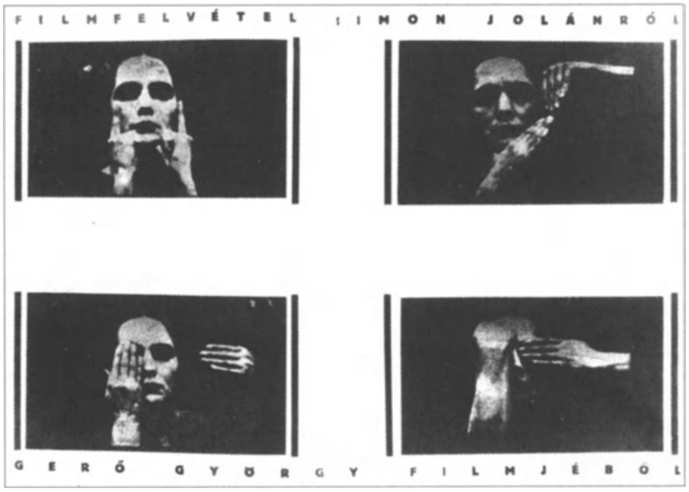
György Gerő

György Gerő, born in 1905. Poet, editor, filmmaker. Initiated and made the first Hungarian avantgarde film based on a book by Lajos Kassák and Imre Pál *Azizmusck töstének (The History of the Isms),* Magvető Budapest 1972. The filmprojekt *Béla* was published in the magazine *IS*, 1924.

My films do not represent any plots. A film must not try to be a moving photo, because the camera itself produces a complete new shape and a new context.

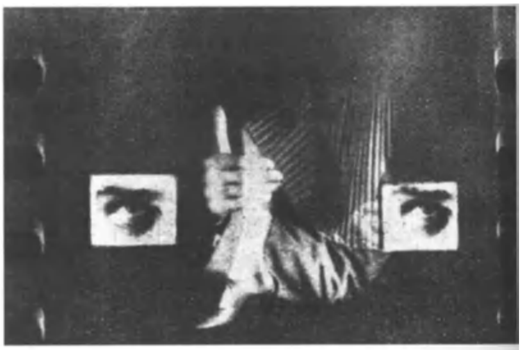
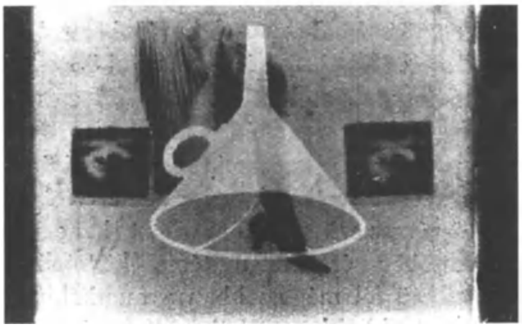
Gerő designs his own vision, according to which only a few techniques correspond to the actual nature of film. Sound films are not allowed, as they bring with them characteristics of space, where sound exists. Backgrounds are regarded as something superfluous, and their death is predicted to coincide with the death of naturalism. Blow-ups are also not allowed, as the missing edges show incompleteness, falsely promising a continuation where nothing exists. Instead, proper films should fully take advantage of the fact that the characteristics of conventional materials are no longer valid in film. In the virtual world, even gravity is missing. From the director's perspective, editing becomes the most important part of production. Various instructions for presentation are possible, too — anything that influences the immediate visual experience is allowed. Films only require the visual faculty.

Dokumentum (1: 1927) 17-24.



Stills from Jolán Simon (from the film by György Gerő)

Stills from the film by György Gerő


László Alexander
Color Light Music

For hundreds of years, people have been attempting to fuse color art and sound art. Newton developed the well-known parallel between the spectrum of colors and the Phrygic scale; Castell constructed the first color piano; then came Rimington, the two Frenchmen, Beau and Bertrand-Taillet, and later on, Scriabin. However, none were able to aid the development of color/sound art. The reason is that all these scientists, except Scriabin, based their work on physical — not physiological — artistic grounds. Newton's observance that the wavelength of each color in the spectrum is equal to the frequency of oscillation of the notes in the Phrygic Scale simply led the matter to a dead end. Physicists who compare a note with a certain color ought to be allowed their own views, but they will never be able to bring about an artistic performance with this alone, just as analytical examinations of the color spectrum will never influence the art of painting. Attempts to turn purely optical color complexes into musical partners did not leave any lasting artistic impression, either, and ended in failure. Scriabin, too, was misguided in trying to beam rays of color from a dome onto the white walls of a hall.

About ten years ago, I had my first "spectral/color" sensation while playing Romantic compositions. Gradually, I developed this new sensation — which Petschnigg called "color listening" — I no longer included any compositions in my repertory which did not shine brightly for me as I played them. In the winter of 1919, I asked to have the hall darkened during my piano recitals in Stockholm, and I adhered to this the whole season long. I wanted no light at all, except for a colored lamp on my piano, which of course attracted the attention of the critics. But soon I figured out that this makeshift arrangement could not convey "color listening" to the audience.

From then on, my plan for a type of "color/light music" matured more and more in my mind. I dealt intensively with the problem per se, and in 1922, I composed the first color/light piece for piano, Dreams, without, however, being aware of the historical development of the color/sound parallel. After lengthy experiments, I realized I had to design a special apparatus in order to present color/light music. This practical realization opened up completely new lines of thought. After many experiments with a test apparatus, which functioned, but was nonetheless entirely insufficient, I succeeded at last in building the apparatus required for concerts.

The color light piano allows a picture to be rendered horizontally or vertically. The picture can appear slowly or abruptly out of nowhere. The whole picture, or just several parts of it, can gradually, imperceptibly change color. The margins of the picture can take a different shape; the entire picture can be rotated. The color light can be clear or blurred: dynamic changes in its luminous intensity (crescendo or decrescendo) can make the picture brighter or darker. Brief movements can be carried out simultaneously with the musical graphics for different lengths of time. Other things that help achieve the artistic goal are wavy, blazing effects, the presentation of the spectrum in a purely visual way, and the refraction of light in numerous, different ways.

In order for the color light piano to render everything exactly, I set up a type of color/light notation, which, like a score, is affixed over the musical staff lines. This notation is based, for one, on rhythmically designating numbers for the selected image; these numbers correspond to the projection bars depicted in the appendix of each composition. (A projection bar is the defining size of a slide, which appears as a projected image.) Second, the notes indicate where so-called "color wedges" should be inserted. These cause a picture to be completely or partially re-colored. The color/light notes are made out of a closed semicircle (secants). The final straight line determines the color, which corresponds to its position in Ostwald's color circle.

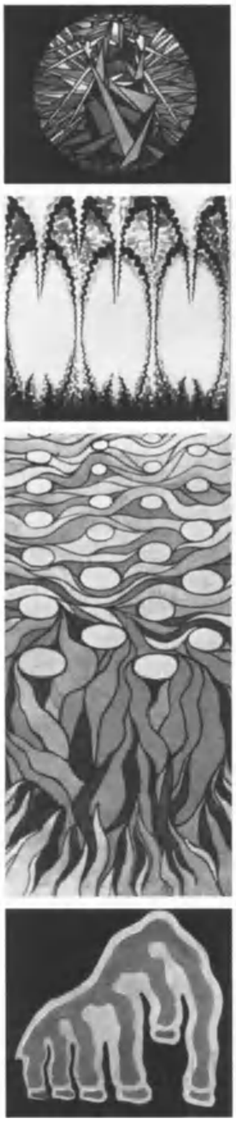
= yellow = orange = red = purple = blue = turquoise = seagreen = leafgreen

All remaining aids correspond to easily understood, unequivocal signs. The player can and should be skillful enough with his instrument so that rendering a composition becomes an artistic act. For the first time, the musical world and the public at large can experience color/light music at a "color-light-music concert" held in Kiel, entitled the Deutsches Tonkünstlerfest 1925. The program features eleven preludes for piano and color/light; each prelude is composed for a primary color. There will also be three pieces from Dreams, the third movement of my color/light sonata, and finally, Scriabin's poem, Vers la flamme. The Ernemann factory in Dresden built the instrument for the concert.

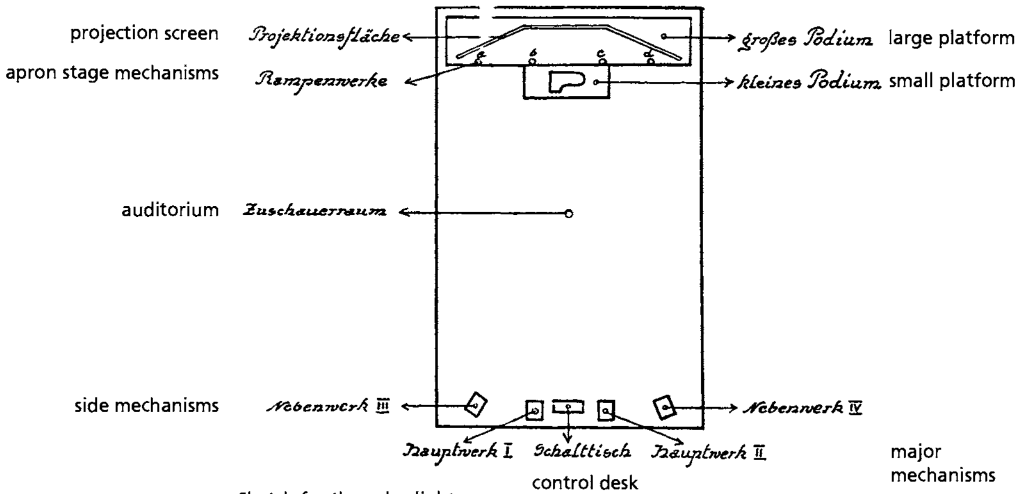
in: László Alexander, *Die Farblichtmusik (Leipzig:* Breitkopf und Härtel, 1925).

László Alexander, born 1895 in Hungary. From 1915 he lived in Berlin. Worked as a solo-pianist, composer, in the 1920s several performances of his *Color Light Music,* a.o. at the Berlin City Opera in 1926. In 1933 return to Hungary. Film dubbing and film music. In 1937 film *Magyar Triangulum.* In 1928 move to the USA. 1944-1953 music compositions for 23 films. Died in 1997.

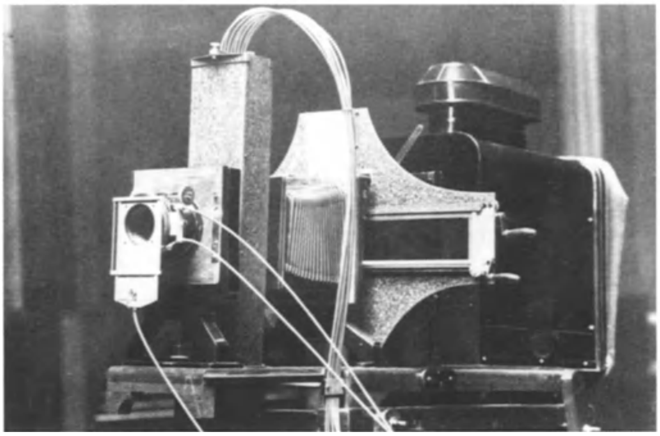
References:
C. McCarthy, *Filmcomposers in America. Checklist of their Work* (New York: 1972).



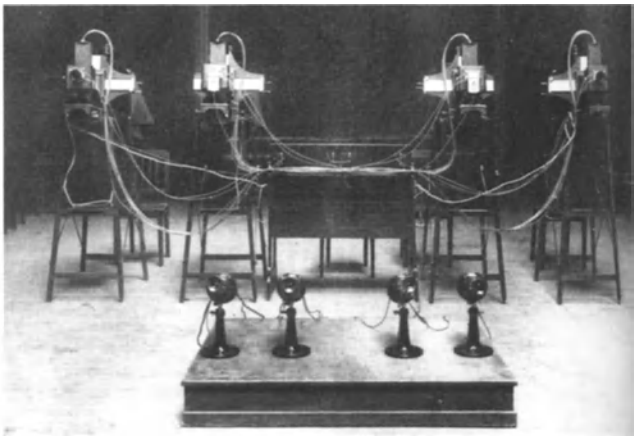
Projection-bars of major works II (after water-colors by Matthias Holl)



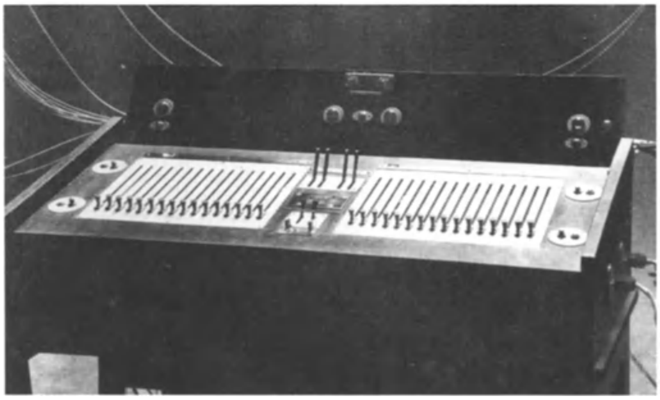
Sketch for the color-light piano



The major mechanisms II



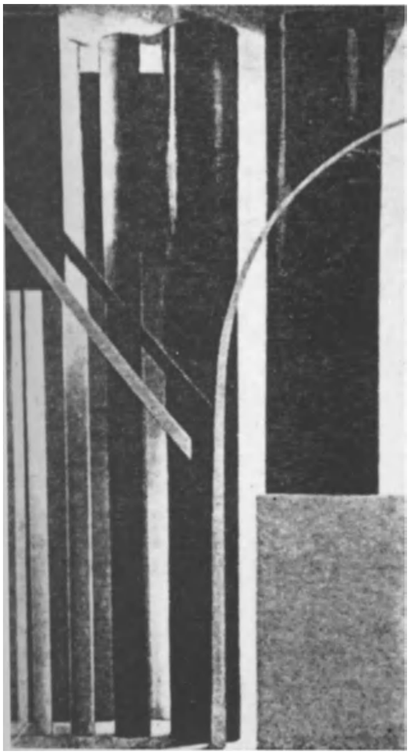
The color-light piano in position facing the platform



The control desk of the color-light piano

The color-light piano seen from the side

Nikolaus Braun
The Concrete Light



Nikolaus Braun
Changing Light Image, Phase 2
lost before 1925

Art is the relative, meaning temporally restricted, expression of our desire for the absolute. It is therefore always the result of the knowledge of the time period to which it belongs. Life in all its parts is fraught with changing perspectives and knowledge, a constant struggle for temporary dominance, full of action and reaction according to the laws of effect and counter-effect. The same struggle for temporary dominance of opinion exists in art as well. The three fundamental factors of the visual arts — color, form, and light — have always fought for precedence. If one traces the individual lines of development of these three factors, it is possible to perceive an increasing awareness of all three, and a drive to turn each one into autonomous, creative material. By dissecting rays of light into their colored components, the Neo-Impressionist discovered color as an end in itself. This lead to the artist's appreciation of pigment, and in turn, color came into its own as a mode of expression. Artists reached for concrete materials such as wood, fabric, metal, etc., which were integrated into the surface of the painting. After mastering the material's power of illusionary reproduction, form pressed forward to dominate. The basis for my sculptures and light reliefs is the idea of adding light as a third component to the elements of form and color used in Constructivist sculpture. I add electric light as a solid element to my works, thus giving them a more real light — the ability to give off their own light. Whereas previously, the most concrete application of one of these elements always forced artists to do without the other two, using light as a concrete element permits the harmonious interplay of all three factors, resulting in an integrated whole. Light is an eminently mobile, highly suggestive material of inexhaustible potential. It is possible to increase the sculptural and three-dimensional effects of body and space using light in an appropriate, concrete way. Light can dissolve or sharply distinguish the existing outlines of objects. In light sculpture, movement results from changing light, which causes constant adjustments, not just in the relationships among the visual objects, but also in the relationships between the objects and the image as a whole. In the same manner, color can be directly taken from light, making it seem as if it has been dematerialized.

Arthur Segal, ed., *Das Lichtproblem in der Malerei*, Berlin 1925.

Nikolaus Braun, born 1900 in Berlin. Student of Artur Segal and member of the November Group. He took part at the exhibitions of this group from 1923 on. In 1924 he participated at the First German Art Exhibition in Moscow, and he had an exhibition at the gallery Der Sturm in Berlin (together with L. Kassák). In 1938 he emigrated to Budapest. In 1949 he moved to the USA. Died in New York in 1950.

References:
H. Kliemann, *Die November-Gruppe* (Berlin: 1969).

New Art has recreated the image once again in the original sense of the German word *Bild* (image, picture), insofar as it means *Gestaltung* (creation, shaping, design). So it happened that modern artists created works that could not be subsumed under the old concept of the painting, nor regarded as sculptures. These works were therefore rejected because they did not fit into the traditional aesthetic scheme. For most people, the new image was even more difficult to acknowledge, as even Kandinsky's absolute paintings had been accused of not being paintings. This accusation was not really meant seriously, since people simply did not want to see images in absolute painting because painting had long ago been reduced to the concept of representation. In the meantime, people have learned to see images even in absolute painting (until they realize that the non-representational image approximates the concept of *Gestaltung*, of creation). And so the accusation is exclusively directed at those works first created by Schwitters and others, for example: compositions made of different materials compiled within a frame.

Rudolf Blümer, "Licht und Schatten," *Der Sturm* (December 1926) 129.

1

Oskar Rainer

Musical Graphics

Oskar Rainer, born 1880 in Vienna. From 1901-1904 he studied at the Academy of Arts. 1909-1912 professor of art at the k.k. State Grammar School in Villach. From 1913 instructor at a science grammar school, Vienna. 1912-1917 studies on the history of art with Strzygowski. In 1913 first abstract graphic designs inspired by music. In 1914 he founded together with Franz Cizek, Alois Kunzfeld, et al. the reform movement *Art and School* as well as the magazine *Die Quelle (The Spring)*. In 1917 he created the art pedagogical reform method Musikalische Graphik (Musical Graphics, publ. 1925). From 1926 intensive international lecturing. Died in Vienna in 1941.

References:

Oskar Rainer, *Die Innervationsmethode* (Nieuw Inzicht, 2/4, 1938) pp. 6-14.

Oskar Rainer, *Die motorischen Wurzeln der Form* (Vienna: Festschrift J. Strzygowski, 1932) pp. 133-37.

20 Jahre Musikalische Graphik. Kunstpsychologische Versuche aus dem Gebiet der Farb-Tonforschung (Vienna: Künstlerbund Hagen, 1934).

B. Ernst, H. Sündermann, *Klang-Farbe-Gebärde. Musikalische Graphik* (Vienna-Munich: 1981).

Probably everyone who has experienced the power of sounds and colors in their whole overwhelming magnitude will have wondered about the essence and nature of this power. People have pursued all modes of cognition, from the most tentative judgment of feelings to the sharpest analysis of ideas and the methodology of the natural sciences, in order to get closer to solving the mystery of this effect; examining the interrelations between the world of sounds and that of colors and forms has been recognized as one of the most fruitful approaches. Newton dealt seriously with this question, and in the second half of the last century physiology and psychology took it up. But just as works of music and painting are related in their effects, so they are certainly related in their creation as well; thus there is a bridge from the effect of one to the creation of the other, and yes, there are many known cases in which forms of music and painting have stirred each other. And although this had just been recognized as a general possibility, this fact — which also promised to foster the recognition of those relations — presented itself as a valuable aid to art education.

Oskar Rainer, *Musikalische Graphik. Studien und Versuche über die Wechselbeziehungen zwischen Ton- und Farbharmonien* (Vienna, 1925).

Hans Kohn
Valkyrie's Ride, 1920
Postscript to Richard Wagner
Charcoal on paper, 31 × 42.5 cm

Franz Urbach
Prelude with Fugue, c. 1923
Postscript to J.S. Bach
Charcoal on paper, 25.3 × 34 cm

Miklós Peternák

Vision in Motion

One of the most importunate artistic illusions of the twentieth century was the belief that it would be possible to discover the grammar of visual language and identify a set of basic patterns in the visual world. This would have made it as easy to deal with and learn about the visual universe as it is to handle acoustic space through the notation of language (writing). It is symptomatic, however, that some of the most promising products were not created in analogy to spoken language, but to another, easily defined (or labeled, at least) sphere of the acoustic universe, namely music.

This failure also has something in common with the disappointment experienced by those scientific disciplines involved in perception research (including optical research). Until recently, scientists also secretly hoped to find and eventually fathom a similar structure in linguistic analogy. The sad truth of the fact is that vision is a process comprising the simultaneous treatment of information absorbed through various channels. By now we have also learned that perhaps the image that appears on the retina is an erroneous generalization (since the process of vision already entirely excludes the only apparently conceivable image), and that when we research vision, we research cognition and the structure of the brain.

With a different dramaturgical emphasis, the two introductory paragraphs could be interpreted as the result of the disciplines mentioned. Research concerning the nature of vision — at least the research published so far — seems to reveal contradictions in the existing theories, in addition to posing new questions. Artists, on the other hand, feel increasingly comfortable in spheres that were previously considered alien to art, and this initially rather instinctive orientation has been exchanged for a radical expansion.

If, for the sake of argument, we cross-correlate different facts and shift into a historical discourse, we will be surprised to find that every scientific and technological theory and tool that would later be of significance was already in existence and readily available in at least an elementary form by the end of the nineteenth century. Still, the utilitarian or practical process, which caused a real shift in the paradigms of art, science, image, vision, perception, and cognition, first began in the 1920s and ended in the 1970s. However, the (practical) results of this process, as measured by sociological standards, are perhaps only being felt today.

For example, photography was paradigmatic because it created a quasi-reality and could therefore be interpreted using contemporary reception theories. Thus, its scientific context can be best described in terms of positivism, while it has had an impact on art ranging from Impressionism to abstract art. Thanks to its ability to record a given illuminated space and — in its capacity as a scientific invention — to affirm certain visual conventions, photography functioned for almost a century as a substitute reality (bearing in mind the fact that photographs were documents), until it was replaced by television and the virtual spaces of the near future. Although even from the start there had always been the possibility of employing it differently, alternative uses were not taken advantage of for long. To quote László Moholy-Nagy:

> *Fox Talbot created the first prototype of a photogram in 1853. He placed lace on a sheet covered with photosensitive emulsion... Around 1920, Man Ray and I, independently of each other, reinvented the photogram. Since then, this technique has become a common tool for visual expression.*[1]

Light Diagram

This is a term Moholy-Nagy applied in several instances to the photogram, and, as further examples, I will quote another two extracts from his book, *Vision in Motion*, posthumously published in 1947:

> *The image taken without a camera (photogram) can also be thought of as vision in motion, since the diagram made of moving light creates a coherence of light and time, which precisely describes the meaning of a photogram...*
>
> *A photogram — interpreted as a diagrammatic record of light in motion, expressed in black, white, and gray transformations — may lead us to conceive of new kinds of spatial connections and representations.*[2]

The author attached the following footnote to the first quote. "This subtle quality was captured in a chapter of James Joyce's *Ulysses*: 'the narrow space of time through the narrow time of space.'"[3]

Photograms are one of the most characteristic examples of the kinds of pictures that were invented to demonstrate the development of a new type of vision. Not only because this gesture introduced a radical new tool into the context of art, thus expanding its limits, but because it seemed to grasp all of the key concepts relevant to the interpretation of artistic intention.

The concepts of vision, light, time, space, motion, and perhaps later, system and structure, too, were and still are the most relevant concepts. As such, they are almost useless in the framework of general formulations,

1. László Moholy-Nagy, *Vision in Motion* (1947) p. 187.
2. Moholy-Nagy, chapter 1, part 3.
3. Ibid.

for they have been used in so many different contexts that they have lost their meaning and become hollow, empty.

"Photograms contain as many meanings as there are viewers," Moholy-Nagy also states (a very unconventional manifestation of the "optical democracy" supported by Ernő Kállai in 1948). In the present context, this statement is useful in illustrating how the character of artistic expansion is not definitive, but rather that its purpose is to destroy meaning, whether intentionally or not. Photograms, like new images by new artists in general, strive to represent a personal, exploratory visual experience, to create an opportunity for collectivism in its own particular way. On the other hand, a scientific approach is motivated by the search for an essence commonly shared by everyone, since such an essence can also be successfully applied to personal anomalies (e.g., an understanding of vision will aid the treatment of the blind, as well as assist in developing optics machines for industry).

The question arises of whether there is any connection between twentieth-century art's "new vision" (referring to the title of an English publication, *New Vision: From Material to Architecture*) and the results of scientific research on vision. Such a question would seem to imply that we are looking for a connection between Fraunhofer lines, geometrical abstraction, and commercial bar codes.

A significant number of the illustrations used in the literature about vision as perception, optical illusion, or deception — indeed, all scientific physiological and psychological research on vision — can be categorized in two groups. One is that of the simple image, which demonstrates that something that we see is, in fact, not there (the analogy is taken from physics and denotes the example of simple machines such as the inclined plane, the lever, or the pulley). The other main group connects, compares, or merges two structures (or two structures permitting ambiguity) in order to demonstrate their sensed or real (measurable) contradictions. (I am thinking of diagrams and effects such as the Kanizsa triangle, Rubin's figures, the Poggendorf illusion, the Ponzo illusion, the Müller-Lyer illusion, the Hering illusion, the Ebbinghaus illusion, the Necker cube, the Glass pattern, the implausible Penrose pattern, the Arnes room, etc.) There are instances in art history of similar yet more complex schemes dating from as early as the fifteenth century. One of the most famous examples is that of the anamorphosis, where the image is modulated toward the viewer by means of bending regular reflective geometrical surfaces, e.g., the cone, the cylinder, or the pyramid, to determine the correct point of perspective and render a virtual image. However, they were never applied in functional terms.

Parallel to this, art was interested in not just the visible world, but also in the world that makes things visible (or at least look different), regardless of whether it was shown in the work itself or owed its existence to previously inaccessible methods such as photography (Moholy-Nagy listed eight different types of photographic vision). It does not matter if the goal was a visual construction (e.g., Kassák's image architecture), the direct manipulation of light (Moholy, Kepes, etc.), the "supremacy of the senses" (Malevich), or a record of what Vertov called the "cinematic eye": they all share an obvious optical consciousness, whose intention was to show things that had never been seen before.

Stereo

Before Ernst Mach's lecture, Helmholtz was probably the only scientist who had been seriously occupied with the question of why humans see with both eyes. He recognized the importance of this question during his experiments with the stereoscope, which was invented by Wheatstone in 1838 and later developed by Brewster into a commercially viable optical product that caused a sensation at the London World Expo. (Helmholtz even patented a device called the Telestereoscope.)[4] In conjunction with direct experience, the notion that a complete, homogeneous image of the outside world is the result of the joint effort of the two human eyes aided by a third eye (the mind's eye or the brain) neutralized almost fifty years' worth of conventions pertaining to the processing of images. There can be a great sensation in the surprising experience of space caused by stereo images, because the image created by two eyes, each working from a slightly different perspective, is based in binocular vision, whereas the method used to adequately represent the illusion of space on a plane — central perspective (and the camera, as well) — is strictly monocular.

On the other hand, it took a century for something truly surprising to became plain, thanks to an invention by Béla Julesz. His random-dot stereograms (RDS), invented in the 1960s, demonstrate that when two correspondingly constructed schemata, each separately composed of random dots, are united, they reveal a hidden pattern that is invisible in the separate images. As research continued, it was learned that the capacity to perceive an illusion of depth, i.e., stereopsis, is a basic visual ability that develops at an early stage. (This served as a new starting point for research involving the perception of patterns.)

The mutual relation of the two previously described stereoscopic images creates a sense of depth (space) if both eyes see them parallel to each other, beside each other (i.e., through a stereo device). However, when

4. "Das Telestereoskop," Wissenschaftliche Abhandlungen 2 (1857): 484-92. See also *Hermann von Helmholtz and the Foundations of Nineteenth Century Science*, David Cahen, ed. (Berkeley/Los Angeles/London: University of California Press, 1993).

two images are projected in a rapid sequence (with a projector or a stroboscopic device such as the daedalum, described by Horner in 1834), we perceive an elementary illusion of motion. Maybe this simple example illuminates how different the results may be, as they depend on the different instruments or methods we use to observe the same object. It also explains why experiments based on the combination of the two lead only to partial results.

In the twentieth century, the expansion of the image into space and time (meaning the process of adding a third dimension to the plane Vilém Flusser defined as "the meaningful surface") moves in two directions on the technical/terminological level. If time is added as a third dimension, the result is a long sequence of moving images. If the third dimension is space, we call it a three-dimensional image, which projects out of the plane into the line of vision. The latter has a whole range of possible forms, and the same thing can be said for its combinations (here, admittedly, the terminology becomes rather hard to follow: compare stereo cinema, i.e., the 3D-film, with 3D-computer animation).

If we nonetheless try to create some kind of order or at least define the limitations here, the anamorphosis still one of the end points, thanks to its simultaneously visible (real and virtual) image, for the modified diagram apparently projects out of the plane into space. (The mirror does not create an image; the eye assembles it by means of a distorted, or, more precisely, an appropriately arranged projection of light.) The other end point, for the time being, is the simple virtual reality interface, which is basically an interactive stereo film in parallel projection, accessed with a pair of glasses (miniature monitors).

One of the simplest and as yet unmentioned ways to create an image of illusory space is the anaglyph, where red and green patterns are seen through red and green glasses. Imre Pál published several books on this phenomenon. Another is the holographic image, derived from Dénes Gábor's theory. The hologram is better known, but more complex. The anaglyph is based on direct physiological experience, while the hologram provides a supplementary illusion for a better understanding of visual information processing. According to Gábor, the original idea resulted when he was correcting a bad image:

> *The problem that had concerned me as a teenager returned to capture my attention again in 1947, in connection with electron microscopy. At that time, it was known that electron lenses would never be perfect, and their errors made it impossible for microscopes to perceive an image in enough detail to make atoms visible. That is when I had the idea that this difficulty could be overcome once we had recorded an imperfect image, which would nevertheless hold all the necessary information. It would indeed be distorted, but could still be corrected with the electron lens by means of light/optical procedures.*[5]

In a later lecture, given when he was awarded the Nobel Prize, Gábor said:

> *The ... diffuse hologram has a rather remarkable shape. It seems as if it is full of noise. As a comfort, we might even call it the ideal Shannon code, for in his theory of information, Claude E. Shannon proved that a code is most effective when all regularity disappears from the signal, so that this code becomes 'noisy.' But where is the information hidden inside this chaos? It has been proved that the hologram is not as irregular as it seems. It is not the same as randomly pouring grains of sand onto a record. We are talking about a very complex structure, a diffracted image of the object, which is repeated at irregular intervals, but is always the same size and goes in the same direction.*
>
> *It is a rather interesting feature of diffuse holograms that even the tiniest parts that are big enough to contain the diffracted pattern display all of the information necessary to the entire object. The object can even be reconstructed from this tiny part, although the noise is increased. The diffuse hologram, therefore, is divided memory. In this context, there has been much speculation about whether human memory is of a holographic nature.*[6]

Texture – Facture – Structure – Color

It is perhaps presuming too much to see a connection between the holographic pattern, or one of its elements, and the diffracted pattern, not to mention Béla Julesz 's textures and the theory of textons — beyond the fact that the lecture quoted above was held in the same year that Julesz's seminal book was published, in 1971. (I should like to draw attention to another coincidence, especially as I will mostly refer to Moholy-Nagy in the following paragraphs: the year 1947, mentioned in the first Gábor quote, is also the year *Vision in Motion* was published.) At any rate, the appearance of regular or irregular visual patterns — their ability to be regulated, their information, noiselike qualities, and their parts (divided, structured, or individual) — denotes a field of themes that has not yet been mentioned, although it is of special relevance. It is necessary

5. Dénes Gábor, "Holography, or the Whole Picture," The New Scientist, 29 (January 1966): 74-78.
6. Dénes Gábor, "Holographie 1948-71," Nobel Lecture (December 1971), The Nobel Foundation (1972).

7. Béla Julesz, *Dialogues on Perception* (Cambridge, Massachusetts/London, England: MIT Press, 1995) p. 138.

to address these topics, including color, at least a little bit, since any visual pattern can only appear as a deviation in color.

In his 1929 book, *From Material to Architecture*, part of the Bauhausbücher series (vol. 14, p. 33), Moholy-Nagy conducted an interesting terminological experiment, which was further developed by György Kepes in *A látás nyelve* (The language of vision). Moholy-Nagy set up a sort of logical, sensorial hierarchy for the common expressions used to name and distinguish among the various kinds of materials. Following the brief text was a whole series of visual examples, which, although it did not contribute to a better understanding, did, however, clarify the problem. The author called the "unalterable construction of the material" a structure, whose "organically created surface" is the "texture (epidermis, organic)." These two elements are joined by a third, termed the facture, which "describes the method of creation," the traces of workmanship in a material, and the external influences, whether artificial or natural. Moholy-Nagy added a fourth element: the amount (what has been amassed). Although he did not precisely define it, the visual examples show it in combination with the other three. Thus we can consider this a category that defines the set of photographs that do not fit into any of the earlier mentioned categories. The practicality of this categorization is that is promises a way of systematizing patterns and surfaces represented by images that would be difficult to deal with otherwise. At stake was a kind of conceptual apparatus, which could potentially lead to a better understanding of the language of art, and which the public could use to interpret what were, at least at the time, barely accessible products. This experiment, which was not at all hopeless, has not been forgotten, yet it has never been used in practice and so has not been significantly developed any further. On page 87 of the same book, the image referred to as *Linear Facture* (which, we learn later, is incorrect) is reminiscent of early Vasarely prints, including one he created by printing a negative on plastic. Moving it produces the familiar moiré effect, which stimulates visual excitement. It became the model for his later "systematic" artworks. Both Vasarely and Schöffer were drawn to the city as a potential terrain for the expansion and universal (or in their term: metroverted) elaboration of their activity. Vasarely wanted to enlarge the amount of colorful patterns in accordance with urban proportions; Schöffer imagined kinetic sculptures the size of monuments or even skyscrapers. In both cases, the course of history has moved in the direction of intangibility; its results are absorbed and applied by the universal machine, the computer, just as light or laser shows, as well as civic art (which Kepes translated into Hungarian as collective art) retreated inside and became known as multimedia performances or events.

Moholy-Nagy's terminological experiment recalls the system of categorization developed and discussed in varying tones at the Bauhaus. Its purpose was to decide which of the three primary colors (red, blue, and yellow) best corresponded with the primary forms (circle, square, and triangle). It is necessary to remark here that in the physiological sense, the primary colors are red, blue, and green, although Arnheim solves the obvious contradiction by referring to "generative" and "elementary" primary colors. In noting this, we must quote Julesz's observation that the only true scientific theory in psychology was trichromacy, and he considered formulating his own texton theory on the basis of this model.

> *Along with textons, anti-textons expand the theory of trichromacy, the only real scientific theory in psychology. The theory of trichromacy stated that any color could be matched to a combination of the three basic colors of red, green, and blue, so that the boundary between the selected color and the combined colors would become minimal, or disappear without scrutiny. When I introduced textons into psychology, I wished to extend trichromacy to encompass colors as well as textures. I wanted to know whether any texture could be matched to a finite (and not overly large) number of textons, so that the boundary between any textural array and an array containing a mixture of textons would cause the boundary to disappear from perception, without scrutiny. It seems now that this can be achieved; the fact that the gamut of colors can be matched by just three colors is in itself amazing. Discovering that the infinitely richer variety of 2D textures could be matched to a mixture of a finite number of textons is even more unexpected!*[7]

The Mobile

Among the representative art forms of the traditional visual arts, panel paintings (frameable works done in any kind of technique) have been chosen to renew and adapt to what is considered a modern attitude. This attitude is oriented toward a direction that has not been more closely defined than a demand for a new point of view and a new sense of time. Yet it is this renewal and adaptation that has resulted in visual forms such as the photogram, stereogram, and the hologram. The other classic form is the three-dimensional sculpture that can be seen from all sides, where the element of space is already a given. In this case, motion as such (drive), in conjunction with time (which subjects the classic sculpture to a process), takes on the form of kinetic sculpture. Just as images can be derived from notions of virtuality, the virtual image produced by lenses can be developed as a latent image on a light-sensitive surface (photography, for example). Thus, Moholy-Nagy described kinetic sculptures as a process of changing material mass into virtual mass. ("A sculpture is material mass and at the same time, its transformation into a virtual mass: it has a palpable existence, but it can also be changed into a visual concept: from the static to the kinetic, from mass to a relation of time and space," *Vision in Motion*). Moholy-Nagy's own work, the *Light Requisite* , created between 1922 and 1930, is one of the most complex realizations of these expectations.

Space Kaleidoscope

Moholy-Nagy also titled his work *Space Kaleidoscope*. It was not just an independent, moving, kinetic object, but it could also be used to generate light effects in the theater. Its creator filmed the motion of projected light and its modifying effects, and so his camera recorded a well-organized example of function, which was arranged in such a way that it became a work of art.

> *...when, in 1930, we began operating the Light-Space Modulator in a small assembly hall for the first time, I felt like a sorcerer's apprentice. The mobile's sequences of moving lights and shadows were in such astonishing accordance that it looked like magic to me. I have learned a great deal from this mobile, which I have been able to apply to my later paintings, photographs, and films, as well as my architectural and industrial design activities. Although I designed this mobile in order to see the transparencies as they functioned, I was surprised to discover that the shadows projected onto transparent and perforated plates caused new visual effects — they had a kind of constantly changing effect upon each other.*[8]

In retrospect, Moholy-Nagy regarded his photographs — the photograms made without a camera — as preparatory images for the *Light Requisite*, and so the expression "light diagram" can be associated with a "constructive mental sketch." The *Light-Space Modulator*, on the other hand, is a device that generates shapes. It is good for observations and investigations, and allows the terms "experiment, research, cognition" to be perceived in an artistic context, and also demonstrates the new vision, or vision in motion.

After all this, however, a disturbing question arises, which, from a physiological perspective, has not been asked and might never be answered: Why is the artist attracted to the new vision?

8. Lázló Moholy-Nagy, *Egy müvész összegzése* (Chicago 1944); Krisztina Passuth, *Moholy-Nagy* (Budapest: Corvina, 1982) pp. 345-346.

1

László Lengyel

The Brain of the Scholar, the Eye of the Painter, and the Heart of the Poet: György Kepes

György Kepes, born 1906 in Selyp. Studied at the University of Applied Arts in Budapest (C. István). In 1937 he founded the Chicago New Bauhaus together with László Moholy-Nagy and later the School of Design. 1941-1942 he directed the camouflage course within the framework of the National Defense Program, and from 1945 he taught visual planning at MIT, Cambridge. 1967-1974 director of the Center for Advanced Visual Studies, MIT, Cambridge, which he had founded. Died in 2001 in Boston.

1939 Katherine Kuh, Chicago
1944 Art Institute of Chicago
1954 Municipal Arts Center, Long Beach
1955 Stedeljik Museum, Amsterdam
1958 Galleria di Via Montenapoleone, Mailand
1962 Gallery 303, New York
1968,1970,1972,1974 Alpha Gallery, Boston

Group shows
1929 KUT exhibition, Budapest
1939 *Kelion, Kepes, Moholy-Nagy,* Grand Rapids Art Museum, Grand Rapids, Michigan
1946 *Designed with light,* Philadelphia Art Alliance, Philadelphia, Pennsylvania
1952 *Moris Graves, György Kepes, Mark Tobey,* Mayo Hill Galleries, Wellfleet, Massachusetts
1970 *Hungarian artists of the XX. century abroad, Műcsarnok,* Budapest

Cooperation between art and science is not unprecedented in the history of art. The strong desire to reconcile and unite these two branches of cognition occurs from time to time. To create a synthesis of the scientific and artistic achievements is a great challenge in each era.

Cooperation between scientists and artists has occurred several times in the art of the twentieth century, most significantly in the Bauhaus. László Moholy-Nagy intended to eliminate the so-called "split-man" state by creating a synthesis of the scientific and artistic achievements of the era. His educational programs, pamphlets, and writings reflect this endeavor. György Kepes, who was a close colleague of Moholy-Nagy from 1930 (their first meeting in Berlin) until as late as 1945, worked in the same spirit. Their ideas were formed in the workshops prepared for the Chicago New Bauhaus in 1937, and for the School of Design some years later. Both schools were directed by Moholy-Nagy, while Kepes was one of the senior teachers.

In the first period of his career, as a colleague of Moholy-Nagy, Kepes was concerned with formal and technical experiments; he named this period "the time of playful lovemaking with form and technique." Kepes, who began as a painter, gave up traditional panel painting for decades and turned towards new means of expression. In the New Bauhaus, Kepes led the Light and Color Workshop; in the course of solving a many practical problems, he often faced scientific questions.

One extraordinary opportunity was in 1942, when he prepared and led the so-called Camouflage Course, which was part of the national defense program. The uniqueness of the program — which covered camouflage techniques, the development of perception, as well as the mimicry of animals — is still striking. There was fortune in misfortune that these artists were given the opportunity to test their ideas, to link scientific and artistic research with the financial support of the state in the situation generated by the war. The whole program proved to be very fruitful for both students and teachers. In connection with this program, perhaps for the first time in our century, ideas of ecologically-based visual constructions of immense extensions were formed.

Fundamentals

In the Color and Light Workshop, the student was acquainted with visual fundamentals that are valid in every field of visual activity. The scope was not limited to the handling of color, surface treatment (covering, pigmenting, dyeing), and photography alone: all aspects of vision were coordinated in Kepes's studies, with all their static and mobile relationships and of vision. Because of this experience, the school's camouflage program was organized and taught by Kepes, head of the workshop.

Theory: Basic Investigations

At the beginning of the camouflage course there was a basic investigation of point, line, tone, color, shape, and so on, in all their possible interrelationships. To mention the most important ones: psychological and physiological phenomena, such as figure to ground relationship, consequences of similarity, closure, inclusiveness, submergence, and the optical mixture of tone and color values; borders; successive and simultaneous contrast; various forms of optical illusion; perspective, size, and motion; and so on. To acquire the necessary knowledge of the visual properties of forms and textures, they also investigated the interrelationship of light and shadows as they define forms. This study included the elementary laws of geometrical optics as well as practical exercises with light boxes, mirrored devices, and different types of reflecting screens. The work with light and shadow — which also included the control of diffusion, reflection, refraction, and all other aspects of illumination — served as key to many important camouflage solutions: counter-shading, projection of false shadows, and shadow elimination. The next step was the study of basic laws of projection: complementary colors, color filtering, additive and subtractive color mixtures, measuring illumination, photometry, and many other processes.

(Outline of the Camouflage Course at the School of Design in Chicago, 1941–1942)

In art-school programs' ideas about the art of the future, the wish for a "perfect" life was given emphasis; they considered the linking of artistic and scientific cognition a prerequisite. The career of György Kepes manifests this idea quite aptly. After the publication of his successful book *Language of Vision* in 1944, he took a job at one of the best technical universities of the world. In 1945 he taught visual design for more than a decade at the Architecture Department of the Massachusetts Institute of Technology (MIT) in Cambridge. During those years he gathered the material for his book *New Landscape*, which was published in 1956. At that time he started the organization of interdisciplinary courses, in which several world-renowned scholars participated and lectured. He compiled the 7-volume *Vision and Value* series from the material in these courses.

In the first part of the 1960s, he published several theoretical studies that reflected his conviction that the creation of an artificial world and the re-establishment of the balance between man and environment is only possible if the representatives of scientific and artistic life cooperate completely. In the preface to a volume of studies, *The Visual Arts Today* (Daedalus 89.1 [1961]), Kepes explains that man is only able to face the challenges of the changed world if he widens the basis from which he observes and lives life. We must completely exploit our abilities: we need the brain of the scholar, the eye of the painter, and the heart of the poet.

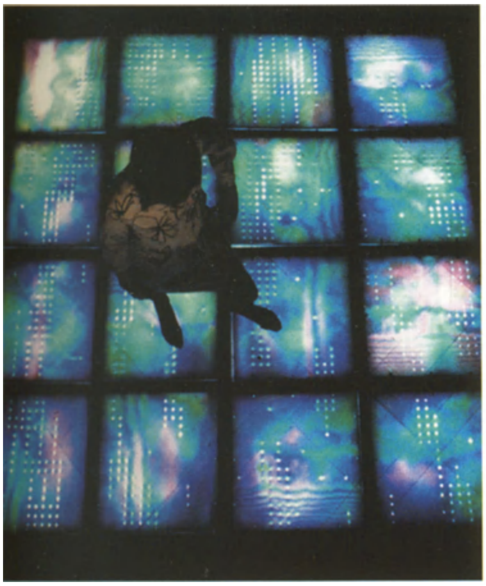
György Kepes published his proposition concerning the collaboration of sciences and visual arts in the Daedalus scientific journal (*The Visual Arts and the Sciences: A Proposal for Collaboration*, Daedalus 94.1 [1965]). In this article he outlined the possibility of scientist-artist cooperation which became the theoretical basis of the Center for Advanced Visual Studies, the institute he founded within MIT. (He was director of the institute until he retired in 1974.) In his proposal he named the two main fields of possible collaboration: the creative usage of light and the problems of environmental art and new technologies. The workshops he set up studied these two fields in the institute. In this period he also created his kinetic works and carried out concepts he had not previously realized. First he created a kinetic light wall, *The Night View of the Town*, in collaboration with T. McNulthy and O. Stevens for the Triennial of Milan in 1968. This was preceded by the kinetic wall at the site of KLM Airlines in New York in 1959–1960. In 1970 he finished the *Photoelastic Pavement* in cooperation with W. Wainwright. In 1971 he created *The Garden of Flames* with the application of gas flames. This kinetic composition, which was a great success, was made in cooperation with Maurizio Bueno, William Walton, and the composer Paul Earls. This work was followed by *Projected Magnetic Fields* and *Burning Column* in 1973.

His kinetic works prove the efficiency of the associations of scientists, engineers, technicians, artists, and the promise of a new synthesis. During the years his friend Vasilikas Takis, the Greek-born kinetic sculptor, spent in the Center for Advanced Visual Studies, another work was born, the beautiful result of a scientist-artist cooperation. Influenced by their debates and discussions, Takis and a professor of physics constructed a mobile sculpture that operated in the sea; with the help of large metal sheets moved by the waves of the Pacific Ocean it generated electricity for the West Coast.

Although many distinguished representatives of art and science visited the institution of György Kepes, his program had rather modest objectives: with his colleagues he studied the language of collaboration, in the hope of a future improved by science.

György Kepes, ***Language of Vision***, Paul Theobald & Co, Chicago 1944

György Kepes (ed.), *sehen + werten (vision + value)*, 5 vol., La Connaissance, Brussels 1967-72.



György Kepes
Photoelastic Pavement, 1970

György Kepes
Garden of Flames, 1971

1

Victor Vasarely

Optical Kinetics

Victor Vasarely, born 1908 in Pécs. Studied at the Academy of Fine Arts and Mühely-Academy in Budapest. Lived from 1930 in Paris, where he died in 1997.

1933 Ernst Museum, Budapest
1944 Galerie Denise René, Paris
1954 Palais des Beaux-Arts, Brussels
1958 Rose Fried Gallery, New York
1963 Kestner Gesellschaft, Hannover
1964 Kunsthalle, Bern
Gemeente Museum, Den Haag
1965 Pace Gallery, New York
1968 Galeria Suvremene, Zagreb
Fészek Club, Budapest
1973 Museo d'Arte Moderna, Mexico City
The Goodman Gallery, Johannesburg
1978 Vasarely Center, New York

Group shows:
1947 1. Salon des Réalités Nouvelles, Musée d'Art Moderne, Paris
1950 *From the Twelfth Century to Our Day*, Kunsthaus, Zürich
1953 *Arte Astratta Italiana e Francese (École de Paris)*, Galleria Nazionale d'Arte Moderna, Rom
Young European Painters, The Solomon R. Guggenheim Museum, New York
1955 documenta I, Kassel
1958 *Painting and Sculpture Acquisitions*, Museum of Modern Art, New York
1959 documenta II, Kassel
1960 *Kinetische Kunst*, Kunstgewerbe-Museum, Zurich
1961 *Le mouvement*, Stedelijk Museum, Amsterdam
1962 *School of Paris*, Tate Gallery, London
1963 *Internationale Grafik-Ausstellung*, Moderna Galerija, Ljubljana

References:
B. Reinhardt, *Vasarely: Geometrie, Abstraktion, Rhythmus. Die fünfziger Jahre* (Ostfildern: Hatje Cantz, 1998.

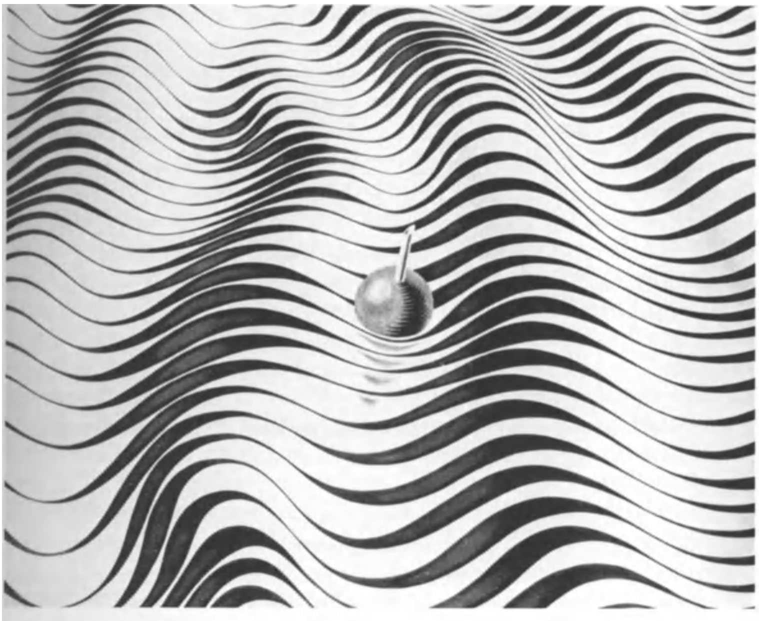
I came across Futurism — the two-dimensional imitation of movement — around 1932, at a time when I had already drawn up a series of so-called movement studies: studies of human movement while working manually, dancing, in different postures of expression; movement studies of animals, in groups and individually; movement studies of things, of falling, converging, of vibration, of dissipation, of undulatory movement, and so on. Certainly those robots, athletes, female dancers, and workers as well as those flying antelopes, those rotating and bouncing springs, tops, and ping-pong balls could well express the illusion of movement, but in reality they were only an optical illusion. Just like the whole of Futurism those studies of movement were leading us astray.

Strangely enough, it was in my graphic studies in two dimensions, created between 1933 and 1938, that optical kinetics finally appeared, and I experienced a striking and final breakthrough. The chessboards, harlequins, zebras, tigers, prisoners, and Martians did not move in a mimetic way, but rather due to the aggressive effect of their structures on the retina of the eye. Even though still entirely representational, these inventive studies made up the main repertoire of my abstract kinetic paintings created from 1954 onwards. In addition to this repertoire were added geometric drawings that I designed, together with Claire, for the Lyons silk industry as a basis for fabric printing. I designed only a few; Claire, on the other hand, designed thousands between 1931 and 1932. A selection of these 10 x 10 cm drawings if enlarged enough would certainly have resulted in the first collection of Op Art. In any case, I developed some of my main works from 1954–1956 out of them: Tlinko, Eridan, Betelgeuse, Andromede, and Bellatrix. In 1954 I noted:

> *The browsing through a picture book engenders entirely different sensations for me than the observing of a single picture. When flipping through, the picture is successively shortened in its perspective by extending it into the three-dimensional and finally disappears completely enabling the appearance of the next ... Through the movement, the sculptural content of a picture book becomes infinite.*

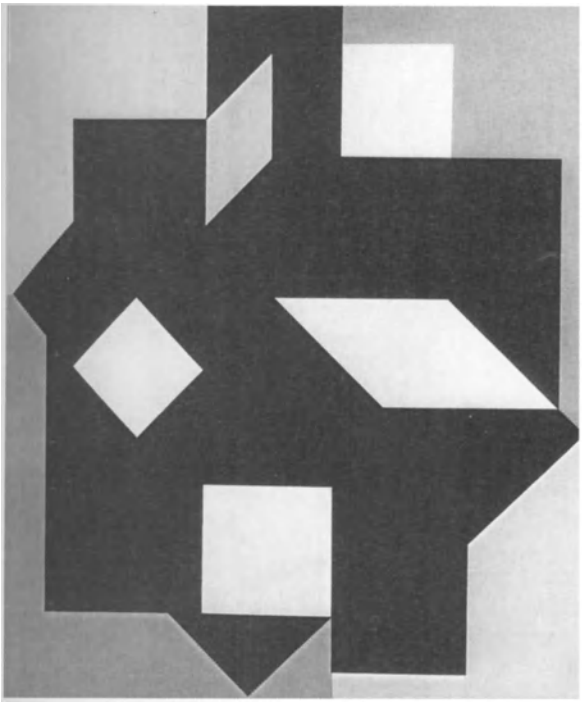
The idea of movement on the plane has occupied me since my childhood. Favorite themes of my first drawings were railroads and marching herds of elephants. One of my favorite games was drawing figures onto foggy windowpanes. I must explain this further. In my native country, Hungary, all houses are provided with double-paned windows because of the rigorous Continental climate. Once during winter I drew a moon face onto the exterior pane and tried to repeat the same drawing in the most accurate way possible onto the second pane, which was shut and separated by 20 cm from the other one. This had to be done quickly as the condensed steam would convert into large drops of water immediately. However, these two exactly overlapping moon faces doubled the grimacing if I turned my head a bit to the left or to the right. Nevertheless, this little miniature cinema left deep imprints in my unconscious mind. A short time later I started sketching my amusements onto tracing paper: to let the depth, the transparent surface with its specific characteristics recto and verso arise at the same time. With pen and ink I drew the upper half of a bathing woman onto one side, and the other half of the woman onto the other side of the tracing paper. The effect was surprising: the transparent material of the tracing paper covering the legs of the bathing woman evoked the dimension of water. The same effect was achieved with a factory on the recto and the smoke coming out of its chimneys on the verso of the tracing paper. I finally trebled the tracing paper and drew silhouettes changing in shapes onto each of the sheets using gouache, whereby I achieved the image of a crowd of people in milky mist. This overlapping anticipated the space, that space which was movement and time simultaneously. In two gouaches, Green Study and Blue Study, created in the Budapest Bauhaus, overlapping nets of lines showed the effect of moire for the first time pointing to the later "photographisms," the depth images, and the grids that appeared twenty-five years afterward.

Marcel Joray, ed., Victor Vasarely, *Kunst des 20. Jahrhunderts* (Neuchatel, Switzerland: Editions du Griffon, 1965) pp. 67–68.

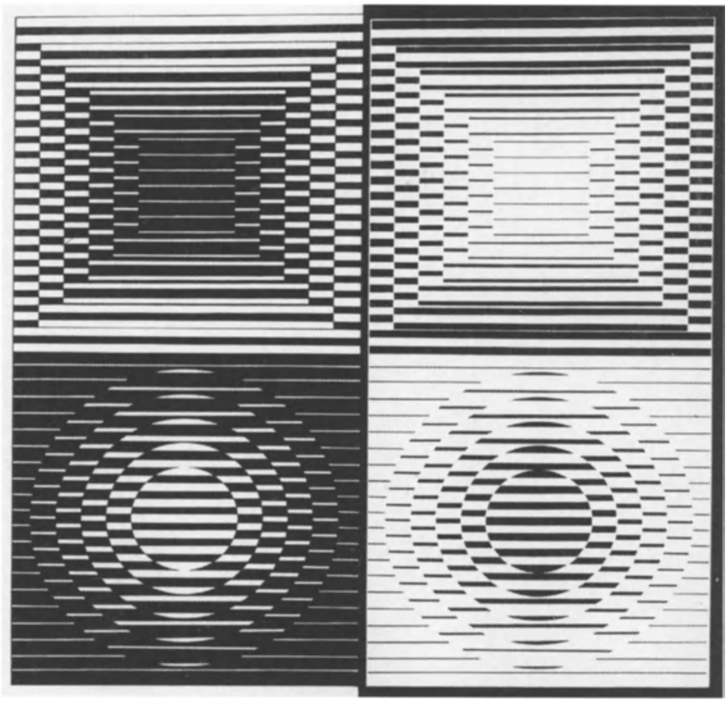


Victor Vasarely, *Movement Study,* 1939
60×70 cm
© VBK, Vienna, 2005

Victor Vasarely, *Dessin Denfert,* 1952
41.5×37.5 cm
© VBK, Vienna, 2005



Victor Vasarely, *Larissa II,* 1954/56
96×80 cm
© VBK, Vienna, 2005



Victor Vasarely, *Capella II,* 1964
© VBK, Vienna, 2005

1

Lajos Németh

Homage to Nicolas Schöffer

Nicolas Schöffer
born 1912 in Kalocsa. Stuied at the University of Applied Arts in Budapest. He emigrated to Paris in 1936, died there in 1992.

1958 Galerie Denise René, Paris
1960 Institute of Contemporary Art, London
1963 Musée des Arts Decoratifs, Paris
1965 Jewish Museum, New York; Washington Gallery of Modern Art, Washington D.C. (with J. Tinguely)
1975 Galerie Denise René - Hans Mayer, Düsseldorf
1977 Museum der modernen Kunst, Bonn
1982 Műcsarnok, Budapest
1989 Centre Culturel Hongrois, Paris

Group shows:
1953 *Quatre et quatre*, Galerie Colette Allendy, Paris
1959 documenta II, Kassel
1964 documenta III, Kassel
1966 *Lumière et mouvement*, Musée d'Art Moderne, Paris
1971 *Art et Science*, Museum of Tel Aviv, Tel Aviv
1988 *Digital Visions*, Gallery IBM, New York
1990 *Abstraction géometrique: du constructivisme au cinétisme*, Centre Culture de Compiegne, Compiegne; Maison Falluer de Cambrai, Cambrai

References:
N. Schöffer, *La ville cybernétique*, Tchou (Paris: 1969).
N. Schöffer, *La Tour Lumière Cybernetique*, (Paris: Denoël-Gonthier, 1973).
N. Schöffer, *Le nouvel ésprit artistique*, (Paris: Denoël-Gonthier, 1970).
Ph. Sers, *Entretiens avec Nicolas Schöffer*, (Paris: Belfond, 1971).
N. Schöffer, *Perturbation et Chronocratie*, (Paris: Denoël-Gonthier, 1973).
N. Schöffer, *La théorie des miroirs*, (Paris: Belfond, 1981).
N. Schöffer, *Surface et Espace*, (Paris: Capitales, 1990).

The art of our time is marked by a desire for constant innovation. However, there are only a few capable of creating something really new. Nicolas Schöffer belongs among them: he is one of the artists who determined the art of our era; some features of his work even anticipated the art of the next century.

Schöffer was born in Kalocsa in 1912 and studied in Budapest at the Academy. However, he belonged to a generation that sensed that the horizon of Hungarian art at the time, especially the artistic life, was too narrow, which is why he went to Paris in 1936. After years of experimentation, he found the path that led him to become a real pioneer. His artistic experiments were theoretical and practical at the same time. At the end of the 1940s, he developed the theory of spatial dynamism, which surpassed the traditional static attitude toward viewing sculpture. He exhibited the first sculpture reflecting this new attitude in 1950, and the first cybernetic sculpture, *CYSP 1*, in 1956. At that time, he became acquainted with modern ballet, and broke through the traditional boundaries between different branches of art. His research concerning spatial dynamism was replaced with the analysis of lumino-dynamism; later, he widened the topic to the theoretical study of chrono-dynamism. His sculptures based on lumino-dynamism became well known; his art became world-famous. He exhibited the first spatial dynamic cybernetic light tower in the city of Liège. Several other works followed the first cybernetic construction in public space, and in the 1970s, his art became decisive for the entire era. Handbooks and encyclopedias of art history label Schöffer's art — light mobiles that are rational and mystical at the same time — in an approximate, simplified way as kinetic art. Nevertheless, the dimensions of his artistic activity are much larger and cannot be tied to a single artistic trend. Schöffer seeks out the possibilities and functions of art within the framework of technical civilization. If we want to give a brief account of the essential features of his art, we may quote an epigraph in his book, *La ville cybernétique* (The Cybernetic City) which can be considered the theoretical basis of his art. "The task of the artist is no longer the creation of a piece, but the creation of creation." He does not want to create a traditional artwork, but intends to give shape to the process of creation itself. He creates dynamic constructions that constantly create themselves. Their uninterrupted motion and lumino-dynamic play of colors, which follows a predetermined program, elevate these works to symbols of modern science, cybernetics, and electronics; at the same time, they make the mathematical perfection of cybernetics poetical. They speak about even more: the creativity of the human mind and the possibility of constant creation. The other key statement about Schöffer's work might be a quotation from Paul Valery, "Two lethal dangers threaten mankind: order and disorder." The sentence seems to be a paradox, but it refers to the most serious problems of our era: the danger of the abstract, bureaucratic system of totalitarian state power, and the danger of anarchy. Both are capable of destroying human completeness and freedom. This is the point where Schöffer sees the existential significance of art as a socio-cultural phenomenon: it might possibly defend human freedom, free creativity, the ability to play. He believes that by means of art, man is able to avoid the danger of becoming a controlled robot. The incalculable caprice, playfulness, and diversity of art, sublime and graceful at the same time, acts as a protection from the dictatorship of uniformity and automatism, which restrains the individual. Schöffer's cybernetic *Light Towers*, his large-scale projects, *Chronoses*, and his laser compositions are all mechanisms that follow the perfect operational rules of cybernetic logic, controlled programs, and electronics. At the same time, due to their uninterrupted motion, changing forms, and their rhythm, which enlivens and moves the environment, they symbolize change, coincidence, and the pulse of life: the formula for balance between order and disorder.

Schöffer's works are based on the bulwark of the technical revolution of our era: cybernetics and electronics. Nonetheless, they are tied to the great tradition of art as well, for the basis of his art consists of light, the dynamics of space, motion, form, and change. His mobiles and lumino-dynamic constructions interpret the new light and color experiences, which our modern age and science — the technological civilization — offers us. Light, once the reflection of the divine in the Middle Ages, a mystical fluidum leading to the transcendent sphere, was secularized in the age of Impressionism. In Schöffer's art, it became the symbol of dynamism, of lightning, of discharge, the vibrating energy of the universe. It is a transcendent power, the result of scientific cognition described and controlled by cybernetics, and, at the same time, a poetic messenger. Science and art meet in Schöffer's works, although this is not novel in the history of art. It was the great endeavor of the Renaissance to elevate art, considered the product of the artisan, to the level of the natural sciences and philosophy. As Leonardo — who dreamt of reconciling art and science — emphasized, the activity of the artist armed with science is a creative activity in which spirit, action, scientific knowledge, practice, and artistic intuition unify. Science and artistic intuition meet in Schöffer's works of art as well, so that a work represents and follows the phases of birth, the process of creation. His works are the fruits of a mind that recognizes laws and wants to create something new. Human planning, programs, and the mathematical logic of cybernetic systems poetically meld in the works, which provide new experiences of space, time, light, and color.

***Parisiens Hongrois, Revue d'art* 21:1 (Paris 1994): 15-16.**

Nicolas Schöffer

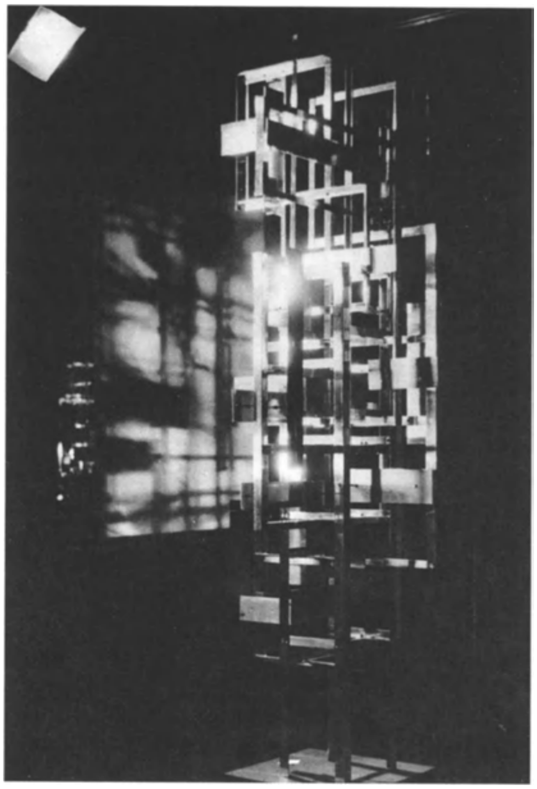
Autonomous Cybernetic Sculptures

Wherever people move on horizontal planes, wherever they stand or sit — meaning in work, living, and leisure areas — the rhythmic, environmentally dependent presentation of autonomous cybernetic sculptures has to be planned according to the decision of the central cybernetic brain. The sculptures will wander about either individually or in scattered groups. They are aesthetic elements forming a counterbalance, whose surprising effect is also strongly distracting.

These spatio-dynamically conceived sculptures are built upon a visible frame whose parallel arms have vertical revolving axes, which are in turn equipped with horizontally rotating discs; other discs revolve around horizontal axes. Furthermore, hinges can be included in the plan, enabling telescopic as well as rocking motions. These constructs of structures and surfaces, some or all of which move, are controlled by their own cybernetic control systems, which issue commands to move on paths that are specified by either the C.C.C. (Cybernetic Command Center) or their own electronic control system. The structures set their movable elements in motion according to the commands of their own control system.

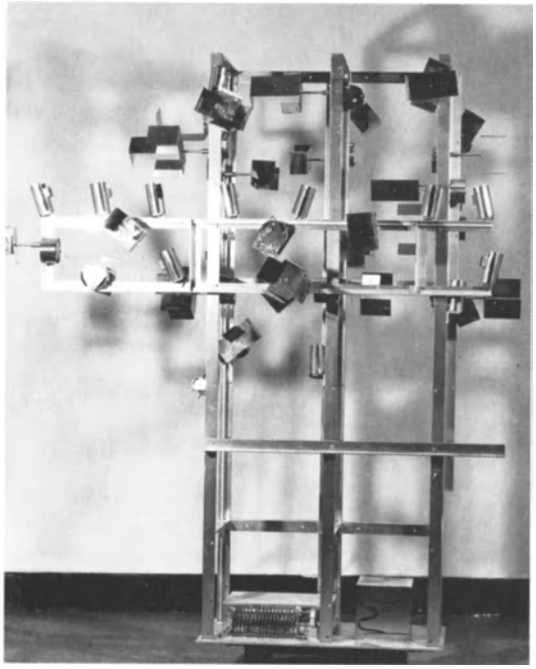
They will be equipped with radar units, which will enable them to avoid collisions with passers-by and to move safely. Small motors drive the movable elements. The motors that provide power and maneuverability, as well as the electronic control system, are safely placed in a pedestal that carries the whole structure. An aerial on top receives the commands of the cybernetic center. These sculptures will appear individually or in groups, depending on their configuration, and they will exhibit specific behavior.

Nicolas Schöffer, *La ville cybernetique* (Paris: Ed. Tchou, 1969).



Nicolas Schöffer
Spatio Dynamic Sculpture 24, 1954
© VBK, Vienna, 2005

Nicolas Schöffer, *Mini Sculpture,* 1970
Height 19 cm
© VBK, Vienna, 2005



Nicolas Schöffer, *Chronos,* 1965
Chrome, 150 × 115 × 229 cm
© VBK, Vienna, 2005

Friedrich Kiesler
The Vision Machine

Friedrich Kiesler, born 1890 in Vienna. Studied architecture at the Academy of Arts in Budapest and at the Technical University in Vienna. In 1923 he designed the first theater scenery made with the help of film projectors. In 1924 *International Theater exhibition* in Vienna. In 1926 he moved to New York. In 1928 design of several galleries and theaters as well as of his first movie theater. 1934-1947 director of stage property at the New York Juillard School of Music, designs for the Metropolitan Opera. 1936-1942 director of the Design Laboratory at Columbia University School of Architecture. In 1942 he designed Peggy Guggenheim's museum and he planned the renowned "Infinite House" from 1949-1959. From 1957 up to his death projects together with Armand Bartos. Died in New York in 1965.

Group shows
1936 *Cubism and Abstract Art,* Museum of Modern Art, New York
1960 *Visionary Architecture,* New York

Exhibition design
1947 *Exposition International du Surrealisme,* Galerie Maeght, Paris
1951 *De Stijl,* Stedelijk Museum, Amsterdam
1952/53 *De Stijl 1917-28,* Museum of Modern Art, New York

References:
F. Kiesler, *Inside the Endless House* (New York: Simon and Schuster, 1966).
F. Kiesler, *Us-You-Me,* in: *Frederik Kiesler* (New York: Howard Wise Gallery, 1969).
D. Bogner (ed.), *Friedrich Kiesler. Architekt. Maler. Bildhauer 1890-1965* (Vienna: Museum of the 20. Century, 1988).
H. Nevidal, *The Book of the Shrine* (Alte Galerie am Landesmuseum, Graz and Jewish Museum of Vienna, Vienna 1992-1993).
D. Bogner, *F. Kiesler, Inside the Endless House,* (Vienna: Historical Museum of Vienna, 1997).
Frederik J. Kiesler: Endless Space (MAK Center for Art and Architecture, Los Angeles, Ostfildern: Hatje Cantz, 2000/01).

The *Vision Machine* will enable us to classify the sculptural creations of man. Since the *Vision Machine* tries to demonstrate the different constituents of seeing and of imagery, it should facilitate the analysis and understanding of the various physio-psychological sources, which are the origins of the sculptural arts.

It is commonly known that types of paintings or sculpture recur. It is evident that these recurrences must have a common root in each type. It is also the aim of the model to show the interrelationship of these roots.

For this purpose, we shall arrange typical works of art in one cycle, beginning with works from prehistoric times and ending with the present. This cycle will consist of the following types:

01.) prehistoric cave drawings
02.) Assyrian murals
03.) fresco by Giotto
04.) painting by Piero della Francesca
05.) painting by Raphael
06.) Van der Meer
07.) Turner
08.) Seurat
09.) Cézanne
10.) Picasso
11.) Mondrian
12.) Miró
13.) Dalí
14.) Marcel Duchamp

There will be three sections: one consisting of works of the physically impaired (blind), one composed of examples of the mentally impaired (insane), and another section made up of paintings by children. The flow of this continuity indicates, in the following manner, the complete cycle of creative imagery:

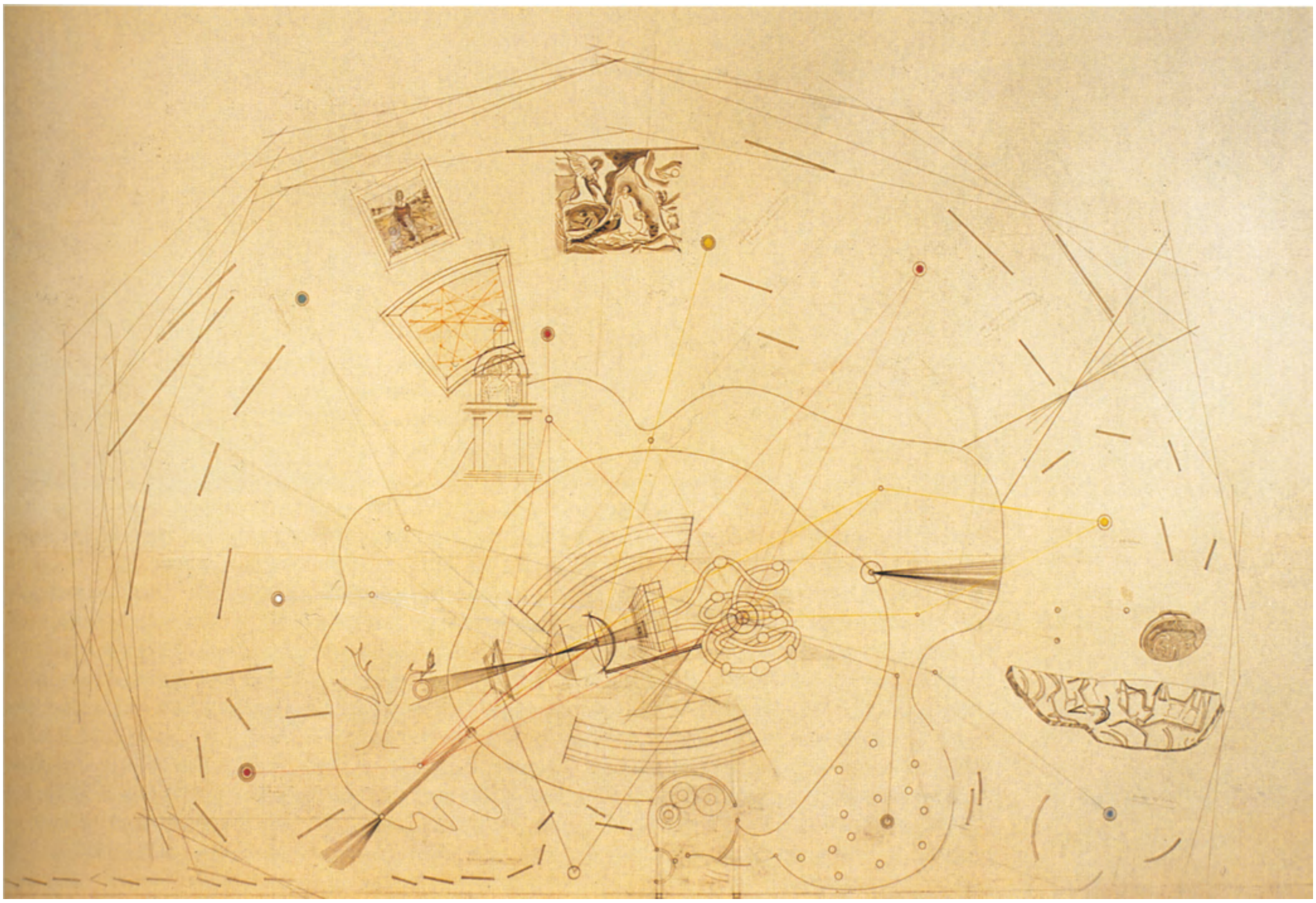
From the subconscious to work mainly sustained by memory;
to work significantly influenced by the direct observation of nature;
to an attempt to reproduce the illusion of nature;
to the balance between directly absorbed observation of nature and memory;
to an attempt to directly reproduce images of nature (Dutch);
to the reconstruction of natural images with technical illusions;
through the abstraction of nature despite direct observation (Cézanne and Picasso);
to the complete abandonment of the object and the creation of independent visual objects (Mondrian);
to an attempt at direct subconscious production (Miró);
to an attempt to realistically interpret visions from dreams;
to the integration of visionary realities in the real environment (Duchamp).

Brief Description of the *Vision Machine*

First, the *Vision Machine* demonstrates the flow of sight. It also depicts the origin and flow of visionary images. All parts of this machine are mechanically connected, except for the object, which remains a separate unit. From the beginning to the end, a soundtrack provides an explanation, which is synchronized with the unfolding of the process demonstrated.

A. The Vision Machine consists of:
1. the object,
2. the eye,
3. a division between outside and inside,
4. a circulatory system (like that in a human body),
5. a pedestal, upon which the machine rests and which contains the built-in soundtrack.

B. By touching an electric button, the mechanism demonstrates itself automatically as follows:
First, the object (in this case, a glass apple) reflects the light rays directed toward it. Second, the eye then focuses on the light reflected by the object. This part of the demonstration is carried out by means of glass tubes, in which bubbles are seen moving from the object to the retina. The stimulus on the retina does not produce



Friedrich Kiesler, *Vision Machine*, c. 1942
Drawing, 98.5 × 155 cm

the actual picture of the object (as is commonly assumed). Instead, the stimulus is transformed into a force that expands the original path of light into the internal structure of the human body, where the processes of perceiving and forming the picture are completed.

C. The *Vision Machine* interprets this process in the following manner:
The division of the human body into inside and outside is indicated by a heavy wall with an opening in it. Glass tubes going through this opening keep up a continual flow of stimuli from outside the body to the internal structures of the body, and then back again to the outside.

D. To demonstrate the different reactions that take place in the mind as well as in the body, this continuous impulse allows us to see via the glass tubes an abstract circulatory system leading to and from the brain. The different-colored tubes glow successively, until the cycle is completed. Each color has a specific meaning within the total coordination system.

E. As each cycle is completed, a new stream of light, formed inside the human body, moves outward from inside the brain, superimposing its own image upon the object it has "seen." A transparent screen suspended close to the real object (the apple) is the receiver for this projected image.

With this demonstration, we learn that neither light, nor eye, nor brain, alone or together, can see. Rather, we see perceived objects only by coordinating all of the experiences. Seeing is therefore a creative ability and does not consist of simple mechanical reproduction.

First publication of the original text belonging to the Kiesler estate.

1

Nikolaus Schaffer

Georg Jung or Almost a Color Religion

Georg Jung, born 1899 in Salzburg. He studied medicine in Vienna. Evening nude classes at the Academy of Applied Arts. In 1918 first exhibition in Salzburg. In the beginning he was influenced by the Austrian Expressionism, later on by futurism, Cubism, and new functionalism. From 1935 he dealt with the building of furniture, interior design, wall-painting, and sgraffito. In addition, he designed the most significant series of Austrian stamps of the time between the Wars, the folk costume and the airmail series. In 1938 he moved to Vienna. In 1948 first abstract paintings. From 1950 he dealt with moving picture objects. 1948/49 group exhibitions at Vienna Secession and the Zedlitz-Hall. All his life he also dealt with literature, wrote short stories as well as the (lost) novel *Die bereitende Zeit*, 1927 and the posthumous manuscript *Wir Sechs*. He died in Vienna in 1957.

Exhibitions
1923 Secession, Vienna
1925 Galerie Hans Goltz, Munich
1975 Künstlerhaus, Salzburg
1976 Galerie Würthle, Vienna
1982 Museum Carolino Augusteum, Salzburg

Nikolaus Schaffer, born in 1951. Studied art history. From 1983 he has been the curator at the Salzburg museum Carolino Augusteum. His special field is Austrian art of the 19th and 20th century. Publications, a.o. on: Johann Fischbach, Hans Makart, John Q. Adams, Anton Faistauer, Dagobert Peche, Max Pfeiffer, Watenphul, and Rudolf Hradil. He lives in Salzburg.

When, in a text accompanying the exhibition at the Zedlitzhalle in Vienna in 1949, Georg Jung wrote, "I am especially interested in the mutability of things," he merely hinted at the direction that would guide the last eight creative years remaining to him. It could not be predicted that he would embark on such an astonishingly direct path of creation, incorporating movement as a constitutive element of his painting. No longer did he content himself by merely suggesting movement with the aid of purely painterly methods of creating dynamics with paint, characteristic style, or composition. Now he sought to move on from the conventional panel painting to the creation of fluid sequences of movements, assisted by mechanical devices and electrical equipment. On one hand, he created combinations of painted strips, reeling them off like rolls of film, while on the other, he expanded the concept of the winged altarpiece, increasing its mobility, ultimately creating a rotating drum covered with pictures inside and out. It is to this late experimental work, where the design engineer and painter are united as one, that Jung owes his reputation as at least a regional pioneer of kinetic art. Perhaps Jung's inventions were somewhat too eccentric to be a pioneering; but as original variations on the old desire to transform painting into a kind of art of its time, they can stand up to any comparison. They most definitely cannot be dismissed as whimsical escapades of a rich idler — an appraisal with which Jung was confronted all his life. One fact that negates this assessment is the immense consistency of his artistic development. From the outset, he tended to oppose the static structure of the picture, the solidifying materiality. He did this, for example, by flicking paint onto the chassis and cultivating a corresponding preference for an unemotional, ethereal pallet, or by distorting spatial proportions, altering their angles, and turning space into whirls of clustered curves. Initially a follower of ecstatic/visionary Expressionism, Jung employed elements of Futurism and Cubism in the 1920s, not in order to refract the appearance of the picture, but rather to make it permeable to transitory processes. In this respect, Jung was always concerned with drawing attention to suprasensory forces beyond the realm of perception in order to illustrate conditions of emotional tension, which he arrayed in multifarious genres, often with a mythological or religious reference. He used urban vistas, landscapes, and portraits, but preferred group pictures to serve his aim of advancing from the impressive to the world within. The fact that he continued to focus on the same subjects and patterns of composition for several decades, in order to adapt them to his latest insights in terms of color theory, proves that he worked above all on evolving and consolidating archetypal, psychological constellations. One of his unmistakable features is the underlying romantic, idealistic concept of the artist as a wanderer and mediator between two worlds: a rational, secular, everyday world, and an emotionally laden, spiritual and intellectual sphere. A "secret science" is required in order to comprehend the latter, but its intuitive elucidation promises a return to a preconscious dream state through the artist-magician who consciously employs his tools. In the course of the 1930s, Jung increasingly shifted the focus of his work to color, which absorbs all pictorial functions, and finally, the last reference to objects is dissolved in an intensely colorful, three-dimensional radiation that required no intermediary. In the pictures called Color Dramaturgies, individual color characters are employed as autonomous actors; the aim is to understand the visual tension by means of the color relations alone. In order to prevent superficial associations — particularly in view of the fact that the fluctuating shapes still have echoes of figures — Jung added purely descriptive titles such as Black Tries to Float, Red is Stronger than Green, or Serious Outside and Fiery Inside. The interesting thing is that achieving the abstract form of representation almost always perforce entailed a demand for greater mobility in composition. Simultaneously, with the dissipation of concrete points of orientation, Jung evidently felt dissatisfaction with the single work and a need for complex structures. The eye of the beholder, too, is involuntarily impelled by the color entities drifting by, fleeing each other, or nestling together like cloud formations. 1952's History of Yellow was Jung's first multi-part tableau, whose individual sequences could be related to each other in the sense of a continuous action. Hinges made possible to vary the order of the individual elements and thus partly or completely transform the overall picture, which originally had been integrated into a wall. (In the meanwhile, it has been taken apart and it individual components scattered.) As early as 1948-49, the same time Jung was working on his first abstract pictures,

Georg Jung
History of Yellow, 1952
Oil on hardboards
each 71 × 71 cm

Georg Jung, *The Eye*, 1953/54
Color mobile

Georg Jung, *Untitled*, c. 1950
Oil, celluloid, 23 × 333 cm

he also created the *Altar of Friendship*, whose wings opened up, causing the work to penetrate into the deepest realms of the senses. At the same time, the gradually increasing degree of abstraction was interpreted with a thoroughly mystical understanding. This secular devotional image — the alchemy of emotional life, with its attractions and conflicts, its fateful encounters — still features figures detailed on the outer layer in the form of pairs and groups. However, in the second layer, its theme is gradually liberated from palpable materiality, and finally, in the innermost layer, it is transposed onto a level of pure color relationships, which is supposed to refer to something beyond a psychologizing, emotional cast of characters. In 1950 Jung built the first of his eight color mobiles — bulky wooden casings whose approximately 30 x 30 cm openings behind extravagantly constructed, indirectly lit plastic screens allowed a view of a drifting, aquarium-like scene. The "chassis" in this case is made of criss-crossed, unreeled strips of cellophane. The individual phases of the process of winding up, meaning the rhythms of color and form to be retained, were recorded as still sketches. A kinetic curtain made of velour and painted with oil was created in 1955. The lengths of material are sewn together at both ends to form an infinite strip, which, suspended on a rail attached to the ceiling, is rotated with the aid of an electric motor. The slow change of the visual patterns on the flowing fabric creates an effect that could be termed ghostly. Jung, who endeavored to create and astutely comment on the theoretical foundations of his work, preferred to draw inspiration from the border zone located between strict science and occultism. For example, he was so preoccupied with Wilhelm Ostwald's color theory that he paid a personal visit to the physicist in Dresden in 1922. In later years, he tended toward anthroposophy, having been additionally inspired by reading Swedenborg. Jung combined an enthusiasm for technology and esoteric inclinations. A relatively superficial connection, for example, is his passion for fast cars and his great interest in film and the crucial problem of how to depict a dynamic form of perception in art. By mobilizing the chassis for the image, he creates an illusion of color complexes moving freely in space, detached from any material bonds. Jung combined folding and turning mechanisms in his last work, called *History of Two Colors*, again without taking the final step away from the panel picture to the kinetic object. The work consisted of twenty panels, some painted on both sides, mounted on a pentagonal aluminum frame, which in turn pivoted on two stands (both no longer exist). It could almost be a kind of prayer wheel belonging to some sort of color religion.

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Abbild und Emotion. Österreichischer Realismus 1914-1944, exhibition cat. (Vienna, 1984).

Die Vertreibung des Geistigen aus Österreich, exhibition cat. (Vienna/Salzburg, 1985).

Nikolaus Schaffer, "Aufbruch ohne Sprengsatz," *Jenseits des Realismus*, exhibition cat. (Graz: Arge Alpe Adria, 1988).

Die verlorene Moderne. Der Künstlerbund Hagen 1900-1938, exhibition cat. (Vienna, 1993).

Christoph Bertsch, Markus Neuwirth, eds., *Die ungewisse Hoffnung. Österreichische Malerei und Graphik zwischen 1918 und 1938* (Salzburg, 1993).

Aufbrüche – Österreichische Malerei und Plastik der 50er Jahre, exhibition cat. (Vienna: Österreichische Galerie, 1994)
Neue Sachlichkeit. Österreich 1918-1938, exhibition cat. (Vienna: Kunstforum Bank Austria, 1995).

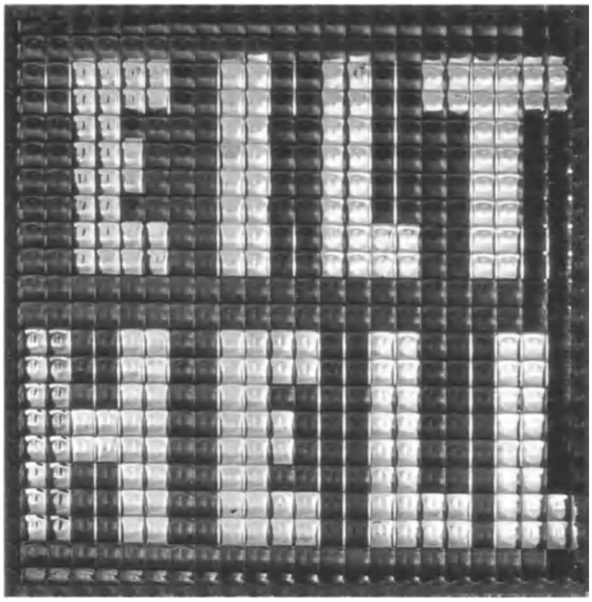
Marc Adrian

Marc Adrian
born 1930 in Vienna. Studied at the Academies of Art in Vienna, Milan, and Paris. In 1961 founding member of Nouvelle Tendance, Zagreb. 1969-1973 professor of painting and the theory of aesthetics at the University of Art, Hamburg. From 1980 fellow at the Center for Advanced Visual Studies, MIT, Cambridge, Massachusetts. 1988-1989 guest lecturer for visual communication at Kassel University 1995-1996 guest professor at the Academy of Fine Arts in Vienna. Lives in Vienna.

1955 Kunstforening, Oslo
1960 Künstlerhaus, Graz
1968 Galerie nächst St. Stephan, Wien
1975 Neue Galerie, Graz; Galerie im Taxispalais, Innsbruck
1988 Museum of modern Art, Vienna
1998 Secession, Vienna

Group shows
1965 *The Responsive Eye*, Museum of Modern Art, New York
1967 Trigon 67, Neue Galerie, Graz
Kinetika, Museum of the 20th Century, Vienna
1968 *Cybernetic Serendipity*, ICA, London
1969 Trigon 69, Neue Galerie, Graz
1975 *Kunst aus Sprache*, Museum of the 20th Century, Vienna
1995 *Austrian Avantgarde Cinema: 1955-1993*, Museum of Modern Art, New York
1996 *Strange Movies*, Minoriten, Graz
1999 *Avantgarde-Kurzfilm*, Diagonale, Graz
2001 *Why Do We Cover Our Interior Walls and Windows?*, Galerie Krobath-Wimmer, Vienna
2002 *Stanze II*, Museo d'arte moderna e contemporanea, Bozen
2004 *SUPPORT. Die Neue Galerie als Sammlung*, Neue Galerie, Graz

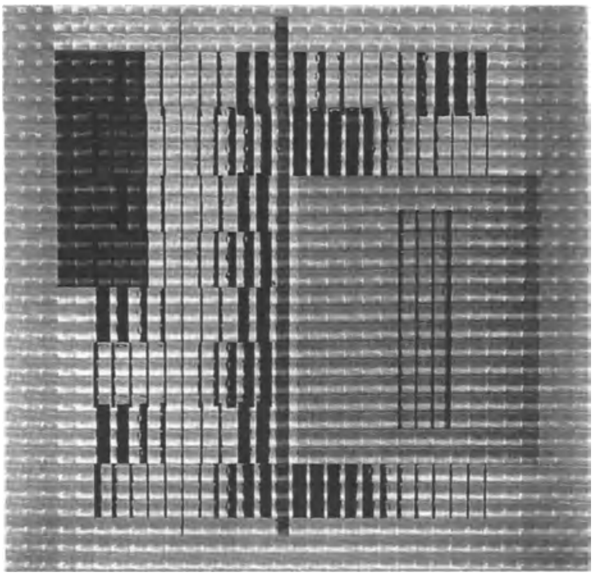
References:
O. Mörth, *Marc Adrian: Das filmische Werk*, (Vienna: Sonderzahl, 1999).



Marc Adrian
eilt-hell-teil-tief (hurries-light-part-deep), 1965
Montage behind glass, oil, wood, ribbed glass
43 x 43 cm
© VBK, Vienna, 2005

motion is the term used to describe a process that arises from a change of relations between two or more complexes.
every motion can be defined by its direction, its rhythm, and its duration.
there is nothing that does not move.
as an optical phenomenon, motion can be three-dimensional or two-dimensional. one-dimensional motion is of a theoretical nature.
motion can be used artistically to design contents of consciousness.
artistically employed motion must be designed in its entirety and must be free of all avoidable coincidences.
the essential process in visual art consists of the alienation of physical phenomena.
every artwork is bound to its actuality.
theories can be established on the basis of existing artworks, the reverse process is hopeless.

zero III (Düsseldorf: 1962).

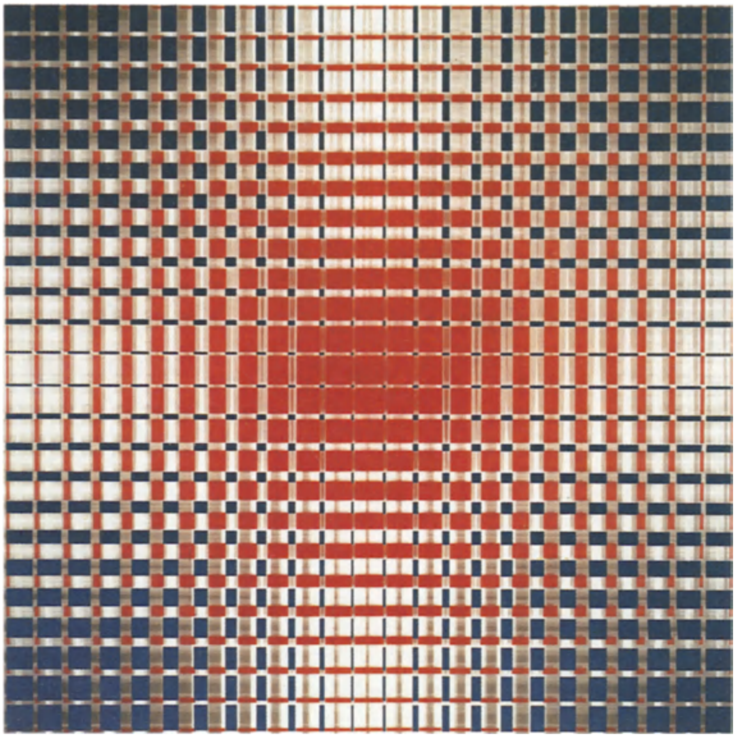


Marc Adrian, *H3*, 1967
Montage behind glass, oil, wood, ribbed glass, 61.5 x 61.5 cm
© VBK, Vienna, 2005

intention: optimum integration of the viewer in the creation of the artwork.
shift of the range of activity to the viewer.
stimulation of mobility inherent in the principle of montage behind glass, i.e., the artistic experience, creation of a latent state of tension, leaving the viewer every opportunity at his means. creation of a variable continuity in an invariable conception. attempt to show a unity of the model for the progress of multi-dimensional human thought and (kinetic) superstructures.

nouvelles tendances
(Paris: Palais du Louvre, 1964).

Helga Philipp



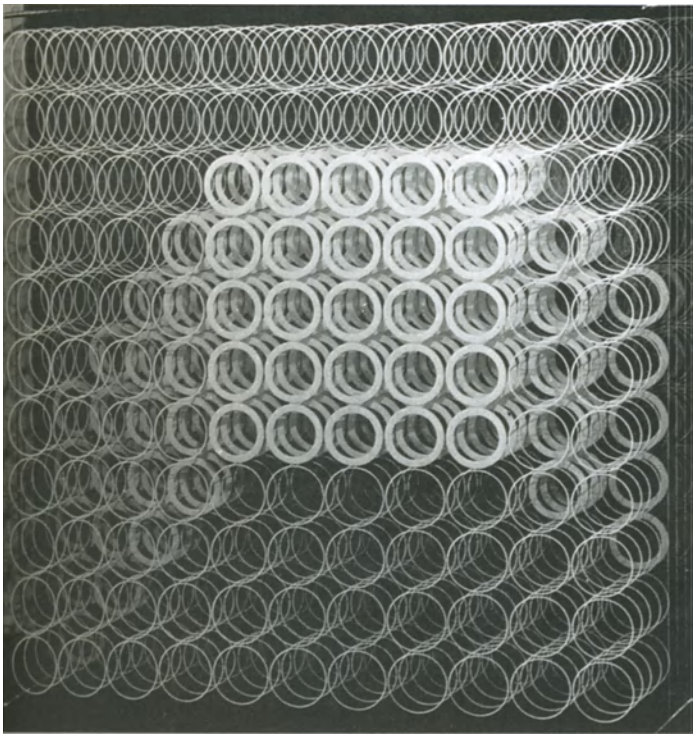
Helga Philipp, *Object*, c. 1968
Perspex (2 sheets), synthetic resin paint, 26.5 × 38.5 cm

Helga Philipp
born 1939 in Vienna. Studied sculpture in Vienna. Since 1965 she has been a lecturer at the Academy of Applied Arts in Vienna. Died in 2002 in Vienna.

1968 Galerie nächst St. Stephan, Vienna (with M. Adrian, R. Kriesche)
Forum Stadtpark, Graz
1972/77 Galerie nächst St. Stephan, Vienna
1974 Neue Galerie, Graz
1978 Modern Art Galerie, Vienna (with K. Basset)
1997/98 Academy for Applied Arts, Vienna

Group shows
1967 *Kinetika*, Museum of the 20th Century, Vienna
1992 *Identität : Differenz*, Neue Galerie, Graz
1993 *Das sogenannte Abstrakte*, Kulturhaus, Graz
1997 *Arte Vienna*, Kurashiki Museum, Kurashiki, Japan
2000 *Concrete Art*, Museum Konkret, Győr, Hungary

References:
Peter Weibel, Christa Steinle (eds.), *Identität : Differenz* (Graz: Neue Galerie am Landesmuseum Joanneum, 1992).



Helga Philipp, *Object*, 1972
Perspex, PVC, 120 × 120 × 10.5 cm

image
viewer
existence of the image
existence of the viewer
mutual relationship
viewer – image
image – viewer
existence of the image through the viewer
existence of the viewer through the image
movement of the viewer towards the image
movement of the image with the viewer
counter-movement
image – viewer
viewer – image
incorporation of space in the image
movement in space and movement of the viewer through the image
movement of the image through the viewer and space
change of the image through change of light
change of the image through change of the viewer
quality of the viewer
quality of the image

helga philipp, objekte-graphik, Neue Galerie am Landesmuseum Joanneum, Graz, 1974.

Hermann J. Painitz

Form, Color, and Information

Hermann J. Painitz
born 1938 in Vienna in 1938. Lives in Vienna.

1966 Forum Stadtpark, Graz
1968 Galerie nächst St. Stephan, Vienna
1973 Maerzgalerie, Linz
1975 Secession, Vienna
1978/85 Galerie im Hofstöckl, Linz
1987 Neue Galerie, Linz; Museum of Modern Art, Vienna
1996 Galerie Lindner, Vienna
2000 Künstlerhaus, Vienna
2004 Galerie Chobot, Vienna

Group shows
1965 Trigon 65, Neue Galerie, Graz
1967 *Internationale Grafik*, Galerie nächst St. Stephan, Vienna
Kinetika, Museum of the 20th Century, Vienna
1968 *Plastiken und Objekte*, Museum of the 20th Century, Vienna
1971 *Das große Format*, Künstlerhaus, Vienna
1973 *Österreichische Malerei*, Künstlerhaus, Graz
1976 *Samdiskunt fra Ostrikke*, Kunsthaus, Oslo
1978 *Position der Zeichnung in Österreich*, Staatliche Kunsthalle, Baden-Baden
Logische Kunst, Secession, Vienna
1979 Konzepte 79, Secession, Vienna
1982 *Odysseus*, Künstlerhaus, Graz
1983 Kärntner Landesgalerie, Klagenfurt
Freiplatz Kunst, Secession, Vienna
1996 *Die 60er Jahre – als alles möglich wurde*, Herberstein castle, Styria
Kunst aus Österreich, Kunsthalle, Bonn
1997 *Alpenblicke*, Kunsthalle, Vienna
2003 Lentos, Kunstmuseum, Linz
2004 MUMOK, Museum of Modern Art, Vienna

References:
"Painitz-Lehren," in: *Die 60er Jahre – als alles möglich wurde* (Graz: Herberstein castle, 1996).
Alpenblicke (Vienna: Kunsthalle, 1997).

Form and Color

The process of perceiving the environment with the senses is subject to an automatic regulation that is meant to convey an unambiguous impression. Sensorial perception of the environment must always be unambiguous, otherwise environmental impressions would endanger our existence. This is why we possess automatisms that affect our sensory machinery and cannot be consciously influenced. Generally, these automatisms are adapted to reality, but sometimes they are out of place. In this case we call them illusions, and then they are generally optical illusions.

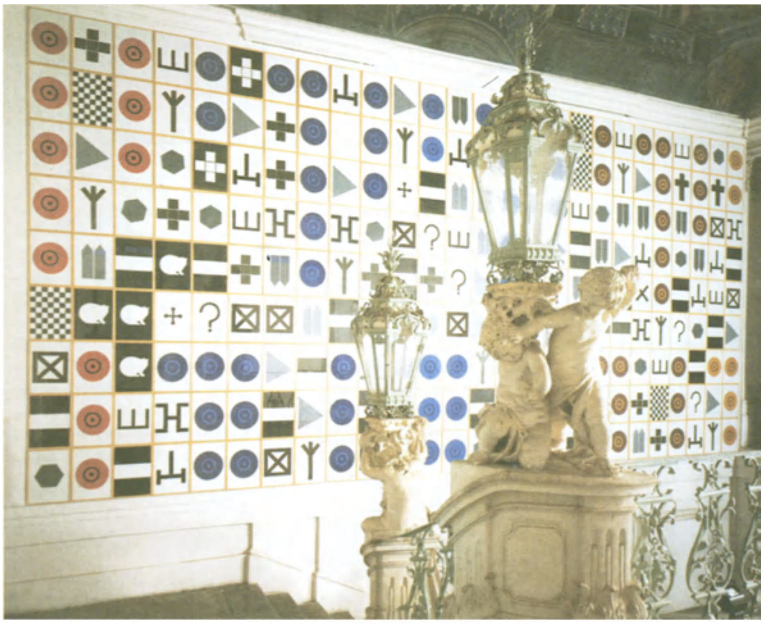
In terms of sensorial perception of the environment, form and color are mutually exclusive. Form is assigned to volume, while color is assigned to surface. If form is presented on the surface, as is the case in painting, it is neither real nor naturalistic — the very foundation of painting appeals to illusion. Hence, someone seeking to avoid illusions and wishing to produce real, naturalistic work would have to rule out painting as a vehicle for artistic ideas.

However, the surface upon which painting is presented is essentially not a surface at all, but rather a plane. The difference between the plane and the surface is that the plane can be imagined as an illusion, while the surface is a body, earth-bound and concrete. Three-dimensionality is subject to constraints that do not come into effect on the plane. Tectonics is the consequence of these constraints. Volumes must rest on something, which makes a horizontal element inadmissible. Tectonics is the result of layering. The vertical is the result of many layers on top of each other. It is only secondarily a consequence of the horizontal.

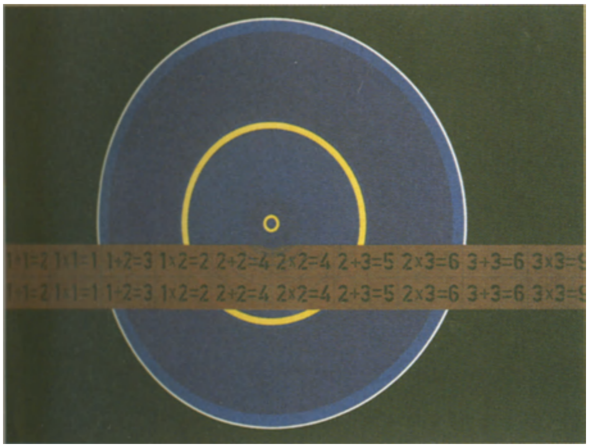
Information

Artworks are perceived like all other presentations of the inner and outer worlds, which is why the repertory of information theory can be applied. Above all, it must be clear that, just as different, complex people possess the same senses, the storage capacity of these sense impressions — the brain — can also be used in completely different ways. Information theory can be traced back to two sources. The structuralist component of information theory stems primarily from France. Both Ferdinand de Saussure's signifiant-signifié polarity and Roland Barthes's system of fashion dealt with questions of information. Abraham Moles developed the polarity of aesthetic perception — semantic perception. In his aesthetic theory, Max Bense takes a physics-oriented, heavily mathematical and technical view. Op Art is to a great extent founded upon his research and teachings, as is so-called machine art. An art form executed by computers also bears his mark.

Information roughly arises as follows: the receptivity of the senses is limited. The eye, for example, can only take in a maximum of sixteen images per second. If this number is exceeded, an optical illusion results, and we see movement. The other senses also have their limits. Perception is comprised of elements of perception. We can resolve and analyze sensorial impressions and obtain measures of information. Such measures are of



Hermann Painitz
More Than the Sum of the Parts, 1997
Acrylic paint on paper, 387 parts
Installation view, Neue Galerie Graz, 1998
© VBK, Vienna, 2005



Hermann Painitz
Two Times Two Is Four, 1999
Acrylic paint on canvas
135 × 200 cm
© VBK, Vienna, 2005

significance for possible technical applications, whereas in art, it is probably more important to challenge these measures by deviating from the norm.

Two of Wittgenstein's propositions are of great significance in this context: 1) The world is all that is the case, and 2) What is the case — a fact — is the existence of states of affairs.

With the aid of diagrams, pictograms, and organograms, it is possible to visualize states of affairs not visible in the world of objects. These are optical modes of representation that may be performed with the aid of graphic or painterly means.

A diagram combines two lines, a timeline and an event line, and two areas, a time area and an event area. This creates a grid that can help record and visualize how selected events occur in a selected period. A couple of examples of this are annual temperature recordings or measuring a patient's various bodily functions. The diagram is a representation assisted by two directions.

A pictogram portrays a state of affairs without requiring any strict form or special regularity. In a pictographic representation, it is sufficient to reduce or simplify the objects representing a state of affairs, so that a symbol or signal is formed that clearly relates them to each other on a presentational surface.

If symbols are used, the pictogram becomes democratic; it is understandable to more than just a circle of experts, and everyone can more or less read it. Otto Neurath's pictograms were created with this intention. A pictogram makes it possible to display how the one thousand billion dollars of armament funds spent in 1977 were allocated to the various nations of the world. This can be done on a map of the world or against a white backdrop; no rules are stipulated. The pictogram is a representation that does not prescribe a particular direction.

An organogram consists of one or more processes represented in linear form. If several processes are represented in a linear form in a single organogram, they are not combined by any set of rules, but rather, each process obeys its own rule. Contacts and intersections correspond to the situation being portrayed and do not constitute any separate rule in an organogram. In its simplest form, an organogram is a consistent time line created by listing certain biological facts, or a consistent time line limited to a circle shape, as is the case in the circle of life, the emergence and passing of individual biological units, the biorhythm. The diagram, the pictogram, and the organogram are three possible ways of turning depicting things that previously could not be depicted.

Art is not just concerned with the presentation and creation of form, but also — and most especially — with representing changes in form. Here, the artist can draw a crucial impetus from the field of Gestalt psychology. Several examples are cited by Arnheim, a perceptual psychologist who dealt in detail with tricks of the senses. Perception without thought is not enough. If both are combined, the artist will be able to shape his art in such a way that it will be apposite — both for society, because it is connected with the world, and for the artist, because it is connected with art.

Art is the result of the artist's cognitive activity and can neither be created nor consumed effortlessly. Art is the connection between the material and the spiritual, a combination of disparate elements of the world.

Hermann J. Painitz. Bilder, Graphiken, Plastiken (Neue Galerie der Stadt Linz; Wolfgang-Gurlitt-Museum; Museum moderner Kunst, Vienna; NÖ Dokumentationszentrum für moderne Kunst, St. Pölten 1987) pp. 97, 103-105.

1

Wolfgang Buchner

Opal III. A Color Instrument

Wolfgang Buchner, born 1946 in Mürzzuschlag. Studied philosophy, mineralogy und ethnology in Graz. Lives in Graz and Salzburg.

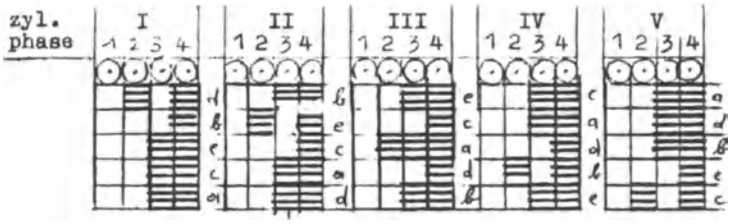
1981 Neue Galerie, Graz
1999 Japan Stipendiate, Fujino, Japan
2001 steirischer herbst, Kunsthaus, Mürzzuschlag

Group shows
1977 Trigon 77, Neue Galerie, Graz
1984 *Neue Wege des plastischen Gestaltens in Österreich,* Neue Galerie, Graz
1987 Palazzo Ducale, Mantova
1992 *Identität : Differenz,* Neue Galerie, Graz Biennale, Udine
1994 *Styrian Window,* Neue Galerie, Graz
1996 *translokal,* Stadtmuseum, Graz
2002 *Flutung – Salinenplastik III,* Stadtmuseum, Graz
2003 *Die Saline des Falken,* A9 forum transeuropea, MuseumsQuartier, Vienna
Meisterwerke der steirischen Moderne, Rabenstein castle, Styria

References:
Wolfgang Buchner, *Bauten, Malereien und Skulpturen* (Graz: Neue Galerie am Landesmuseum Joanneum, 1981).
Wolfgang Buchner, *Die Salinen des Felsendoms. Salinenplastiken* (Graz: Neue Galerie am Landesmuseum Joanneum, 1994).

Color Set 1:

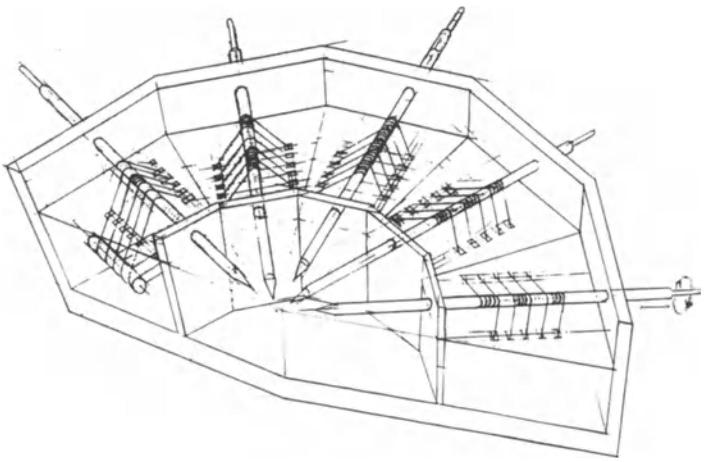
Twenty-five color threads are reeled onto five threaded rods, which can be rotated around and along their own axes. Each has a row of five small color reels forming a color cylinder. Each of the color threads represents one row of linear color compositions, the so-called chromograms or "glowing lines" (a, b, c, d, e) which are, in turn, generated by means of permutation of three basic vectors.



By turning the threaded rods, the twenty-five color cycles of the chromograms are reeled off in four phases, starting with pure white, into the five permanently changing color cylinders.

Color Set 2:

In the projection, each color cylinder (= helix) is represented as a sequence of color circles (core or nucleus circle). According to K = 1/R. q, their curvature energy K can generate chromatic curvature planes obtained from radial color vectors ("opal circles"). They are in a sense the phenotype of the linear genotype.



Wolfgang Buchner, *Opal III. A Color Instrument,* sketch, c. 1981
Threaded rods, wood, perspex, watercolors, cotton threads, 15 × 70 × 40 cm

Opal I - III was originally created in search of an equivalent to a mineral color instrument, the opal, which, by virtue of its natural molecular spherical geometry, changes its color spectrum at the slightest movement.

Hans Florey
On My Works

My contribution to the exhibition *Beyond Art* consists of various versions of the same color shape in a magic square. The magical, harmonic principle (the holistic connection of the equal and unequal, as the synthesis of a polarity) determines the "outer form." The outer form is characterized by separated poles (where the cells of the square are divided into core and shell) and the polarized form of all the colors (two complementary six-tone groups, each assigned to the core and shell elements).

The "inner form" — this magical, harmonic principle — can be reconstructed from the "outer form," the quality of the latter depending on the degree of clarity. In detail, one recognizes the holistic connection of equal core elements with unequal shell elements (or vice-versa). The regular placement of the twelve-tone complexes can be seen in the analytical form of the "six canon cycles;" as well as the logical extension of the color shape into the third dimension, as seen in the model of the "six mirror points of a central mirror point."

A sixteen-cell magic square is painted so that it contains six core and six shell tones in each of the four-part rows, columns, and diagonals. These tones represent the whole of the twelve-part color circle (a twelve-tone complex). The location of the twelve-tone complexes (which total twenty-four) can be taken from the pattern of the "six canon cycles." Each "canon cycle" consists of sixteen combinations of elements (four times four different cores and shells) and forms four twelve-tone complexes through characteristically regular image placement. In this pattern, the black and white dots signify combinations of elements; they correspond to the negative and positive numbers whose value sequence (-2, -1, +1, +2) is the foundation for the arrangement of the elements.

When the color shapes in the magic square are translated into musical notes, the sequence of notes is determined by the spatial color form of the image (black and white notes, corresponding to the core and shell elements). In this case, the translation into notes demonstrates the temporal aspect of the image: the First and After, in relation to the comparison of color tone intervals. By translating the image into sound, the listener is forced to follow a particular path of comparison within the spatially conceived arrangement of tones.

The painted form of the magic square can be extended into the third dimension, thus creating a magic cube. Inside this cube, equal elements can be connected by a straight line that passes through the central mirror point or one of its six mapped mirrored points outside the cube.

Since 1951, I have been investigating ways of superimposing rows of shapes based on circles, cubes, color, and sound, which are in turn based upon the principle of holistically connecting equal and unequal phenomena. In view of our capacity to compare, and our related powers of sight and hearing, I call numbers, color, and sound the holistically comprehensible variables. I regard the geometry of the twelve-part circle and the intervals derived from the equi-tempered tone circle as the only objective bases for comparison of color and sound.

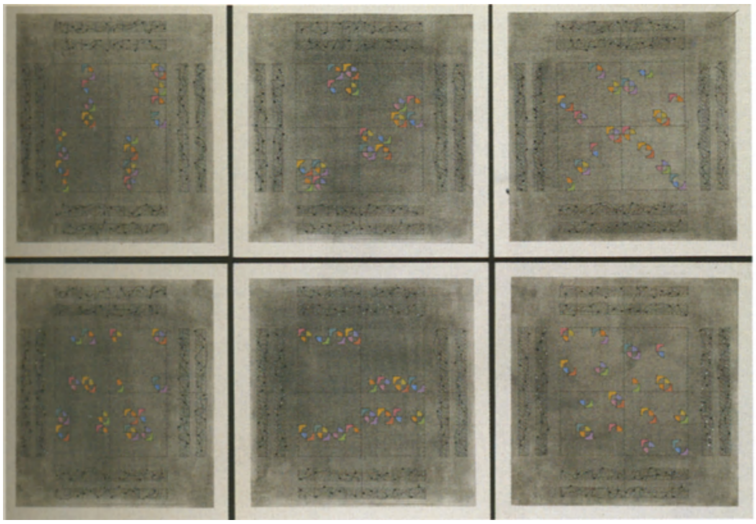
Analyse '82 (Graz, Stadtmuseum Palais Khuenberg / steirischer herbst '82: 1982) p. 308.

Hans Florey
born 1932 in Salzburg. Academic painter. Lecturer at the University of Music and Interpretative Art, Graz. Lives in Abersee, Salzburg.

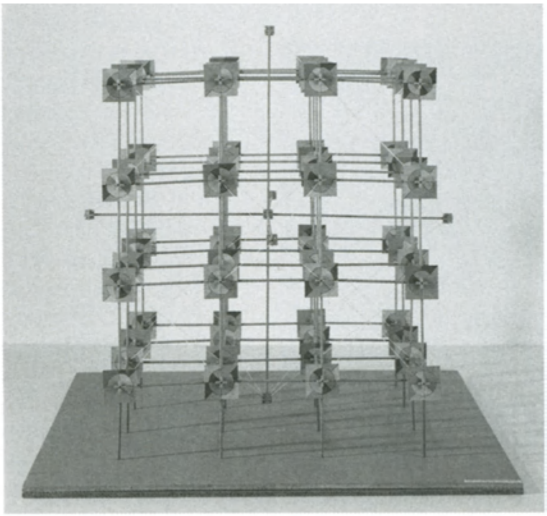
1976 Neue Galerie, Graz
University of Applied Arts, Vienna
1981 Neue Galerie, Graz
1987 Kunstverein für Kärnten, Klagenfurt
1990 Neue Galerie, Graz
Kärntner Landesgalerie
Fészek-Club, Budapest
1995 Palais Wittgenstein, Vienna

Group shows
1977 Geometrica 77, Tulln
1978 *Logische Kunst,* Secession, Vienna
steirischer herbst, Graz
1979 *Exakte Tendenzen,* Galerie Circulus, Bonn
1981 *Gruppe 77,* Secession, Vienna
1982 steirischer herbst, Graz
1987 Europalia 87, Brussels
1992 *Identität : Differenz,* Neue Galerie, Graz
1994 Ambrosi-Museum, Vienna
2003 Kammerhofgalerie, Gmunden
SUPPORT. Die Neue Galerie als Sammlung, Neue Galerie, Graz

References:
Hans Florey, *Zahl-Farbe-Klang in zyklischen Kanonformen* (Graz: Neue Galerie, 1990).



Hans Florey, *The Six Canonic Cycles of One and the Same "Greek-Latin" Square in Color and Sound Form, 1982*
Ink, acrylic on paper, 29 × 29 cm



Hans Florey, *Magic Cube with 6 Mirror Points,* 1982
Wooden sticks, ink, acrylic on paper, 62 × 62 × 62 cm
also sound arrangement for piano (Celeste)

1

Walter Gerbino and Riccardo Luccio

Biographical Sketch of Gaetano Kanizsa

Gaetano Kanizsa was born on August 18, 1913, on the same day Emperor Franz Joseph was crowned, during the time Trieste still belonged to the Austro-Hungarian Empire. Kanizsa embodied many features of the empire and the unique cultural atmosphere that pervaded it in those years. His father was a Hungarian Jew from Nagybecskerek, today known as Zrenjanin, in Banat, a part of Vojvodina, Serbia. His mother was a Slovene from the Bovec area, near Caporetto.

Kanizsa attended a classical secondary school in Trieste. As there was no university in Trieste at the time, he studied philosophy at Padua University, where Cesare Musatti introduced him to psychology. He graduated in 1938, with a thesis in psychology on eidetic imagery in Jaensch's theory, which was published after his graduation.

Unfortunately, the historical und political events of the times caught up with him. Kanizsa was deprived of his Italian citizenship and interned in a little village near Udine, Buttrio. In 1943, he escaped, went to Rome, and joined the Resistance. In Rome, he luckily had the support of Luigi Meschieri, who, by fooling bureaucrats at his own personal risk, was able to get him a job as a researcher at the Institute of Psychology at the CNR (National Center for Research).

After the war, Musatti asked Kanizsa to join him at the Psychology Laboratory at the Olivetti company in Ivrea, where he worked till 1947. In 1947, Kanizsa obtained a position as an assistant professor at Florence University and later became Musatti's assistant at Milan University. At that time, Kanizsa's scientific interest was almost entirely devoted to the study of visual perception, and his theoretical interests gradually turned to Gestalt theory. In 1953, Kanizsa occupied the psychology chair at Trieste University, where he founded the Institute of Psychology. Kanizsa never left Trieste afterward; he stayed there until 1988, the year he retired. In Trieste, he enjoyed his most successful period in research.

Gaetano Kanizsa, *Grammatica del Vedere*, Il Mulino, Bologna 1980

Kanizsa's attention was particularly focussed on closely related issues. The first concerns the modifications in the phenomenal qualities of color caused by various figurative elements; relations between the parts; the characteristics of contour gradients; and color comparison as opposed to color contrast. The second issue to which he owed his international fame has to do with "quasi-perceptual contours" (as Kanizsa then called them) or "anomalous figures" (as he preferred to call them after the 1970s). Also dating back to this Milan period is the research on the "Musatti effect," in which he pointed out an important paradox related to chromatic induction, and his research into contour gradients. The famous triangle with its quasi-perceptual contours (it was originally called "phenomenal contours without discontinuity of stimulation") was presented for the first time at the Tenth Conference of Italian Psychologists in Chianciano, in October 1954. In 1976, Kanizsa wrote an article on anomalous surfaces for *Scientific American*, which was internationally acclaimed.

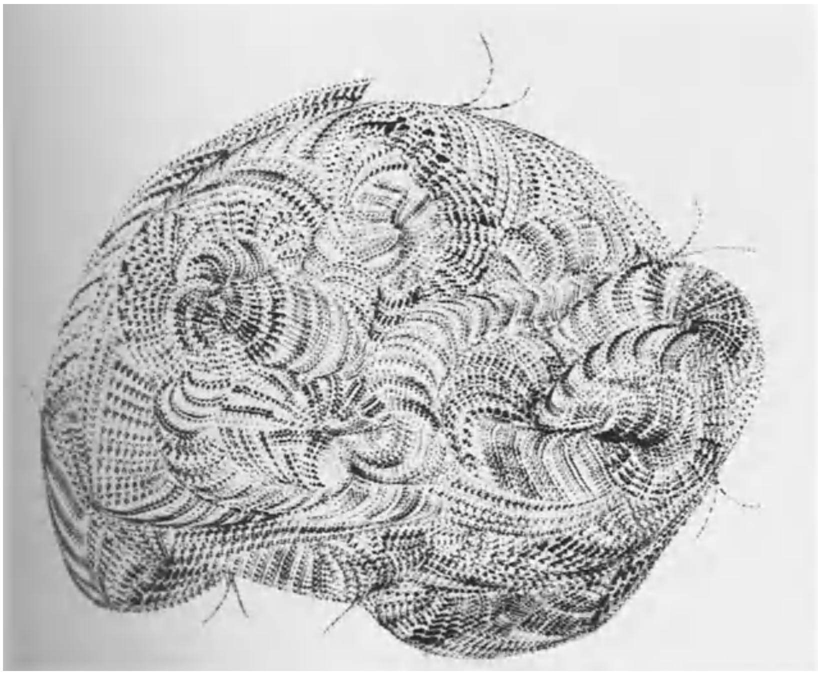
In 1987, Kanizsa saw with great pleasure that one of his 1955 articles had been translated into English. His article, together with the classic studies by Schumann and Ehrenstein, is one of the first in the volume edited by Petry and Meyer on "illusory contours" (the name they chose for anomalous contours). The collection of papers bears testimony to the massive amount of research carried out in the 1970s and 1980s on the "triangle."

The differences between seeing and thinking were first demonstrated in 1975 in a series of papers on the segregation of overlapping figures, and later, in three articles written in collaboration with Gerbino. The original article, which was written as a preface to *Organization in Vision* and later became a classic, explored the "two ways of going beyond given information." It contained the main theoretical idea behind the last fifteen years of his scientific activity: the distinction between a "primary process," which is typically perceptual and responsible for the subdivision of a field into separate units, and a "secondary process," which implies higher cognitive activities responsible for recognizing, classifying, and attributing meaning. Kanizsa thus broke away from Gestalt orthodoxies, although he would always feel tied to their tradition.

Gaetano Kanizsa, *Vedere e Pensare*, Il Mulino, Bologna 1991

On March 13, 1993, during a train journey back to Trieste from Bologna, Kanisza finished reworking the final draft of a paper that he was to present at a meeting in Bremen. Soon after midnight, he suffered a heart attack, which ended his life without even giving him the time to realize what was happening. Organizers Stadler and Kruse dedicated the Bremen meeting "to the memory of Kanisza."

A few words must be said about two very important aspects of Kanisza's activity during his last years. He was an extraordinary cultural mentor for Italian psychology. The younger generation of psychologists no longer identified with the Gestalt tradition, nor with behaviorism, which had never really caught on in Italy. The new term was cognitive psychology, and Kanizsa, far from withdrawing into Gestalt sectarianism — as many incompetent fools believed — listened very attentively to these new theories and tried to create opportunities for the old guard and the new generation to meet. This led him to organize a conference at the CNR in Rome in 1975, where supporters of both cognitive and Gestalt psychology were confronted with each other.



Gaetano Kanizsa, *Untitled*
Acrylic on canvas, 50 × 70 cm

Gaetano Kanizsa, *Untitled*
Acrylic on canvas, 50 × 70 cm

We should not fail to mention another extremely interesting aspect to Kanizsa's personality: Kanizsa the painter. He started painting by chance about forty years ago; tracing black dots on a white canvas, he arranged figures in groups, applying the laws of Gestalt psychology. He did not set to work with a precise plan, but went along with the development suggested by the painting itself. It was only recently that he began to add a little color to some of his paintings. Though his painting started almost as a game, it received important recognition, of which Kanizsa was very proud. He exhibited his canvasses at the Venice Biennial.

Giornale di Psicologia, vol. XX:5 (December 1993): 879-891.

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Gaetano Kanizsa

Subjective Contours

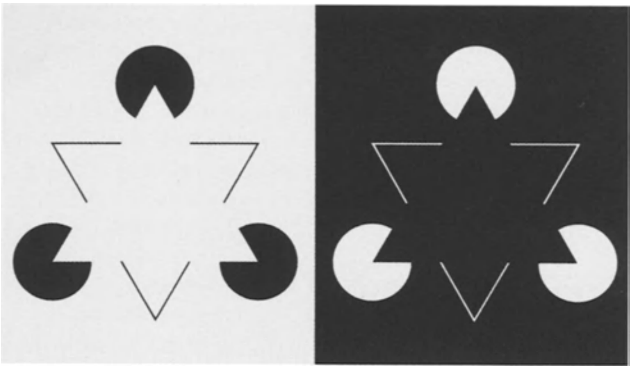

Fig. 1
Two subjective triangles, one whiter than white and the other blacker than black, appear to have distinct contours, but when the contours are examined closely, they disappear. The contours are subjective and have no physical reality. The region bounded by the subjective contours appears to be more intense than the background even though the color of the inner and the outer regions is identical.

Certain combinations of incomplete figures give rise to clearly visible contours even when the contours do not actually exist. It appears that such contours are supplied by the visual system.

If we examine the conditions that give rise to visible contours, we usually find that a contour is perceived when there is a jump in the stimulation between adjacent areas. The jump may be due to a difference in brightness or a difference in color. There are conditions, however, that cause us to perceive contours in visual areas that are completely homogeneous. For example, in fig. 1, the solid triangles in the center of each figure appear to have well-defined contours, but close examination of the contours where they cross an open area reveals that they have no physical basis. If you fix your gaze on one of these contours, it disappears, yet if you direct your gaze to the entire figure, the contours appear to be real.

The phenomenon of contours that appears in the absence of physical gradients has aroused considerable interest among psychologists on both the experimental and the theoretical level. A number of variants of the effect have been discovered, and several explanations have been proposed for it. Here I shall describe some of the more interesting properties of the effect and examine some of the attempted explanations. First, however, let us consider a related visual phenomenon: the phenomenon of virtual lines.

When we view three equidistant dots that are not in a straight line, the visual system spontaneously organizes the dots into a triangle. In addition, the three dots appear to be connected by three straight lines. These lines are called virtual, and although they are not actually seen, they are a real presence in our visual experience. They are far more compelling than other connecting lines that can be imagined. For example, the three dots could just as readily be points on a circle, but the curved connecting lines of the circle are more difficult to "see" than the straight lines of the triangle.

What factors are involved in the formation of subjective contours? Analysis of many examples of the phenomenon yields the following common characteristics: first, the region bounded by the subjective contours appears to be brighter than the background, even though the visual stimulation provided by both regions is exactly the same. Second, the region within the subjective contours appears as an opaque surface that is superposed on the other figures in the illustration.

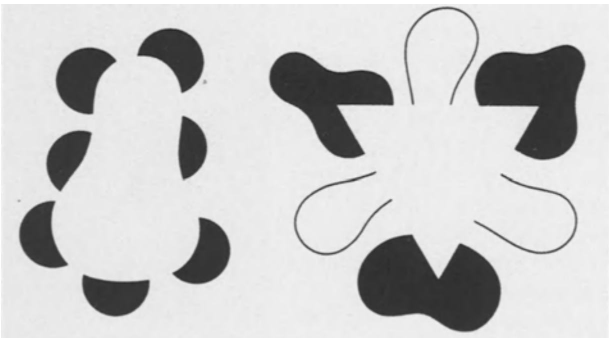

Fig. 2
Geometric regularity is not a necessary condition for the formation of subjective surfaces and contours. Amorphous shapes are possible and irregular figures can generate contours.

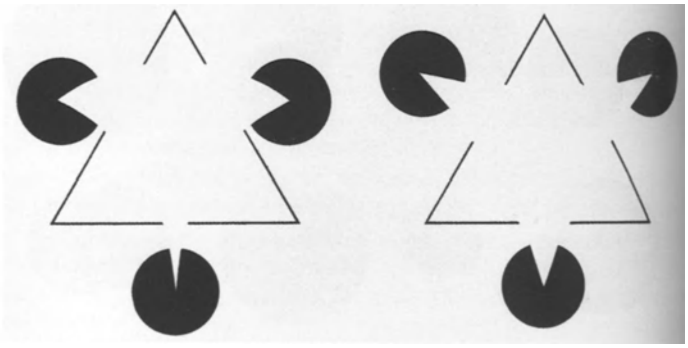

Fig. 3
Curved subjective contours are created by sectors with curved angles (left). Sectors with straight angles can create curved contours if angles are not aligned with one another.

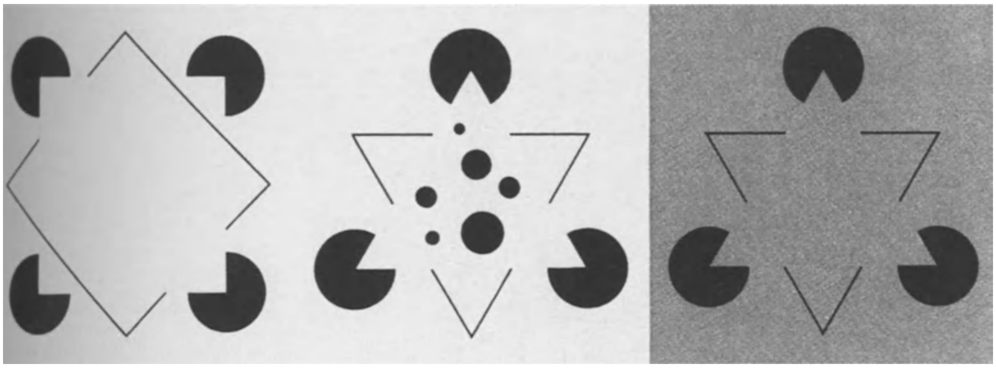

Fig. 4
Resistance to interference is a measure of the perceptual strength of subjective surfaces. A subjective surface appears to pass under lines that intersect with it (left), but subjective contours are destroyed by the line. Spots inside the borders of the subjective surface become part of it (middle). The formation of subjective contours or surfaces is not impeded by the presence of a texture (right).

The subjective contours we have considered up to this point have all been straight lines. Is it possible to create curved subjective contours? As the illustrations (figs. 2 and 3) demonstrate, there are a variety of ways for generating such subjective contours. Indeed, even amorphous subjective figures can be created.

The strength of the phenomenon of subjective contours can be measured in part by determining the resistance such contours show to interference from real lines. When a real line intersects a subjective contour, the contour in that region disappears, indicating that it has a relatively low degree of resistance to interference. On the other hand, the opaque subjective surface displays surprising resistance: it appears to pass under lines that intersect it. The subjective surface also displays strong resistance to interference within its borders. If large spots are placed inside the borders, the spots do not become part of the background but rather appear to be on the subjective surface. What happens when the background, instead of being homogenous, has a texture? It turns out that a texture does not impede the formation of subjective contours or surfaces (see fig. 4).

A number of optical illusions are produced by the reciprocal action between lines and surfaces. These optical illusions offer an opportunity to ascertain whether subjective contours and shapes have the same functional effects as objective, or real, contours and shapes. In many instances, subjective contours and shapes are able to duplicate the illusion created by objectives ones. As fig. 5 demonstrates, subjective contours and surfaces will interact with physically real lines to give rise to familiar optical illusions.

Although the brightness/contrast effect may play a role in creating subjective surfaces, it is not a necessary condition for the formation of such surfaces or contours. This is readily demonstrated in fig. 6, where a substantial reduction in the amount of black does not diminish the effect. A decisive item of evidence that contrast is not necessary for the formation of a subjective contour is presented in fig. 7 at the left. In this figure, no differences in brightness could be attributed to contrast, yet a curved subjective contour between the line segments is clearly visible.

It has been suggested by some investigators that subjective contours can be explained in terms of the partial activation of contour-detector cells in the visual system. According to this hypothesis, the short line segments in the visual stimulus activate some of the contour detectors, and signals from the activated detectors are interpreted

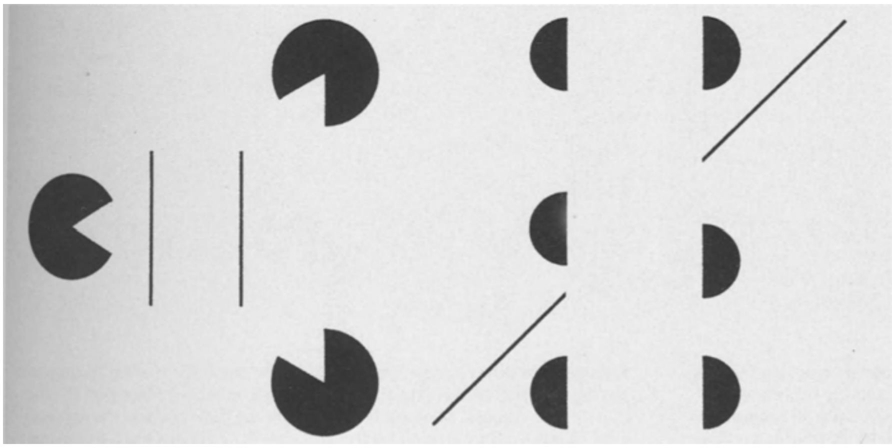

Fig. 5
Optical illusions show that subjective contours have the same functional effects as real contours. In the Ponzo illusion (left), although both vertical lines are the same length, the effect of the subjective triangle is to make the line at the left appear to be longer. In the Poggendorf illusion the subjective surface gives rise to an apparent displacement of the slanted line.

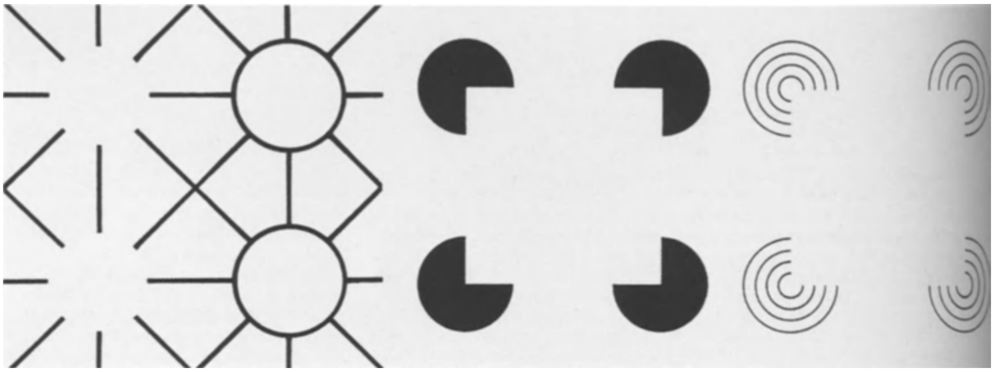

Fig. 6
Enhanced brightness of subjective surfaces is not due to contrast. If contrast were a primary condition of the effect, the blackringed circles should appear to be brighter than the subjective circles (left). Reducing amount of black does not diminish the effect (right).

as stimuli from a continuous line. The hypothesis does not stand up to careful examination, however. In many cases, a subjective contour does not continue in the same direction as the stimulus line segments. Moreover, line segments are not necessary for the generation of subjective contours. In some instances, the line segments can be replaced by dots, yet subjective contours will still be perceived (see fig. 7 at the right).

There is one condition, I have found, that is always present in the formation of subjective contours. That condition is the presence in the visual field of certain elements that are incomplete, which, on completion, are transformed into simpler stable and regular figures. The contours are therefore the result of perceiving a surface and not vice-versa. The subjective surface in turn is generated by the tendency of the visual system to complete certain figural elements.

If these assertions are correct, we should be able to demonstrate that subjective contours and shapes will not be perceived when the visual field does not contain incomplete figural elements. Since figures with open borders tend to appear incomplete, it is not difficult to create subjective contours with them. If we close the borders on these figures and make no other changes, the subjective contours disappear (fig. 8).

The following, I believe, offers further confirmation of the completion hypothesis. Fig. 9 at the right shows four black crosses on a white field. In spite of the fact that the crosses provide the outlines for a rectangle in the central region, we do not perceive the rectangle as a subjective surface. The reason is that the crosses are balanced, self-sufficient figures, and do not require completion. When the crosses are cut in half, however, a subjective surface appears in the central area. The half-crosses are, in this case, more likely to be seen as mutilated hexagons.

We have seen that irregularly shaped subjective figures can be produced. In most of my examples, the incomplete figures I have used to create subjective contours have been regular and symmetrical. Although geometric figures may enhance the effect, they are, however, by no means necessary (see fig. 2).

Finally, is it possible to generate subjective contours that meet and form a subjective angle? Paolo Sambin of the University of Padua found that an incomplete cross gives rise to such an effect (see fig. 10). According to Sambin,

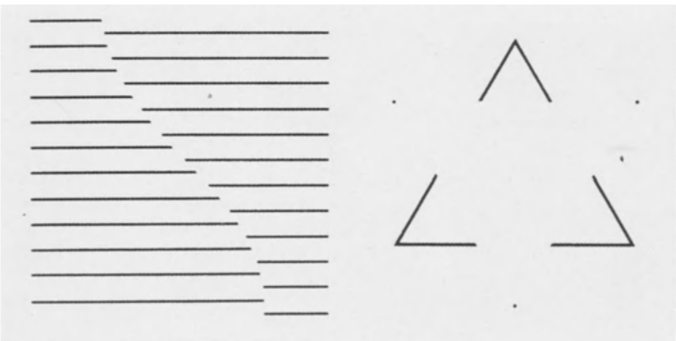

Fig. 7
Contour-detector-hypothesis states that subjective contours are generated by partial activation of contour detectors in the visual system by short line segments in the stimulus. Subjective contours, however, can have an orientation completely different from that of the line segments (left). Furthermore, line segments are not necessary for generation of subjective contours (right). Curved subjective contour formed by line segments also demonstrates that differences in brightness due to contrast are not needed for formation of subjective contours.

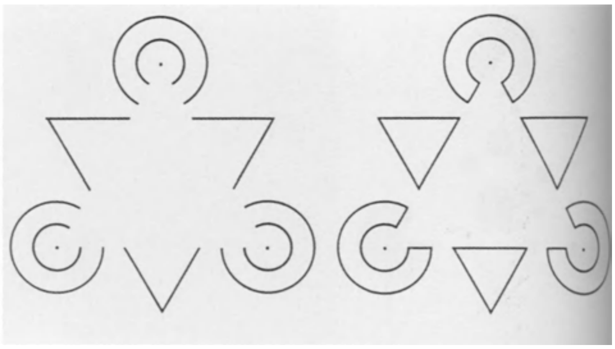

Fig. 8
Figures with open borders appear to be incomplete. In order to complete the figures the visual system superposes an opaque surface that fills the gaps in the figures. Because the surface must have borders the necessary contours are also supplied by the visual system. If borders of figures are closed, there is no further need for completion and contours disappear.

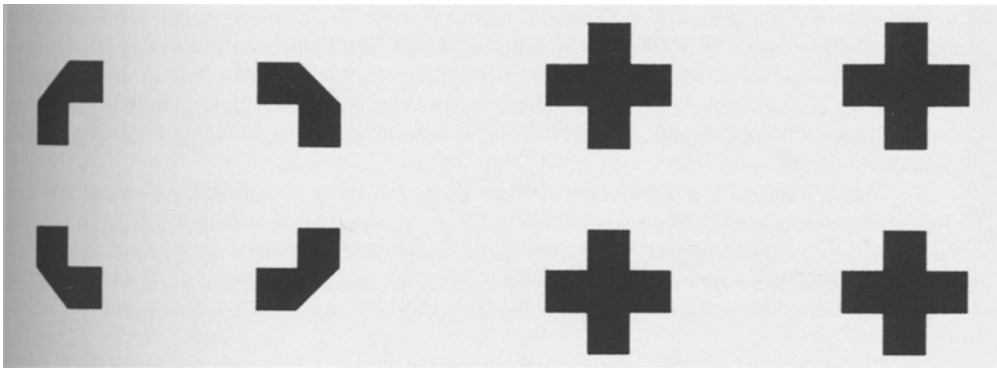

Fig. 9
Complete figures do not generate subjective surfaces. Although crosses provide outlines of a rectangle, the rectangle is not perceived as a surface. When crosses are cut in half, a subjective rectangle is perceived and the half crosses are now seen as mutilated hexagons.

the rectangular shape of the subjective surface perceived is produced by the resistance of the arms of the cross to invasion by the subjective surface. Without such resistance, the subjective contour would assume the shape of a circle. The validity of his hypothesis can be demonstrated by narrowing the arms of the cross to the point where the invasion of the internal area is minimal. Under these conditions, the subjective surface that is perceived has the form of a circle.

Another example of contour perception in the absence of brightness gradients is found in the random-dot stereograms created by Bela Julesz of Bell Laboratories. These stereograms do not reveal any contours when they are monocularly viewed, but when they are viewed with a stereoscope, they combine to form three-dimensional shapes and contours. Stanley Coren of the New School for Social Research has advanced the hypothesis that the

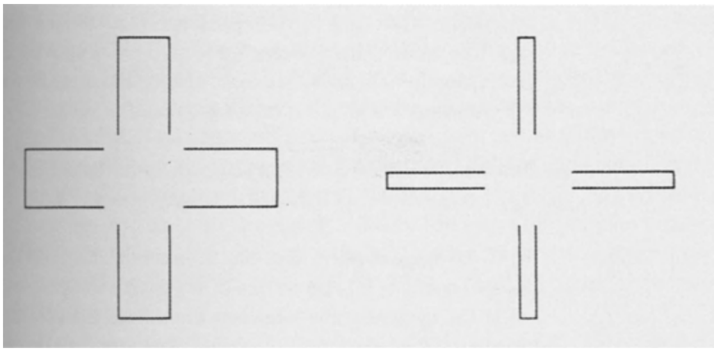

Fig. 10
Incomplete cross (left) gives rise to the unusual phenomenon of subjective angles. The angles are formed by the contours of the subjective square that covers central portion of the cross. Rectangular shape of the subjective surface is attributed to the resistance of arms of cross to invasion by the surface. If arms of cross are narrowed, circular subjective surface results.

perceptual mechanism that causes subjective contours and shapes is the same as the mechanism that gives rise to three-dimensional depth perception.

Since the formation of subjective contours is usually connected with the generation of surfaces and their stratification, or apparent layering, the line of reasoning proposed by Coren may be valid. On the other hand, in all the cases we have examined, stratification depends on the completion of some figural elements. When there is no need for completion, stratification does not occur, and there are no subjective contours. Once more, the primary factor seems to be the tendency to completion. Stratification seems to arise as a function of this completion.

written in 1959
Scientific American, 234 (April 1976): 48-52.
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Imre Pál

The Role of 3D Images

Imre Pál, born 1911 in Kolozsvár, Romania. Studied there as well as in Pécs and Budapest. He received his officer diploma at the Budapest Ludovik Academy. Then he studied at the Technical University Budapest. In 1949 he graduated in mechanical engineering. From 1955 he dealt with anaglyphic pictures. His book *Spatial Geometry in Technical Practise* was published in eight languages. The date of his death remains unknown.

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Primarily, we perceive our three-dimensional environment through movement. By means of optical experience during movement, we transform our impressions into a combinable three-dimensional experience. The expression of this experience is the image. However, the two-colored images in this book offer far more than conventional images in a book. If we observe these images with the enclosed colored glasses, holding the green filter in front of our right eye and the red filter in front of our left eye, we see with one eye only that part of the image intended for the respective filter.

If we lay the book out flat in front of us and view the image from the point indicated in the image, after some time we experience an optical illusion and the image no longer appears to be a two-dimensional picture but rather protrudes three-dimensionally from the page. We call such images 3D pictures or anaglyphs. If we incline our head slightly to the left or right, we have the impression that the image, too, is inclined. Sketchy vertical lines really do appear to be vertical. Curves appear to be really round and cubes appear to be cubes.

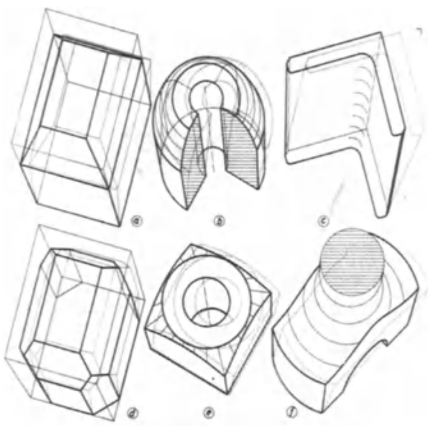


Fig. 1: Typical geometrical forms in the mechanical engineering and metallurgical industries

Truncating edges (a and d) is usually the task of the metalworker, or in the case of plastic, the tool-maker. The edges of (d) are the vertices of a rhombodecahedron. If the surfaces of the truncated edges of the torus are not touched but rather intersected, we do not speak of rounding off but rather of truncation (b). The two-truncated edges make production cheaper as the figures with curved edges do not have to be set as accurately as for rounding off. This is usual practice above all in the production of ballbearings. Rollers round off the edges of the hot-rolled sectional steel. The two 45°-truncated edges of the L-section shown here are in actual fact imperceptibly rounded. The four edges of a nut are intersected to form hyperbolas. The edges of a hexagonal nut are so short that they look like an irregular circle. (Indeed, there is no point in portraying them in any other way). The torus in figure f is not referred to as rounded but rather as a transition surface.

The domain around individual points on the surface of a curved figure is described with the aid of tangent planes.

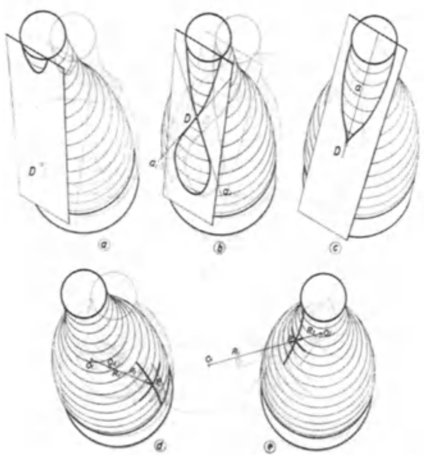


Fig. 2: Curve surfaces

(a) If the tangent plane does not intersect the domain of the point of contact (D), the surface at this point is elliptical.
(b) If the tangent plane intersects the surface in an arc that crosses itself at the point of contact, i.e., creating a double point, and the curve then has two asymptotic points of contact at this point, the surface is hyperbolic.
(c) If the tangent plane intersects the surface in a line in which the two asymptotic points of contact converge, the surface at this point is parabolic.
Let us assume that all the points of a sphere are elliptical and all the points of a cone are parabolic. On a surface containing both elliptical and hyperbolic surfaces, these surfaces are separated by parabolic points, e.g., in a ring.
Figures d and e show the radials of the principal curvature: the centres of curvature are on the normal of point P of the surface, with the elliptical point both are located inside, and with the hyperbolic point one is inside and one outside. (With the parabolic point, one is located in the infinite).

Imre Pál, *Térgeometria a muszaki gyakorlatban (Spatial Geometry in Technical Practice)*, Tankönyvkiadó, Budapest 1973, p. 75, p. 161.

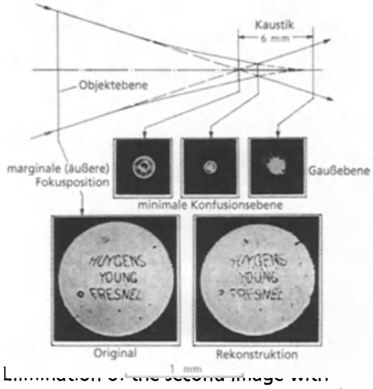
Pál Greguss

Dénes Gábor – The Inventor of Holography

Dénes Gábor was born in Budapest on June 5, 1900, the first son of Bertalan Gábor and Adél Jakobovics. His father, principal accountant and later managing director of the Hungarian General Coal Mining Company, soon recognized the extraordinary talent of his son and did everything in his power to secure him the best possible education.

After taking his final school examinations in 1918, Gábor passed the entrance examination to Budapest University of Technology, but did not commence his studies until 1920, after completing his military service. He obtained his degree as a mechanical engineer quickly, graduating in 1924 from the University of Technology in Berlin-Charlottenburg, where he also earned his doctorate with his thesis *Development of High-Speed Cathode Ray Oscilloscopes*. Afterward, he worked as a research engineer at the firm of Siemens & Halske, based in Siemensstadt, where he got to know Edward Allibone, a research engineer at Associated Electrical Industry (AEI), who was to have a decisive influence on his later career.

In 1933, Gábor, fleeing the Nazis, returned to Hungary, having previously conducted talks with the Associated Tungsram Light Bulb Factory in Budapest, intending to continue work on one of his inventions there. However, he was not able to come to an agreement with the then head of the company, Lipót Ascher, and thus turned to Allibone one year later, asking him to help him get his work patented in England. With Allibone's support, he arrived at the laboratory of the British Thompson-Houston Company in Rugby in 1934. This was a department of AEI, where he developed the white light version of the plasma torch. Meanwhile, however, he also concentrated a great deal on his favorite idea: to improve the resolution of the electron microscope. The outbreak of World War II forced him to focus on solving other problems.



compensation during reconstruction of spherical aberrations (Dénes Gábor, 1948, published in 1951).

The British Thompson-Houston Company was very much interested in improving the quality and profitability of telecommunications and, as Gábor had excellent mathematical training, he was entrusted with this task. The scientist shifted the old, conventional approach to telecommunications, placing it on a completely new information technology footing. His results, published in 1946, inspired many others, including Shannon, and once again became the center of contemporary attention. The military significance of Gábor's research can be clearly gauged by the fact that he was made a Commander of the British Empire, although he always emphasized his Hungarian nationality.

In 1947, Gábor was appointed to the electro-optics chair at the Imperial College of Science and Technology of Electrical Engineering in London. With the aid of information theory, already developed at the time, he recognized the deeper hidden relations that caused resolution error in electron microscopes, and went on to develop a theory for image information processing: holography. After the invention of the laser, which provided the necessary technical and technological equipment, he was awarded the Nobel Prize for Physics in 1971, almost a quarter of century later, for his invention of holography.

Gábor always referred to himself as an engineer and inventor. However, he was not only interested in the physical background of and the solutions to various technical problems, but also in how the future of the human race is influenced — for better or for worse — by technological developments. For example, he became a co-founder of the renowned Club of Rome. In 1963, he wrote the book, *Inventing the Future*; in 1970, he published a paper entitled *Innovations: Scientific, Technological, and Social*, and in 1972, a volume called *The Mature Society*. He and his younger brother, André Gábor, a professor of economics who lived in England as well, also published numerous studies with an economic focus.

After retiring, he lived alternately in England, the USA, and Italy from 1969 until his death in 1979. In the USA, he was engaged in researching various subjects related to holography at the CBS laboratories in Stanford, Connecticut. In Italy, the International Institute of Communications in Genoa awarded him the Columbus Prize.

Editor's note: Dénes Gábor also made a major contribution to Maxwell's and Szilard's demon problem. In his article "Light and Information" (*Progress in Optics* 1 (1964): 111-153), he explains why a "perpetual motion machine of the second kind" is impossible: due to a curious property of light, very weak rays of light cannot be concentrated.

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Ilona Kovács

Béla Julesz: Inventor of the Computer Generated Random-Dot Stereograms

Béla Julesz, born 1928. Diploma in 1950 at the Technical University, Budapest. PhD. 1956, Hungarian Academy of Sciences. AT&T Bell Laboratories, U.S.A, 1956-1989. Professor for sensory and perceptual processes, 1964-1982. Head of the Visual Perception Research Department, 1983. Director of the Laboratory of Vision Research, Rutgers University, New Jersey, 1989. Neurosciences associate of the Neurosciences Institute, 1982-1991. Visiting professor at MIT and various other universities. For his research in the field of experimental psychology and artificial intelligence he received several awards. Author of many books on visual and acoustic perception. Died in 2003.

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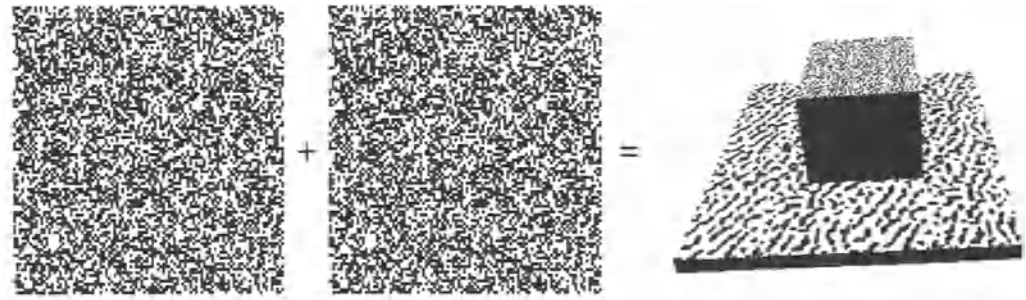


Image of the right eye + image of the left eye = perception
two-dimensional form Random-pattern three-dimensional form

The illustrations above are an example of the random-dot stereograms developed in the early 1960s by Béla Julesz. With the help of a stereoscope, the right and left eyes can see two-dimensional random patterns. There is no recognizable shape or object in the monocular images. The computer arranges the dots at random. The images meant for the left and right eyes are almost identical.

The only difference between the images is that a small square in the right image shifts to the right, and another square in the left image shifts to the left; dots randomly fill in the rest of the space. The brain interprets this small difference as depth information, and the internal, "Cyclopean" eye, putting things together, sees a three-dimensional form along the bottom edges of both images.

This example is striking because there is no visible trace of the three-dimensional shape in the monocular images. In order for the eye to perceive the small, apparently floating square, the brain has to match each point in the left image with a point in the right. This is a very complex computational problem, because each point can have many pairs, and there is a large number of points. After the brain has computed the correlation between the images and established this tiny difference as a distance between the square and the background, we perceive beautifully vivid, even three-dimensional, contours. These contours are not present in the images viewed! (Similar to the illusory contours developed by Gaetano Kanizsa.)

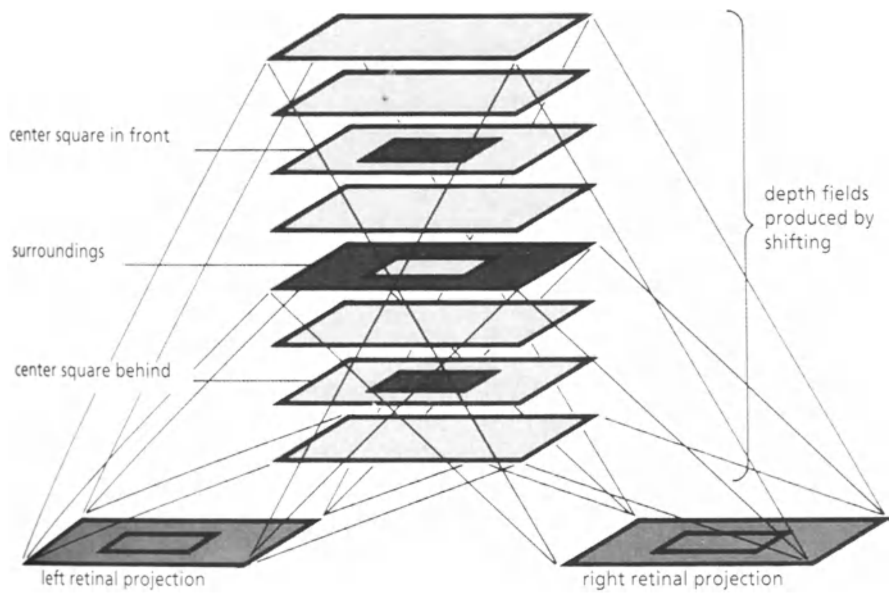
With his random-dot stereograms, Julez created a new paradigm in brain research. He showed that there is hope that scientists will be able to successfully analyze perception, even though it is a very complex process that takes up more than half of the brain. Julez generated the random-dot stereograms at a moment in the history of science when most people believed that the "problem of perception" would be solved by the end of the 1970s, and that soon, a "seeing" machine would prove that the problem had been solved. This optimistic approach was based on the assumption that visual perception is nothing but a collection of linear calculations. All that had to be done was to measure the differences in intensities of an image, and the contours that clearly define objects would appear. (For more on the perception of contours, see the work of Hungarians S. Kuffler,1953; D. Gabor, 1946; and G. Kanizsa, 1976; as well as that of Austrian scientist E. Mach, 1886). In contrast, Julesz's stereograms demonstrated that contours are generated not only by intensity differences, but also by stereoscopic disparities (disparity is the minor difference between the two images). Also, because of the disparity among all other mechanisms used to perceive contours (such as changes in intensity, color, and movement), contour detection can be completely independent if there are no other cues in the monocular images. This made it possible to distinguish and study the subsystems of perception (e.g., stereo, color, or motion perception), and it became clear that these subsystems were capable of solving very complex tasks (just recall the difficulty of the correlation computation in the case of the two images above). Julesz's seminal work (Julesz 1964, 1965, 1966, 1971, 1975, 1981, 1991, 1995) gave rise to modern psychological physics, which, in conjunction with neurophysics, investigates these subsystems or modules.

The random-dot stereograms are a special case belonging to a more general class of images, which Julesz referred to (using Hering's and Helmholtz's terminology) as cyclopean images. Cyclopean images are seen by an imaginary cyclopean eye when the eyes are presented with stereoscopic images. Cyclopean vision occurs outside of the laboratory as well. Cyclopean vision is used by all creatures with stereovision in order to see objects in the environment in depth. Cyclopean vision has an important function beyond providing a rough estimation of depth. In the presence of cyclopean vision, camouflage is impossible. The prey that is perfectly camouflaged by the color or the two-dimensional pattern of its skin will be immediately visible as a three-dimensional shape for the predator with cyclopean vision. The notion of seeing through camouflage was important in the discovery of stereograms. Based on his earlier experience as a radar engineer, Julesz knew that there is no camouflage in three dimensions, and that led him to the idea of camouflaging the monocular images.

There are many ways to generate examples of cyclopean vision. The classic method is to show a pair of images through a stereoscope. Practiced observers, however, might be able to free-fuse the stereograms without a stereoscope, by converging or diverging the eyes. In the anaglyph solution, one image is printed in red, the other is superimposed in green, and the observer views the images through red-green filters. The filters ensure that the views of the two eyes are isolated. Naturally, one needs a computer for all this (it is almost impossible to paint an anaglyph by hand), as is the case for random-dot cinematograms. Random-dot cinematograms appear on the computer screen as a sequence of random-dot sterograms. While there is only a dense dynamic noise in the monocular images, the cyclopean eye can see a moving object. Today we can watch these movies by using liquid crystal stereo glasses.

It is not generally known that the popular auto-stereograms seen on postcards, posters, and photo albums are also linked to Julesz (Burt and Julesz, 1980). The auto-stereograms also belong to the category of cyclopean images. Thanks to this new fad, many people can enjoy three-dimensional adventure — thirty years after the discovery of computer-generated stereograms. The principle of auto-stereograms is similar to the impression of depth that we get when viewing a periodic wallpaper pattern. When we move our eyes while looking at the wallpaper, it sometimes happens that we converge our eyes more than we should based on the distance of the pattern from the eyes. This is what generates the little difference between the images seen by the eyes, and it serves as a depth cue. The pattern jumps out in depth. The auto-stereograms are very similar to this kind of wallpaper, in that they are also periodic, although usually they have more complex patterns in their periodic stripes. The "wallpaper effect" was used by Julesz for mental holography: he generated these kinds of ambiguous stereograms, which had several layers of depth.

The beauty of the three-dimensional shapes emerging from the random-dot clouds almost makes us forget that Julesz not only created patterns, he created a paradigm as well as a new field in science. The field of low-level vision, which has been amazingly developed over the last three decades, was originated by Julesz. According to Julesz's theory, low levels of perception can be studied separately from higher cognitive levels. There is a fast, automatic, parallel type of processing at the low levels. Focal attention selects a few elements from the rich output of these early levels for the slow, sequential, more conscious cognitive levels. Both this distinction and his structuralist approach helped him to bring us closer to an understanding of the human brain.



Depth fields: A possible explanation of depth perception is that the left and the right retinal image are compared and are then substracted layer for layer. The resulting difference field is scanned for differences in the spotted clusters. A layer of difference fields is formed by rearranging the images in the mind before the substraction.

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Béla Julesz, Ilona Kovács (eds.), *Maturational Windows and Adult Cortical Plasticity. SFI Studies in the Sciences of Complexity,* Vol XXIII (Reading, MA: Addison Wesley Publ. Company, 1995).
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Ilona Kovács, Béla Julesz, *A Closed Curve Is More than an Incomplete One – Effect of Closure in Figure Ground Segmantation* (Proc. Natl. Acad. Sci. USA, 90, 1993, pp. 7495-7497).
Ilona Kovács, *Human Development of Perceptual Organization* (Vision Res. Special Issue on Attention, 40/10-12, 2000, pp. 1301-1310).

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G. Kanizsa, "Subjective Contours," Scientific American, 234: 4 (1976): 48-52.

S. Kuffler, "Discharge Patterns and Functional Organization of Mammalian Retina," Journal of Neurophysiology, 16 (1953): 37-68.

E. Mach, Die Analyse der Empfindungen (Jena 1885).

D. Gábor, "Theory of Communication," Journal of the Institute of Electrical Engineers, 93 (London 1946): 429-457.

1

Béla Julesz

Dialogues on Perception

A. I regard myself as a link between two generations of scientists, two cultures, and two disciplines. When I suddenly appeared in the United States in 1956, after the abortive Hungarian Revolution, I did not know that I would play this role. I had spent my first 28 years in Hungary under oppressive fascist and communist regimes. Johnny (János) von Neumann, Dennis (Dénes) Gábor, Leo Szilárd, Georg (György) von Békésy, Albert Szentgyörgyi, Abraham Wald, and Eugen (Jenö) Wigner, who had all escaped to the free democracies before or shortly after World War II, were merely legends for me. Besides these geniuses of Hungarian origin, I had my other living heroes: Claude Shannon, Alan Turing, Kurt Gödel, Harry Nyquist, and Norbert Wiener, to name a few. I never dreamed that I would meet any of them. My secret longing to talk to these idols was not based on snobbery; rather, I felt that they carried the torch of the previous generation and knew many things, even apart from science, which had been suppressed during my youth under dictatorship – things that, for me, might be lost forever.

B. How did you come up with such a varied list of scientific heroes, with backgrounds in engineering, physics, and mathematics?

A. In fact, most of the idols of my youth had physics or engineering backgrounds. I started with a similar background. It seemed unlikely that, as a communications engineer, I could ever achieve anything that would be of interest or intellectual value to these geniuses. Abraham Wald was a mathematician, but my first scientific interest was the "ideal observer," and the fact that Wald's paper on sequential analysis was perhaps the only classified mathematical paper during the war added some mystique to his surprising insights. I first learned of the mathematical work of Gödel and Turing from Rózsa Péter, and I found the feat of proving that certain mathematical problems were undecidable a fantastic achievement of the human mind. Thus, all my heroes ventured beyond routine mathematics, quantum physics, and relativity theory into revolutionary new areas that caught my fancy, such as the foundation of digital computers, the limits of human thought processes, holography, biology, cellular and self-reproducing automata, information theory, consciousness, models of learning, and stochastic processes.
A few weeks after my arrival in the United States, it was my good fortune to wind up at Bell Laboratories in Murray Hill, New Jersey, as a member of the technical research staff. I would occasionally see Nyquist — already retired — from a distance in the library, or talk and lunch with Claude Shannon. Then I had another break: I arrived almost simultaneously with the first mainframe computers. This coincidence fostered the invention of computer-generated stereograms, cinematograms, and textures, which, along with my work in auditory (echoic) memory, catapulted me into another career. I metamorphosed from a communications engineer into an experimental psychologist. Gradually, I drifted into the field of physiological psychology, influenced by the epoch-making discoveries of the neurophysiologists.
My psychological "creations" got me invited to some prestigious conferences, where I met Dennis Gabor and Georg von Békésy. I also recall a week in Versailles, at one of the symposia hosted by the Institute de la Vie, where I sat at the breakfast table with Mark Kac (who had invited me to the meeting), Eugen Wigner, Albert Szentgyörgyi, and Stanislav Ulam. It was a great experience, hearing them discuss daily events and ascertaining that, in spite of my different background, I shared their values, and we were able to laugh at each other's jokes. Furthermore, I was fascinated by the fact that some of my intellectual heroes had had to cope with the same problems of cultural differences that I now faced, and I was greatly relieved to see that they had not only learned the ropes but had also enriched American culture. Unfortunately, Alan Turing was already dead, and Abraham Wald, John von Neumann, and Leo Szilárd died before I had a chance to meet them. I did not have the nerve to try to meet Kurt Gödel.

B. What was so special about the work of Gabor?

A. Most people think of him as the inventor of holography, a rather esoteric technique that was practically useless before lasers provided coherent light. While Gabor had many other original ideas — from searching for the best sampling functions to novel nonlinear system analysis — most people assume that if lasers had not been invented during his lifetime, he might not have received the Nobel Prize. However, for Gabor, holography was merely one of the means of achieving his goal, which was to create a genuine million-power microscope (see Gabor 1948). He had the ingenious idea that there is a wavelength difference of a million between light and ultrasound. If the hologram is created by light, but is then read out by ultrasonic wave, a magnification of a million is achieved without any loss of detail. I am glad that Gabor lived to see a cover picture of the journal Nature showing an atom surrounded by electrons. That was achieved by making a hologram with electron waves and retrieving it with a proton beam. Gabor's magnification idea worked again. Obviously, the same idea works in reverse, and great reduction in image size can be achieved. I can imagine that in the twenty-first century VLSI chips will be manufactured using this technique of hyperreduction. Furthermore, Fourier-transform holograms in such miniature size could be used for optical pattern recognition.

B. I also know that you enjoyed many years consulting Salvador Dali on perceptual problems, particularly on stereopsis. Perhaps you could say a few words about your interaction with this charismatic individual.

A. I had several encounters with artists. In June 1965, I took part in the very first "computer art" exhibit (with another engineer colleague from Bell Labs, Mike Knoll) in the Howard Wise Gallery in New York. Although there was a disclaimer below my computer-generated stereograms and textures, which stated that they were merely the results of scientific experiments, and that their creator did not regard them as works of art, the newspapers disregarded it. I have many clippings with headlines such as "Cold computer art!" and "Computers take over arts!" To my further amazement, there were "artists" who used several of my images in collages. When Salvador Dali invited me to his studio and showed me his recent work, I was honored. There was a picture of Christ nailed on a cross made of the DNA double helix. Below his feet, two silk scarves cascaded downward, creating a moiré effect, and around the figure's head were a stereo viewer and a cutout of an RDS depicting a torus, taken from my Scientific American article (Julesz 1965). This torus had been melted and served as a halo for the crucified Jesus. I knew immediately that I had finally "made it."
After this first encounter with Dali, he asked my advice several times, particularly when he was painting some large stereo pairs at an angle with a half-silvered mirror between them. He also asked me to supply him with some random-dot stereograms, so that he could modify them according to his taste (see figs. 1 and 2). I mention this episode merely to illustrate that the impact of the RDS even permeated art. Because I was impressed by Dali's knowledge of perception during our conversations, I feel that he paid tribute to the RDS not just as an artist, but also as a colleague well versed in my specialty. I should also note that several times I was invited to artistic gatherings by Op artists. While I was always proud of my affiliation with Dali, I did not care much for Op Art. I always felt that artists should be revolutionary thinkers, decades ahead of the rest of mankind (including perceptual psychologists), as Albers, Escher, Kandinsky, and Klee were.
That I met some of my scientific heroes of the previous generation, that I metamorphosed from an engineer into a psychologist, and that I found refuge in the United States — each of these facts is a personal happenstance of minor interest to most people. The fact that I belong to the generation that attempted the first successful linking of perceptual phenomena to neurophysiological findings should be of primary interest.

Fig. 1:
Salvador Dalí "improving" on a 32 x 32-pixel RDS (in anaglyph form), from *Foundations of Cyclopean Perception.*
© Kingdom of Spain, Gala-Salvador Dali Foundation, VBK, Vienna, 2005

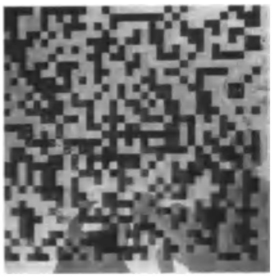
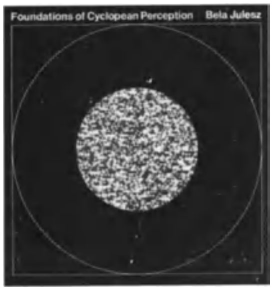


Fig. 2:
Salvador Dali, *Cybernetic Odalisque*, 1978
The original legend reads: "This work started with an anaglyph diagram of Béla Julesz, an American scientist who successfully did research on visual perception."
© Kingdom of Spain, Gala-Salvador Dali Foundation, VBK, Vienna, 2005

Note:
Let me explain to the reader the role Szilárd played in my life. As a teenager, I felt incredible shame and frustration as the Nazis slaughtered innocent and defenseless people around me. I felt great pride and elation, when years later, the secrecy was lifted, and I discovered that von Neumann, Wigner, Edward Teller, and especially Szilárd had acted to ensure that the atom bomb would not fall into Hitler's hands, and that they had subsequently helped the United States and the Free World to withstand Stalin's blackmail. These scientific and politically omniscient geniuses, who lived within walking distance of me in Budapest when I was a child, were not idle. Indeed, they expended a great amount of energy (mc^2) to protect all of us, and their deeds shortened the war. Of course, we were greatly indebted to the non-Hungarian geniuses as well, from Enrico Fermi to Stanislav Ulam, who participated in the Manhattan Project. Yet at the same time, they also helped to unleash frightening forces that could wipe out our civilization. Szilárd was keenly aware of the moral consequences of his quest. Few people know that, just before Szilárd and Einstein sent their letter to President Roosevelt, which initiated the Manhattan Project, Szilárd formulated his own version of the Ten Commandments:

1. Recognize the connections among things and the laws of human conduct, so that you may know what you are doing.
2. Let your acts be directed toward a worthy goal, but do not ask if they will reach it; they should be models and examples, not means to an end.
3. Speak to all men as you do to yourself, with no concern for the effect you make, so that you do not shut them out from your world, lest in isolation the meaning of life slips from sight and you lose the belief in the perfection of creation.
4. Do not destroy what you cannot create.



Béla Julesz, *Foundations of Cyclopean Perception,* The University of Chicago Press, Chicago/London 1971.

5. Touch no dish except when you are hungry.
6. Do not covet what you cannot have.
7. Do not lie without need.
8. Honor children. Listen reverently to their words and speak to them with infinite love.
9. Do your work for six years; but in the seventh, go into solitude or among strangers so that the memory of your friends does not hinder you from being what you have become.
10. Lead your life with a gentle hand and be ready to leave whenever you are called.

(August 4, 1939. Translated from the original German by Jacob Bronowski.)
Béla Julesz, *Dialogues on Perception*, The MIT Press (Cambridge, Massachusetts/London, England: 1995) pp. 93-100.

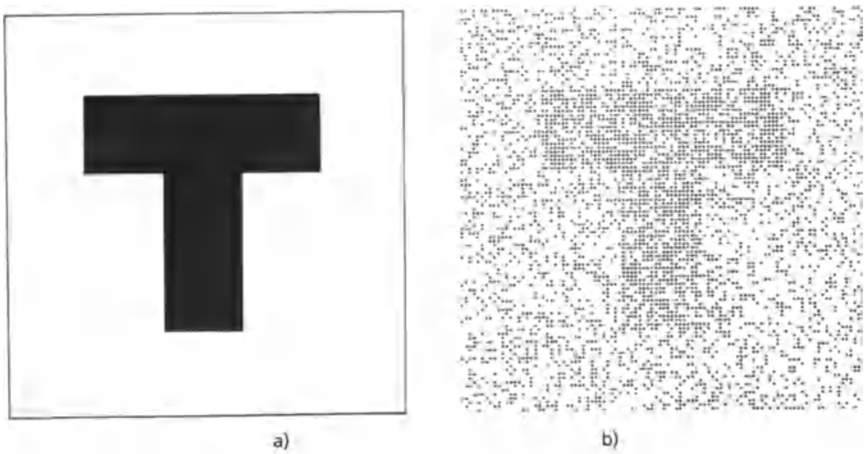


Fig. 1:
a) A classic stimulus which depicts the information, the letter T, by light intensity- or color gradients.
b) A stimulus which depicts the global information (the field in T-form) by texture density gradients.

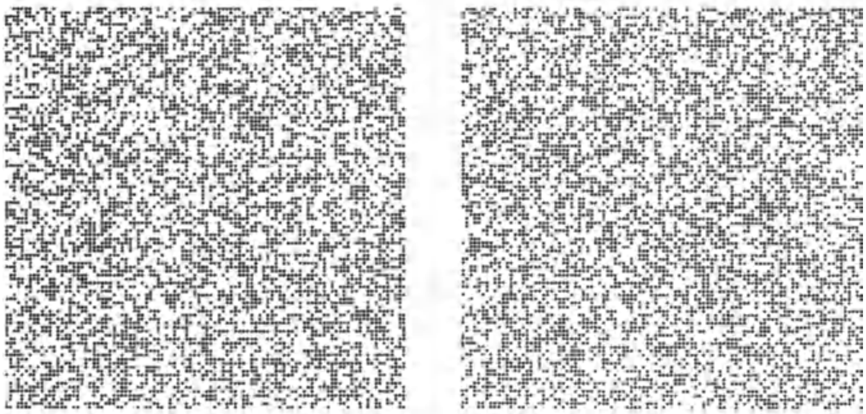


Fig. 2:
Strong cyclopic stimulus which depicts the global information as a random-dot cinematogram. When the two images are shown in a rapid chronological order, a T-shaped surface of dynamicnoise is shown in a static noise environment.

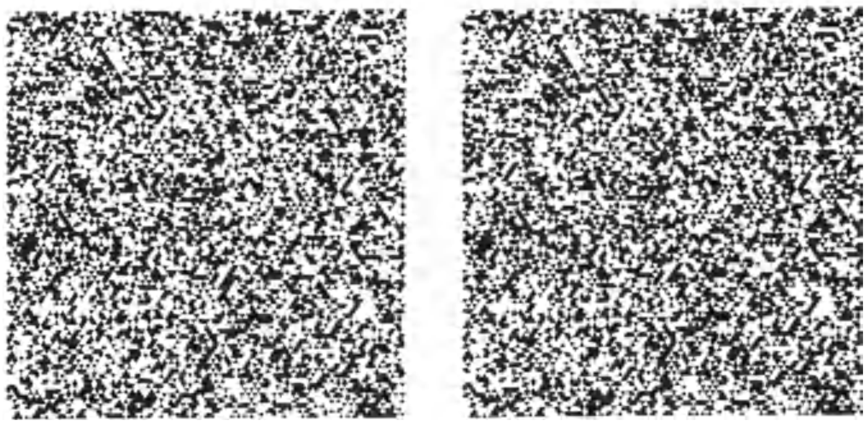


Fig. 3:
A random-dot stereogram compiled from two areas of randomly divided black and white cells in triangular form. Seen monocularly, these areas appear to be formless random textures. Through stereoscopic merging a large triangle floating over the surface is produced.

Alfons Schilling

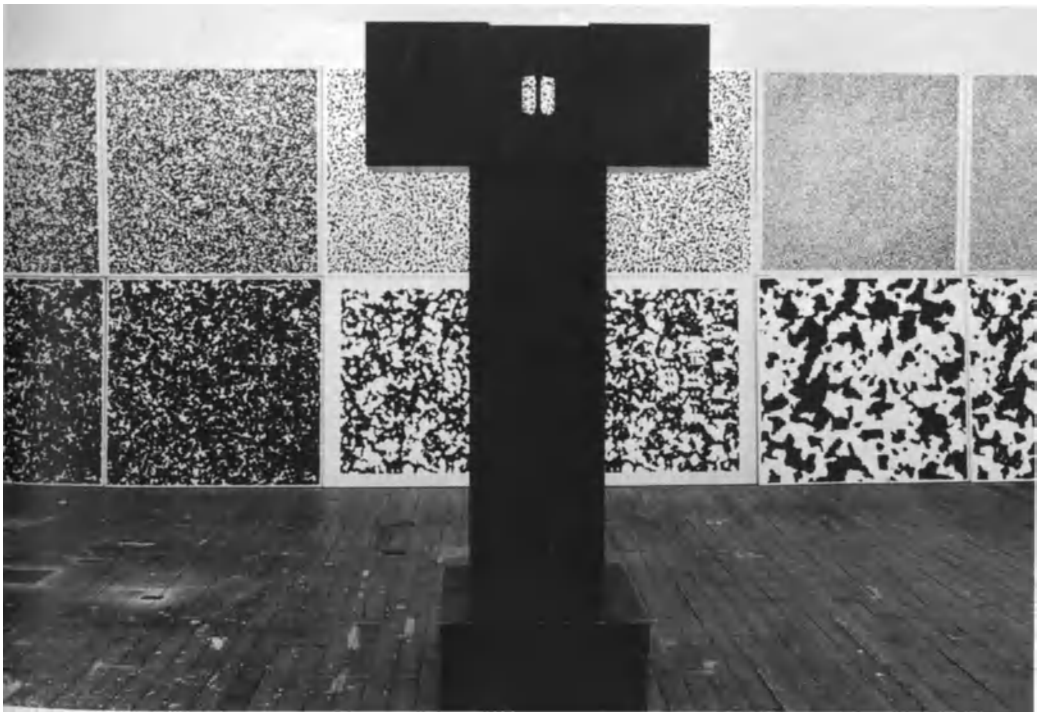
Vision Machines – Talking About Vision

Optical phenomena concern me, if at all, in that I aim to unmask them. These phenomena are based upon ignorance; they are only a symptom of our isolation from processes. In my work up until now, I have wanted to penetrate appearances and, to do so, I had to undertake something fundamental that was taboo in art: that is, to investigate more closely into and to impeach the process of seeing itself. Man's relationship to his environment and the objects in it has changed quite dramatically. I felt that I could no longer rely on my eyes because they would not show the counterfeit nature of the (new) world. I looked into this matter. I wanted to understand.

The claim to know and understand has never been a monopoly of science: it must equally be made by art. This claim is far too strictly tied in with the logic of language anyway, because the person who has language also has power. Understanding of optics has thus gained great importance. I have long been convinced that the concept of the image in painting needs to be radically changed, and that this change must come from a completely different place — that is, from the perspective of the significance and status in which we hold the eye. This is an opportunity for the beginning of a real (image) revolution. Thus, the scientific aspect of my work should not be overrated. The only new thing about it is the unusual idea. The way in which I create and the materials I use for my objects are quite medieval: wood, glass, fabric. I am an artist.

I have realized that what we see adapts to the structure of the eye—that is, cannot be detached from the eye. It assumes, as it were, its structure and possibilities. If we had a different type of eye, we would see differently. Normal vision, I realized, is a product of chance. It is be important for us to divest the human eye of its uniqueness and to see it as just one of many possibilities. This could pave the way for a new image — and would also reduce the prevailing arrogance quite significantly.

Alfons Schilling, *Sehmaschinen* (Vienna: Academy of Applied Arts and Austrian Museum of Applied Art, 1987) pp. 9–10.



Alfons Schilling, *Large Viewer in Front of a Series of Camouflaged Binocular 3D Stereo-Images*, New York, 1975

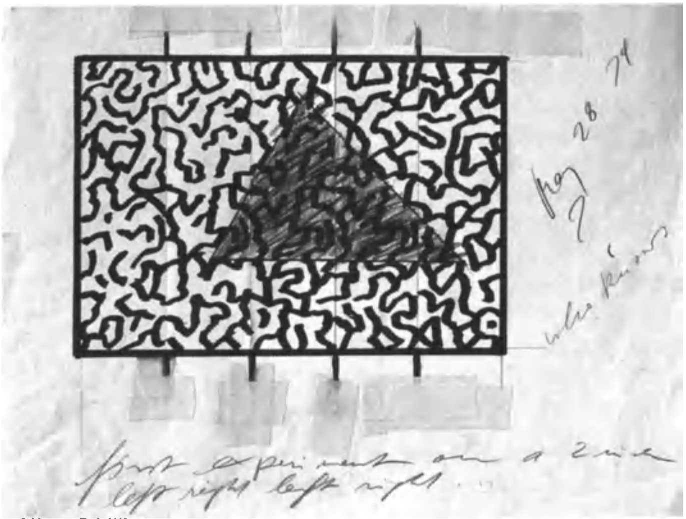
Alfons Schilling
born 1934 in Basel. Studied at the University of Applied Arts in Vienna. Lives in Vienna.

1961 Galerie Junge Generation, Vienna (with G. Brus)
1970 Richard Feigen Galerie, New York
1972 The Kitchen, New York
1975 Ariadne Galerie, New York
1978 Whitney Museum of American Art, New York
1979 Kunsthaus, Zurich
1987 Museum for Applied Arts, Vienna
1989 Setting for *Die Blinden*, opera by Beat Furrer, Vienna
1991 steirischer herbst, Graz (with M. Peintner and B. Leitner)
1998 *Ich/Auge/Welt – The Art of Vision*, Kunsthalle, Krems
2000/2001, Galerie Charim, Vienna

Group shows
1988/89 *Von der Aktionsmalerei zum Aktionismus, Wien 1960-1965*, Kassel; Winterthur; Vienna
1998 *Out of Actions*, Museum of Contemporary Art, Los Angeles
2003 *M_ARS. Kunst und Krieg*, Neue Galerie, Graz

Film documentations
1962 Niklaus Schilling, *Desperate motion, Cosmos action painting*, b/w, 8/16 mm, 11 min.
1984 Larry Gottheim *Natural Selection*, color, 16 mm, 35 min.
1986 Niklaus Schilling, *Unter vier Augen, Alfons Schilling beobachtet von Niklaus Schilling*, 44 min., (ARD)

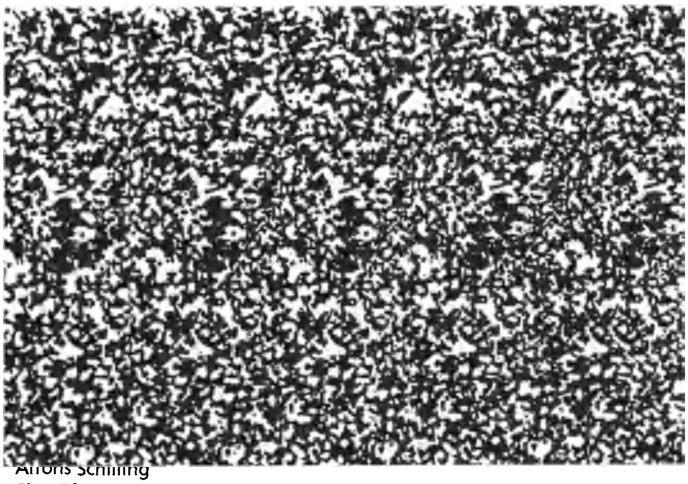
References:
Birgit Scheib, *Zur Bedeutung der Musik in der Aktionsmalerei von Brus & Schilling*, (Vienna: University for Music and Interpretative Arts, Vienna 1989).
Alfons Schilling: Ich/Auge/ Welt, (Wien/New York: Springer, 1997).
Out of Actions, (New York: Thames & Hudson, 1998).



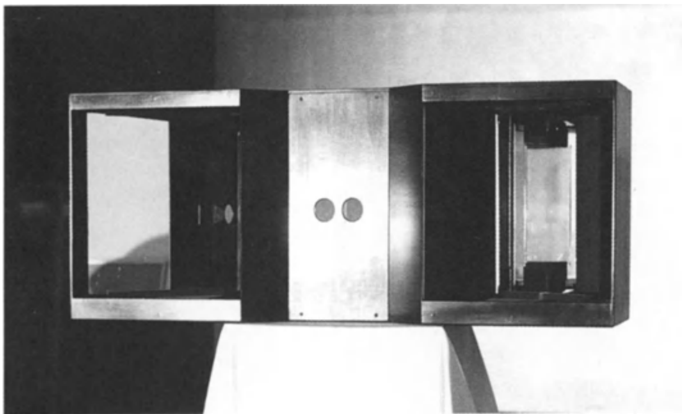
Alfons Schilling
Sketch of the strip stereogram displayed below, 1974

Schilling, who lived in New York from 1962 to 1986, was originally interested in recording motion in space, and performed experiments aimed at creating holograms at the Bell Laboratories with his friend, the scientist Don White, in 1967. Later, after having worked with various types of 3D stereo image systems such as lenticular photography and vectography, he began designing individual images for the left and right eye, obfuscating them with lines and dots. Schilling developed a random-dot method with which he was able to paint directly on canvas without the aid of a computer. Because of this, White arranged a meeting with Béla Julesz. In 1974 Schilling published several sketches in connection with an exhibition of his 3D art in New York. They described a new method of creating random-point images. Several series of vertical lines are arranged in parallax and closely lined up, thereby creating a coherent 3D image. This method was taken up by Christopher Tyler in 1974 and further developed with the aid of a computer. It became popular under the name of "magic eye" pictures.

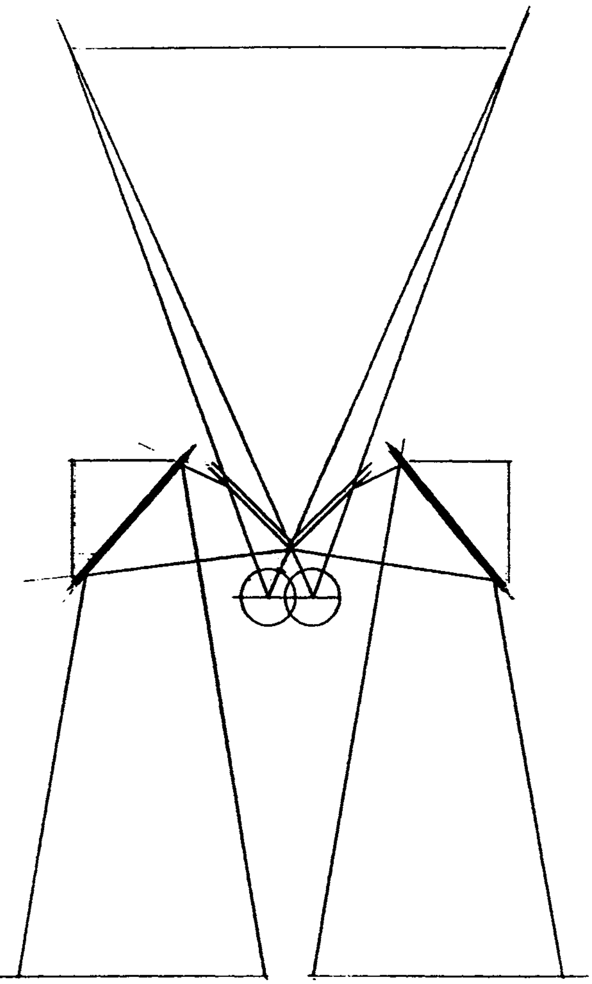
Itsuo Sakana, *Stereogram*, ed. Seiji Horibuchi and Yuki Inoue (San Francisco: Cadence Books, 1994), pp. 75–76.



Alfons Schilling
First "free-vision" 3D strip stereogram, 1974
(a stereoscopic continuous field of vision made of narrow vertical strips)



Alfons Schilling
Seeing Machine for Combining a Stereoscopic Painted Picture with a Real Image, 1974



Alfons Schilling, *Sketch*, 1974
The binocular image at the back is inverted over the front space.

Max Peintner

On Three Pictures About Seeing

Waterfall, Seen with the Head Tilted to One Side and a Dark Filter in Front of the Lower Eye

Max Peintner, *Waterfall, Seen with the Head Tilted to One Side and a Dark Filter in Front of the Lower Eye*, 1975
Pencil, 73 × 102 cm
For Alfons Schilling, who drew my attention to this effect

This picture is based upon the so-called Pulfrich effect that Alfons Schilling demonstrated to me with the aid of various fast-moving objects. Standing in front of a waterfall, you must turn your head so that the line connecting your eyes is practically parallel to the line of motion taken by the falling water. If you then hold a dark filter in front of one of your eyes, this eye reacts with a certain delay, still seeing a moving configuration of water droplets where they had been fractions of a second before. The brain ignores the difference in time, assuming that the information supplied by both eyes is actually simultaneous, and so it constructs a displaced image of the position of the water in space. It is shifted noticeably forward or appears to be moving back into the rock depending on whether the filter is in front of your upper or lower eye.

Looking Into the Sun and Turning One's Head Away

Max Peintner, *Looking Into the Sun and Turning One's Head Away*, 1977
Colored pencil, 62.5 × 88 cm

Max Peintner
born in 1937 Hall, Tyrol. Studied civil engineering at the Technical University Vienna and architecture at the Academy of Art in Vienna. He lives in Vienna.

1972 Galerie Grünangergasse 12, Vienna
1974 Galerie Buchholz, Munich
1981 Galerie Heike Curtze, Vienna; Düsseldorf
1986 Biennale, Venice
1987 Museumspavillon im Mirabellgarten, Salzburg
1988 Galerie Ulysses, Vienna
1991 Zentrales Künstlerhaus der UdSSR, Moscow Kulturhaus, Graz (with B. Leitner, A. Schilling)
2000 *Take Off. Wahrnehmung im technologischen Zeitalter*, Neue Galerie, Graz

Group shows
1973 *The Austrian Exhibition*, Richard Demarco Gallery, Edinburgh; ICA, London
1975 *Architectural Studies and Projects*, The Museum of Modern Art, New York
1977 documenta VI, Kassel
1982 *Die Handzeichnung der Gegenwart II*, Staatsgalerie Stuttgart
1988 *Peinture et Dessin en Autriche*, Musée Cantonal des Beaux-Arts, Lausanne
1989 *Land in Sicht*, Mücsarnok, Budapest
1992 *Identität : Differenz*, Neue Galerie, Graz
2003 *M_ARS. Kunst und Krieg*, Neue Galerie, Graz
2004 *From Above*, Galerie Georg Kargl, Vienna

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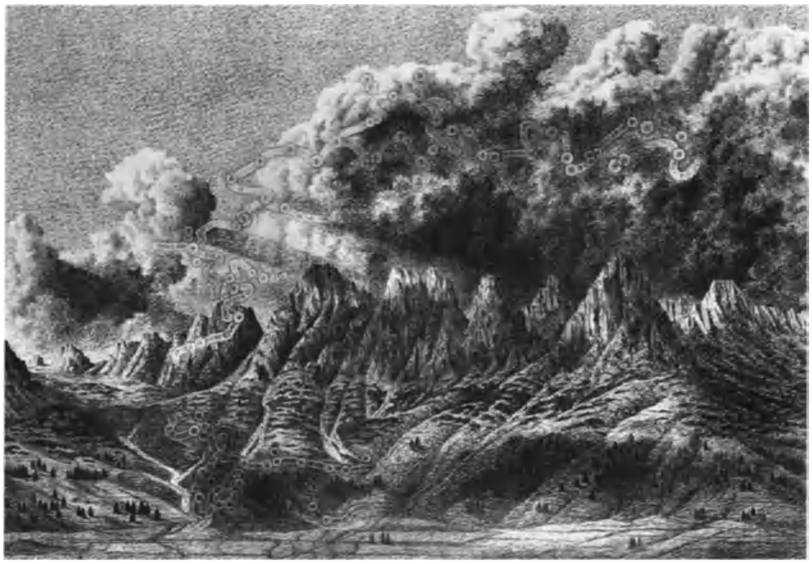
The drawing shows the afterimages you see drifting across the retina after accidentally looking into the sun. With some practice, it is possible to see afterimages of objects that are not light sources. For example, you will see a yellow sandbank framed by a transparent blue band. Or, after staring into a semi-dark room, its complete furnishings are stored behind your closed lids — but they are strangely rotated, because the dark, more distant parts of tables and chairs force their way to the fore as bright, obtrusive components of the negative afterimage.

The Age of Impure Images



Max Peintner, *The Age of Impure Images. Landscape with Impaired Vision Caused by Vitreous Opacity,* 1975
Pencil, 62.5 × 88 cm

I mean the time around the age of forty; at least that was the age when I was first faced with a sight defect. As a result of an eye infection, the vitreum — the jelly-like substance between the lens and the retina — shrank in both my eyes, and I began seeing dark spots surrounded by a ring of light, occasionally at first and then with increasing frequency. These spots were connected by vermicular, sometimes tangled streaks; the figures elude your sight when you try to focus on them. They seem to be outside space, and yet the minute distance between the opacity structures in the vitreum and the ocular fundus corresponds to the apparent depth of space. I was told that the streaks are remains of blood vessels that once laced the vitreum in the embryonic stage. Drawing this sight defect turned out to be a way of converging outside reality and the reality in my mind in one image; I intentionally chose a "beautiful" landscape with dramatic cloud formations in order to attempt to caricature the concept of Cartesian theater.

Pál Greguss

PALoramic Imaging and Art in View of Information Theory

In an earlier paper[1] dealing with the possibility of a psychophysical approach to the pattern aesthetics, I explained that man has developed two approaches to interpreting his place and activity in nature: namely a "natural/scientific" and an "artistic/aesthetic" approach. Accordingly, he has developed a so-called "scientific" worldview and a "human" weltanschauung, which includes theology. At the beginning of the eighteenth century, a debate began, which still goes on today, as to which perspective describes reality as it really is. At first glance, it does not seem possible to resolve this conflict. However, considering the motto as well as the spirit of the *Beyond Art* exhibition (on which this book is based), I would like to point out that the roots of these two worldviews spring from basically the same origin, i.e., they arise from the functional symmetry of life, and therefore this virtual conflict is not irresolvable. Nevertheless, we usually feel that the two approaches contradict each other because, on the basis of the generally accepted mathematical definition of symmetry, it does not even occur to us that functional symmetry is the very manifestation of the unity of nature: it means unity rather than pairs of opposites. But if these two approaches differ so much in their attitude and methodology, and consequently, if they seem to contradict each other so much, how can they form a unit? No matter how true it seems, raising and answering this question is not solely a task for philosophers, but in many respects, involves problems of information theory relying on biophysical foundations.

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1. Life and Non-Life

The answer begins with Einstein's famous energy/mass equation, according to which mass is the result of structuring. However, the characteristic features of matter that comes into being this way are dependent upon the construction of the structure itself. That means these features depend on how coincidence in the microcosmos is reflected in the structure of the macrocosmos, or, in other words, upon when and how the principle of causality is or is not manifested.

Particles of material that make up the structure are constantly being created according to a certain rhythm (frequency), are then transformed, and finally disappear. Additionally, changes in the environment are regarded as a signal or patterns of signals that influence the structure. Depending upon these two factors, as well as how the structure responds to the signal patterns, two main configurations can be distinguished. In one configuration, the modifications in the structure caused by the pattern of signals are not altered until another pattern of signals affects the structure; hence, there is a static equilibrium present in the structure. This kind of structure is characteristic of 'non living' matter.

In the other configuration, however, it is characteristic for the structure to try to resist the changes inflicted by the pattern of signals, in order to return to its original state. There is, therefore, a dynamic equilibrium present in this case. This structural characteristic — called homeostasis — is what makes matter alive. The higher the living matter is on the evolutionary ladder, the more complex the process of homeostasis becomes. Homeostasis is at its least complex at the biomolecular level, and at its most complex at the level of vertebrates, which includes the human being as a social animal.

It would be a great mistake, however, if we were to equate homeostasis with the principle of feedback, which is derived from John von Neumann's architecture and found in our computers. The basic difference between feedback and homeostasis is that, in the former case, the signal affects a stable, temporally unchanging structure (substratum) and propagates inside it. In the latter case, however, the pattern of signals inside matter we consider "living" propagates in a continuously changing structure, although within temporally restricted limits. For living matter, this also means that the information content of the same signal or pattern of signals depends on when and where it meets the structure, i.e., in a certain respect, it depends on the future, which we believe can only be predicted, not known. As a consequence, the information processing capacity of living matter is apparently not as precise as people expect, since we have been 'spoiled' by computers. Nevertheless, if survival requires it, living matter is so functionally constructed that it is able to process data in a very exact manner, even to the point of recognizing when it is necessary to alter the structure in order to survive. As long as it is present, this ability can be considered the intelligence of living matter, and it forms the basis of evolution. If, for any reason, it ceases to exist, living matter becomes non-living.

2. Relevant Future

It is well known that signals describing changes in the environment are carried in blocks of energy by mechanisms that we could call waves (electromagnetic waves in the case of light, mechanical waves in the case of sound, etc.). If we want to lay claim to the entire information content, we have to be able to analyze not just according to temporal function or frequency. We also need a mechanism that will process patterns of signals that allow the simultaneous analysis of time/space and frequency — meaning, at the point where the symmetry of time/space and frequency is not lost, but preserved. The basic problem, as discussed by Denes Gabor in his work on the *Theory of*

1. P. Greguss, "Minta – az egész a részben (Patterns – the Whole in Detail)," catalogue (Budapest: Second International Patterns Triennial, December 1991) pp. 13-18.
2. D. Gábor, "Theory of Communication," J. IEE 93, part III (1946) pp. 429-457.

Communication[2] exactly fifty years ago, is that in the course of completely processing the elementary signals (which Gabor called "logons"), causality, in the strict sense, is valid only in the language of time. As soon as we want to include frequency, uncertainty — which modern physics calls the termination of causality, or the uncertainty relation — arises. Gabor surprised specialists working in the field of information processing by claiming that this problem can be solved, except that, "it is not enough to know the past, one has to know the future as well"[3] — a virtually impossible task for a man of science. Yet a creative artist takes this possibility — although not always consciously — almost as natural. However, Gabor also recognized that the duration of this 'relevant future' is not fixed: it can be limited to an amazingly short period, and so who or whatever is processing the signal (or signals pattern) can create the relevant future as the signal is being processed. This is what happens when our hearing — the signal processor — turns sounds (the signals carried by the mechanical waves) into information so as to delay the processing of some of the individual signals and thus "sends the future back to the past."[4]

Basically, this creation of the relevant future is the key to holography as well.[5] When a hologram is recorded, the so-called reference background creates the relevant future, which, when the hologram is reconstructed, in turn enables the simultaneous analysis of light waves in the dimensions of time/space and frequency, so that the symmetry of time/space and frequency is not lost — the sole precondition that guarantees the recognition of the three dimensional aspect of space via the signals carried by the light waves.

3. Biomalehgraphy

Living matter, including the human being, perceives the surrounding space as three dimensional. However, it is not the formal space imagined and developed by mathematicians. In the case of man, it is an independent physical space felt by touch and kinesthesia, which appears as a result of the processing of signals transmitted mainly by electromagnetic waves, or light. This physical space is manifested in the cerebral cortex, where the processing of signals that cause spatial perception occur, so that the organism sees the three dimensional physical space outside of itself and knows where it can feel this space through touch and kinesthesia.

Hence, the human being has to have a strategy for processing signal patterns that is able to resolve the following contradiction: his optical signal pattern sensor, the retina in the eye, is sensitive only to the intensity of the wave carrying the signal pattern. This means that not only is information tied to the wave phase (e.g., depth) lost, but also the information connected to the amplitude as well, for intensity is proportional to the square of amplitude. In other words, as far as the retina is concerned, the condition that would make it possible to simultaneously analyze patterns of signals in the time/space and frequency ranges is absent, and so the symmetry of time/space and frequency is lost in the course of processing the signal pattern. Yet, as mentioned above, the latter is necessary for the optical perception of three-dimensional space and its equivalent, objects. Nevertheless, both human beings and animals orient themselves very well in the world we consider three-dimensional. Therefore we have every reason to assume that there is a process of biological signal pattern processing that is able to create the relevant future as required by Gabor's criteria.

As I have shown in some of my previous papers,[6,7,8] the activity of man's neural architecture or at least some of its segments, may, under certain circumstances, be able to take on the role of processing the relevant future. Thus, when processing biological signal patterns (stimulus patterns), the situation may be the same as it is in holography: a reference background might possibly be created. It directly follows that the processing of several biological signal patterns (stimulus patterns) can be described by the mathematical apparatus that interprets holography,[9] but I should also stress that the outcome of the signal pattern processing in the living organism also depends on other processes present in the organism at the moment of processing (including the processing of other patterns of signals). This, however, does not mean that the processed signal pattern does not reflect the original signal pattern; it only means that the processed signal pattern — which becomes information in this way — is not perceived from the outside, but is extended over the whole neural system. This is one of the reasons why it cannot be localized. Naturally, we cannot go into the details of how the mathematical apparatus interprets holography, but we have to note some of its consequences, the things that allow understanding of the development of the two worldviews previously mentioned. Whenever signal pattern processing takes place according to the above principles, the result is always a pattern (image) and its complex conjugate. In order to understand this mathematical expression, just remember that whenever a hologram is reconstructed with the help of its reference background, the three-dimensional object will be seen in space at the place where it was at the time of recording, i. e., from where the optical signals came. Nevertheless, we cannot touch the object itself, because the image seen is the "virtual content" of signal pattern processing, while its "complex conjugate" — which is also three dimensional — can be seen and captured only on a screen, that is, in two dimensions.

3. Ibid., p. 439.
4. D. Gábor, "Acoustical Quanta and the Theory of Hearing," *Nature* 159, no. 4044 (1947) 591-594.
5. D. Gábor, "A New Microscopic Principle," *Nature* 181, no. 4098 (1948) 777-778.
6. P. Greguss, "Bioholography – a New Model of Information Processing," *Nature* 219, no. 5153 (1968) 482.
7. P. Greguss, "Bioholography – a New Model of Information Processing," *Progress of Cybernetics*, J. Rose, ed. (London: Gordon & Breach Science Publishers, 1970) pp. 433-440.
8. P. Greguss, "Bioholography," *Developments in Holography*, B.J. Thompson and DeVelis, eds. (SPIE Proc,. vol. 24 1971) pp. 55-83.
9. This is why this description of biological signal pattern processing was named "bioholography." Unfortunately, there has been some misunderstanding regarding this description, since it is not understood that this is a functional scheme, not a morphological equivalent. Some people, bordering on charlatanism, have already talked about the interference of waves in the brain, and even about tuned systems of resonators. Therefore, at the "Building HAL" conference (Normal, Alabama, August 1992), H.J. Caulfield, J. Shamir, and P. Greguss suggested that it would be more useful to replace the expression "bioholography" with the etymologically equivalent "biomalegraphy."

4. Vision and View

The poet László Tóth wrote in his poem, *The Blind Gallery Guide*:

I say
the function of the eye is not to see,
but simply to observe,

and how right he was!

It is well known that no matter how often an optical signal pattern from the external world reaches the eye (even the fovea, the most sensitive area of the retina), no signal pattern processing takes place while the eye is immobile. However, this fact indicates that the relevant future, which is indispensable for the processing of a signal pattern (stimulus pattern), can be provided by the neural activity related to eye movement. If this is the case, several artistic products related to vision might be interpreted with this in mind.[10, 11, 12] Here I mention only two. First, we have so-called ambiguous figures, which communicate two kinds of information but can "see" only one or the other at a time; this phenomenon is usually explained with the process of selective observation. In my opinion, however, this is not an appropriate interpretation of the phenomenon. When an optical signal pattern hits the retina, thus creating and processing a stimulus pattern for the first time, then seeing one or the other variant cannot be attributed to selective observation, because it is not certain from the start where we should direct our observation (which, by the way, is quite a loosely defined concept). A real explanation is offered by malehgraphy, which mathematically presents the probability that the individual will be able to see sections of the image that are not serving as relevant future (reference background) in the signal processing. In this process, so-called selective observation only plays a role later (if at all), when a particular section of the optical signal pattern becomes visible. This example demonstrates that vision is really a function of viewing, which in turn seems to be related to the prevailing neural development of the relevant future.

If we look at fig. 1, we cannot decide if the images depicted are protruding cubes or indented cube-shaped hollows. A viewer can see either one or the other version, but never the two together. In this case, however, it is not the manifestation of the previously mentioned optical signal pattern processing scheme, but another one, which allows real three-dimensional vision, since there is also a variation of depth perception here.[13] As I have already noted, when the above-mentioned optical signal pattern processing scheme is manifested, the usual depth information develops. If, however, information is extracted by relying upon the complex conjugate of the reference background, we will see an image corresponding to reversed depth relations. This means that surfaces and objects closer to the viewer will seem smaller, more distant objects will seem larger, and the viewer experiences a feeling of reversed perspective. This concept was introduced by O. Wulff in 1907.[14] If this is true, and if it also true that in the course of viewing, optical signal patterns are processed according to the principles of malehgraphy, then the information content of both types are present in the processed pattern of stimulus. That would mean that both kinds of perspectives could develop, depending on how information is produced: either through the original reference background or its complex conjugate, which is a function of the prevailing neural state and activity. Sometimes artists employ the psychological phenomenon of reversed perspective, as Picasso did in his painting, *Meal* (fig. 1).

5. Flat Cylinder Perspective

When looking at a supposedly realistic perspective, we have the sense that we are looking through a frame. This effect can be traced back to the fact that information carried by optical signals from space, as if "through a window," can be processed only in fragments, and only as if we were outside the three-dimensional space, not in the center. Furthermore, none of the lines of depth appearing on the retina will run parallel to the straight lines on the retina, i. e., information related to phase differences seems to disappear as distance increases, which is manifested in the so-called feeling of perspective. However, we try to code this feeling on two-dimensional surfaces, as if the lines carrying depth information might converge on an apparently horizontal line (the horizon), the so-called vanishing point. However, keeping this strategy of signal pattern processing in mind, it follows that we cannot see the entire space surrounding the person or instrument engaged in collecting optical information from space, because the entire field of vision — meaning the totality of "looking through the window" — can be described as a sphere, which, in contrast, cannot be transferred onto a plane without tearing or distorting, as mathematics have proved. Nature seems to realize this, and does not consider the field of vision a sphere — at least in the case of human beings — but more like a cylinder. This is supported by the fact that parallax, the foundation of spatial orientation, is only perceived horizontally: we have no sense of vertical parallax. If the visual field is considered

10. P. Greguss, "Egy holográfiás esztétikai bionikai modell leheto˝sége: mito˝l szép a szép? (A Possible Holographic Aesthetic-Bionic Model: Why Is the Beautiful Beautiful)," *Fizikai Szemle* 27: 1977 (174-182).
11. P. Greguss, "Újabb adat a 'szép' bioesztétikájához (New Contributions to the Bio-Aesthetics of the 'Beautiful')," *Fizikai Szemle* 28, no 7: 1978 (1-5).
12. P. Greguss, "Phosphenes in the Light of Bioholographic Models," *Progress in Cybernetics*, Trappl, Klir, and Riccardi, eds. (Washington, D.C.: Hemisphere Publishing Corporation, 1978) 476-488.
13. Three-dimensional vision is often mixed with stereo vision, which does not result in real parallax, but just the impression of space. Stereo vision probably developed in the course of evolution for reasons related to the defense of territory, since it makes it possible to determine distance very precisely. This notion seems to be proven by the fact that stereo vision begins to operate as the distance between the external object and the individual decreases to about three meters, which marks the boundary of personal space, the individual's so-called security zone. It is effective until about twenty-five centimeters, beyond which there is no need for signal pattern processing to provide optical distance measurements, but where three-dimensional vision is still necessary. The watchmaker, for whom parallax is essential, closes one of his eyes to prevent the intrusion of stereo vision!
14. O. Wulff, "Die umgekehrte Perspektive und die Niedersicht," essay on art history, publication in honor of August Schmarsow (Leipzig: 1907).

Fig. 1:
Pablo Picasso, *The Meal*, 1953
© VBK, Vienna, 2005

15. P. Greguss, Hungarian patent 192125, U.S. patent 4566763, Japanese patent 1962784, German patent 3402847.

cylindrical in shape, the volume of an image is first projected onto an imaginary cylinder wall located at the horizon, and the whole surface of the cylinder wall is then projected onto the plane perpendicular to the axis of the cylinder. Then, the whole visual field (and not merely a fragment of a selected visual angle) appears on a two-dimensional plane, so that there is a 1:1 correlation between the points of the two-dimensional image, just as in three-dimensional reality. Image volume appears as a ring-shaped image, where the width of the ring corresponds to the vertical visual angle of image formation (as seen in fig. 2), while the concentric rings represent different horizontal spatial angles in a given vertical angle of vision. In other words, these ring-shaped images provide the two-dimensional skeleton of the three-dimensional environment, i. e., the phenomenon of the appearance of depth is illustrated on a two-dimensional surface as a convergence upon a single point, which means that they have a single vanishing point. Thus the entire space becomes visible all at once, so that both usual and reversed perspective appear together. This is why, at the beginning, it is difficult to orient ourselves when viewing images that feature this kind of flat cylinder perspective, if we look at them the usual way. If, however, the picture is held horizontally above our heads, the discomfort caused by the simultaneous effects of the two perspectives disappears, because the eye movements that cause reverse perspective cease. Art has long been experimenting with the possibility of this kind of centric-minded representation of the environment. It was probably Leonardo da Vinci who, without consciously understanding, first sensed that there were mechanisms for optical signal processing, which would make such a method of representation possible, when he created his so-called anamorphic pictures. This word comes from the combination of the Greek ana (repetition) and morphé (form). It attempts to express the notion that an image is composed of a series of figures showing different viewing angles. Fig. 3. shows such an anamorphic image, that of a dancing couple, taken from J. M. Bruckner's collection in the Darmstadt Museum, Germany. The picture becomes truly understandable if a coned mirror is placed, base-down, at the center of the image, and we look at the image in the mirror. Scientists and technologists, however, first imagined inventing an image-producing device capable of distortion-free, centric-minded imaging of space only toward the end of the nineteenth century. Since then, different, more or less complex technical solutions have appeared. The author of this paper, investigating the different visual methods in the animal kingdom, came across an optical solution in the eye of a shell, Pecten maximus, which he believe could be modified and used to construct an imaging block that would solve the problem of central perspective imaging more simply than before. Since this imaging block produces a ring-shaped (annular) image, it became known as a *PAL lens*, from the abbreviation of its English name, *Panoramic Annular Lens*.[15] The PALoramic image in fig. 2 was also created with the help of such a lens. Owing to the dark spot in the center — the result of transforming a cylinder wall into a plane — some people may feel that there is something missing, but it is easy to compensate for this. One part of the cylindrical volume around the axis of the PAL lens does not help to form the image, so it is possible to use this round, dark spot, which does not contain any image information, as a projection surface. Any part of the 360° panoramic image can be selected and even projected onto it in magnified form. This means that the lens can operate similarly to the human eye, having peripheral and foveal vision. Fig. 4 shows a picture of the Ludwig Museum in Budapest with its entrance, taken by this type of PAL lens. In this 360° panoramic annular picture, it is easy to see the building, its entrance, and the different objects on the square in front of the building. The magnified image of the entrance is in the center of the picture, capturing attention, exactly as if the eye had made a move that would allow the most important part of the image to fall on the fovea.

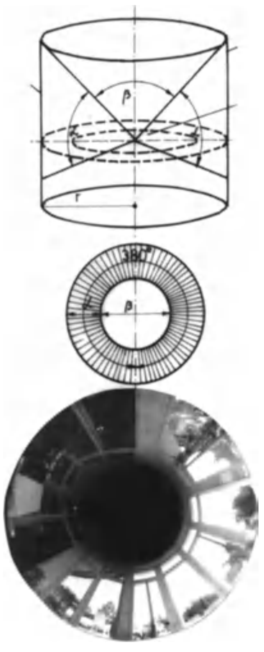


Fig. 2: The principle of central perspective imaging of space.

Fig. 3: Anamorphic picture showing a dancing couple from J.M. Bruckner's collection in the Museum of Darmstadt, Germany.

Fig. 4: The Ludwig Museum of Budapest, and the environment of its entrance, taken by a PAL-lens providing foveal vision

András Mengyán

Logic of Forms

The Form-System "M"

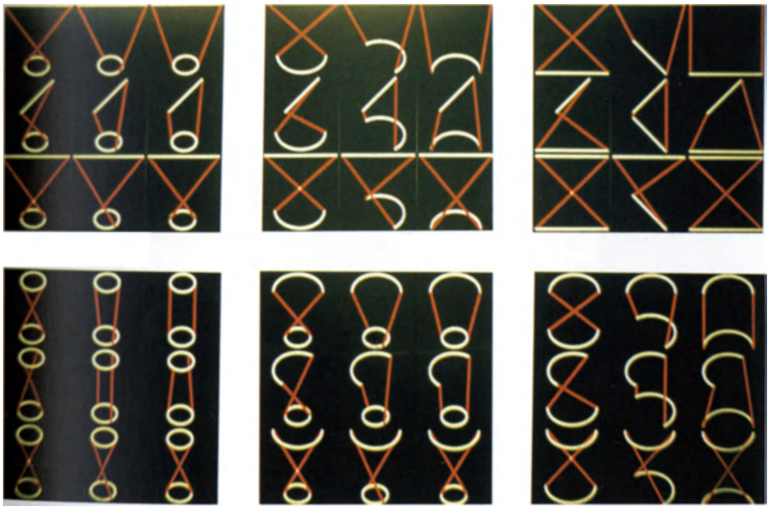
Systematizing the relationships of forms and colors, approximating the endless color and form possibilities by way of logic and aesthetics.

Starting point: Mathematics, especially geometry (topology).

Items:

A) Abstract. Establishing "concrete" forms by way of logic. Basic research on planes and space.
B) Combination elements. Moveable elements containing the results of basic research, which demand great computational and logical capacity.
C) Combination forms. Particular moveable forms are combination elements whose defined amounts and characteristics vary with a limited planar or spatial motion. These plays of colors and forms demand a certain combinating and logical inclination.
D) Spatial coordinate system. The organization of colored planar and spatial configurations in a determined space.
E) 2D and 3D forms.

Within this system, the most important task is to determine and solve the adjustment of different-quality 2D and 3D configurations in terms of each other. There is a modulated relationship between the lines and surfaces that have taken on shape, as well as to the bodies. This is valid for the different geometrical configurations, straight and curved lines, straight and curved surfaces, as well as angular and curved bodies. The relationship between straight and curved elements is aided by transitory configurations. The adjustment of different geometrical configurations enables the establishing of variation forms. These engagements result in new variations of forms, and open the possibility towards repeating and non-repeating permutations. The modulation linkage of geometrical configurations starts an endless chain that cannot be solved and developed except by logic.



András Mengyán
Logic of Forms I-IV, 1974
Acrylic, each 120 × 120 cm

Visual Programs

The most important aim of a visual program is to reveal the most general connections and interactions among the visual ingredients with the utmost care and consideration, as well as to reveal the effect of these connections on people and their environment. This activity is partly mental, partly research and exploration, and partly the analysis of effects: only in its appearance does it have aesthetic motivations. My visual programs are based on the "system of forms" I have elaborated.

The system of forms is meant to handle its ingredients as objectively as possible. The systematized knowledge of the ingredients is indispensable for the creation of visual programs. A visual program is the correspondence of these ingredients with one another, by way of visual realization (e.g., the combination of 1 to 12 straight lines without repetition in a limited space).

Programs may be simple or complex; short, long, or endless. By stating this I want to express that programs are based on visual systems, and they may be open or closed. The primary task of visual programs is to synthesize the corresponding ingredients so that the synthesis is free of any (objectified) function. Thus, considering visual

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1974 Egyetemi Színpad, Budapest
1976 Józsefvárosi Kiállítóterem, Budapest
1984 Csók István gallery, Székesfehérvár
1985-86 Műcsarnok, Budapest
1992 Bergen Kunstforening, Bergen
1995 Műcsarnok, Budapest
1998 Éri Galéria, Budapest
2001 IKM, Oslo
2003 BTM – Fővárosi Képtàr, Budapest

Group shows
1971 Fáklya Club, Budapest
1975 *Neue Ungarische Konstruktivisten*, Städtisches Kunstmuseum, Bonn
1981 *Ungarsk Konst 1905-1980*, Liljevalchs Konsthall, Stockholm
1985 *Meditáció IV*, Bartók 32 Budapest Galéria
1989 Hungarian National Gallery, Budapest
1994 Ernst Museum, Budapest
1999 Kévés Galéria, Budapest Hungarian Consulate, New York
2002 Győri Kisfaludy Színház, Győr
2003 Gutmann Galéria, Budapest
2004 Ludwig Múzeum, Budapest

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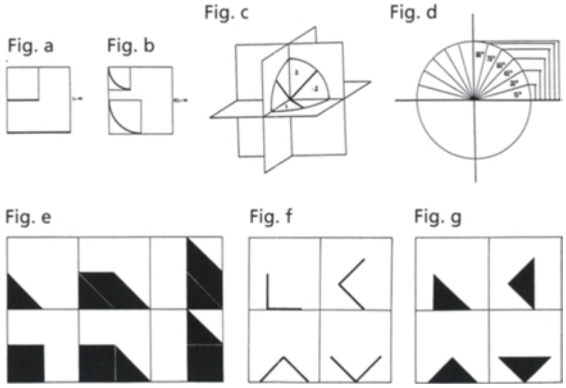
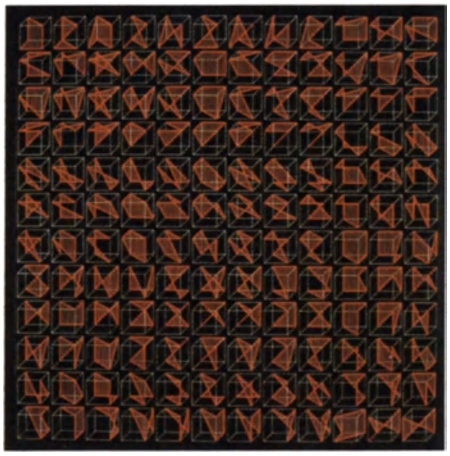


a) Determining the original basic form. Here the original basic form is the "embodied" unit line or the unit arcs. (fig. a-b)
b) Determining the shift of geometrical configurations in the plane and in space. Three-dimensional angular change. (fig. c) Angular change according to degrees. (fig. d).
c) Origin of planar and spatial geometrical configurations in the plane by way of logics. (fig. e-g)

programs from the point of view of the complex human environment, they may be said to be analytical; whereas from the point of view of visual ingredients (the system of forms) they appear to be synthetic. It is necessary to know what the interrelationships of the visual ingredients are, because the effectiveness of consciously influencing the environment depends on this knowledge. So it is necessary to know the interrelationships of the visual ingredients for creating functional aesthetic environmental and aesthetic objects. If, with the help of the program, we get to know the connections and interrelationships among the ingredients, we can develop our knowledge, thought, and — as a final aim—our complex environment far more effectively. Since we perceive, analyze, and react to most of the phenomena of nature and the human surroundings visually, it is of utmost importance to be able to consciously feed this knowledge back into the surroundings, be it intellectual or functional.



András Mengyán
Visual Programs 1977-82
Silk screen print, tempera, 60 × 60 cm

We have accumulated so much visual knowledge by now that we are increasingly less capable of acquiring, analyzing, and transmitting it. This is one of the reasons that the visual arts are far less effective than they could be. One of the most effective ways of approaching the optimal is creating visual programs. It is rational to create the programs composed according to the most general laws by "intelligent" means. Since the biological constitution of the human being is unable to record information over a long period, or to realize it quickly visually or verbally, when necessary we always need the most "intelligent" means at our disposal — these days, computers—to help us. This is, of course, not the only possibility, and we can create programs without these means as well. Like every program, the visual program presupposes the solution of the problems in the visual arts and the connecting of these problems with those in other fields. The value of the visual programs is determined by the quantity, the quality, and the usefulness of the knowledge manifested in it.

András Mengyán, *Theory of Forms* (Budapest: unpublished manuscript, 1970-1971).

Antal Nemcsics

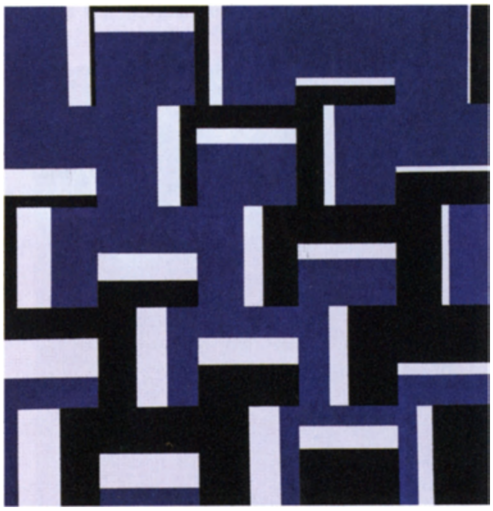
The Coloroid Color System

I developed the *Coloroid Color System* at the Technical University of Budapest, as a result of a sixteen-year period of research in the field of color dynamics in construction. Like the color codes of the Munsell color system, the coordinates of this new system refer to color perceptions. However, a major difference from the Munsell system is that the psychometric scales of the Coloroid system do not rely on the ability of human eye to subdivide series of hue, saturation, and brightness, but rather on the human ability to judge the uniformity of these kinds of series. As in the Ostwald system, every color in the new color system is also expressed as an additive mix of a saturated color with white and black. It is, however, essentially different from the Ostwald system in that these tristimuli have a clear relation to the CIE XYZ system and permit a numerical description of the quality of our color sensation. The range of the Coloroid system was developed with the help of several thousand test persons.

Our experiments aimed to create a color range that would describe harmonic color relationships. Colored surfaces in our environment simultaneously display a wide range of colors of different hues, saturation, and brightness. A designer must arrange these colors in an aesthetically pleasing relation — that is, create a beautiful combination. Selection is easier if the change of color codes rhythmically corresponds to a change in the aesthetic content of colors. This kind of change, which is characteristic of a color scale, can be described as an aesthetically uniform change of colors, if the color scale as a whole changes in a uniform manner. These kinds of scales constitute an aesthetically uniform color system, in which the difference in color sensation between two adjacent patterns is an integrated multiple of the harmonic color difference. Earlier experiments proved that harmonic color difference is the least difference between two adjacent colors, and it allows these colors to be combined in the same harmonic composition. Among the adjacent colors in scales consisting of harmonic differences, the number of perceptible color differences is not uniform, referring to the smallest color differences as perceived by a CIE 1931 colorimetric sensor.

For the artist concerned with visual creation, color is a tool for both technical and artistic activities. Therefore it is necessary to use codes to unambiguously identify every member of the color set, to be able, in the former case, to assign technical parameters to colors, and in the second case, to quantify compositional relations between colors. In addition, the color designer is expected not only to be familiar with the colors, but also to define perceptual relations by measurement or estimation, just as for distances or volumes. This requires a system of measurement whose units are directly or indirectly international. The codes of various color systems are not really suitable for this purpose, since they are either discontinuous, or their color range is aesthetically non-uniform, or they are not in exact correlation with the CIE XYZ system. This is why I have developed a new color system especially for architects and artists, namely, the Coloroid.

In the Coloroid color system, colors are arranged so that their correlation appears to be aesthetically uniform to the average observer, i.e., it is made of approximately equal harmonic intervals (units), which are, at the same time, in an exact relation with physical parameters and color stimuli. That is, it closely approximates the structure of an aesthetically uniform color system, and is at the same time in a perfect, mutually unambiguous relation to the CIE XYZ color system. Its codes have been directly derived from tristimuli obtained through instrumental measurements. These codes are used to define concepts of hue, saturation, and brightness that closely approximate our color sensations. The system allows for approximation, which is an essential characteristic of the concept introduced, but it guarantees an exact relationship to other systems, however, whenever it is applied with the help of instruments. Coloroid hue, Coloroid saturation, and Coloroid brightness are the perceptional characteristics of the Coloroid system. Owing to its direct relation to the CIE XYZ color system, it follows that the Coloroid system is based on additive color mixing. Colors are treated as mixtures of a tristimulus, black, and white. Coordinates of a color in the Coloroid color system can be determined from the components and their proportions. According to the principle of color systems based on perceptional characteristics, the three dimensional array of color perception is arranged inside an orthogonal circular cylinder, so that hue changes occur along the cylinder shell, saturation along the radius, and brightness along the axis. Hence, achromatic colors from absolute white to



Antal Nemcsics, *Static and Dynamic. Diametrical Order*, 1995
Acrylic on canvas, 130 × 130 cm
© VBK, Vienna, 2005

Antal Nemcsics, born 1927 in Pápa. Studied at the Budapest University of Applied Arts. Since 1951 he has been teaching color dynamics at the Budapest Technical University. Vice-president of the International Academy of the Sciences of Color. Fields of research: Coloroid color atlas, the theory of the complex harmony of colors, theory of the color dynamic area, color preferences, and the index number system. Other reseach areas: ensembles of urban features, color planning for public buildings. Chairperson of the Hungarian National Color Committee (AIC– International Association for Color). Lives in Budapest.

Exhibitions
1949 Municipal Gallery, Budapest International Arts Prize
1963 Town Museum, Castelfranco Veneto International Giorgione price
1967 Galerie Stonzel, Munich
1984 International Color Design Exhibition, Stuttgart Venice Biennial
1993 *Axial and coaxial orders*, Vasarely Museum, Budapest
1996 *Laws of Colorland*, Vigadó Galéria, Budapest

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R.W.G. Hunt, *Measuring Color* (New York/Chichester/Brisbane/Toronto: Ellis Horwood, 1987).
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A. Nemcsics, "Color Harmony in Architectural Space," Polytech. Arch. 24 (1980): 79-112.
A. Nemcsics, "Der Farbenraum des Coloroid-Farbsystems," Die Farbe 32/33 (1986): 327-343.
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A. Nemcsics, "Coloroid Color Atlas," Innofinance, 1988.
A. Nemcsics, *Color Dynamics* (NewYork: Ellis Horwood, 1993).

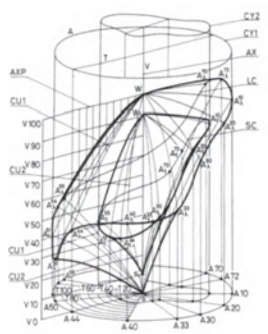
absolute black are found on the axis of the cylinder. Planes vertical to the axis contain colors of the same brightness. Saturation of colors increases with the distance from the axis. Colors of equal saturation each form a cylinder shell. Colors of the same hue are on half planes of vertical axial sections of the cylinder. An approximately elliptic perimeter of an inclined plane section of the cylinder shell accommodates the spectrum colors and purples, which are the limit colors of the Coloroid system.

From among the limit colors of the Coloroid system, forty-eight approximately aesthetically equidistant colors with integer codes have been adopted as the Coloroid basic colors. Absolute white and absolute black are the two end points of the achromatic axis. Every Coloroid limit color is related to absolute white and absolute black by a curve in the common plane of achromatic axis and limit color, the so-called limit curve. Surfaces made up by the array of limit curves confine the Coloroid color space. Coloroid color space is the circumscribed part of a space that contains all perceptible colors arranged according to Coloroid perceptional parameters. In the Coloroid color space, the radii containing the achromatic axis from absolute white to absolute black, as well as the radii vertical to the achromatic axis, which contains the limit colors and extends to the cylinder shell, have been divided into one hundred equal parts. The Coloroid solid is inside the Coloroid color space. It is the part of the color space that contains the surface colors. The most saturated colors of the Coloroid color solid are also on a curve on the cylinder shell, which is, however, no longer on the curve that delineates the circular cylinder shell.

Half planes intersecting the Coloroid color space are called Coloroid color planes. A Coloroid color plane is circumscribed by a straight line, the achromatic axis, and two limit curves. Similar to and inside of the limit curves are curves cut from the Coloroid color solid by half-planes. These are the limit curves of the surface colors. Colors in the same Coloroid color plane have the same Coloroid hue.

Colors in the Coloroid color solid, which are located along straight lines parallel to the achromatic axis, have the same Coloroid saturation. Colors along the achromatic axis have the same Coloroid brightness. Whereas the shape of a section of the Coloroid color space depends only on the Coloroid brightness of the spectrum color or purple at the vertex of that section, the shape of the section of the Coloroid color solid depends both on the Coloroid brightness and on the Coloroid saturation of the most saturated surface color in that plane. The Coloroid color system is therefore is especially good for describing harmonic color relations.

The saturated colors mark the boundaries of the Land of Color. These saturated colors, mostly spectrum colors, are basic colors in the *Land of Color*. All existing color hues can be mixed using these colors, along with black and white. The disk shows basic colors, with black becoming increasingly evident toward the center. If the mobile is at rest, we find ourselves at the border, the gate to the *Land of Color*. If you start the electric motors, the disks beginning to rotate, and we pass through the gate to see the colors in the *Land of Color*. In 1986, the mobile was displayed at the main exhibition of the 42nd Venice Biennial, whose theme was Art and Science.



Antal Nemcsics, *Axonometric view of the model of the Coloroid color system*
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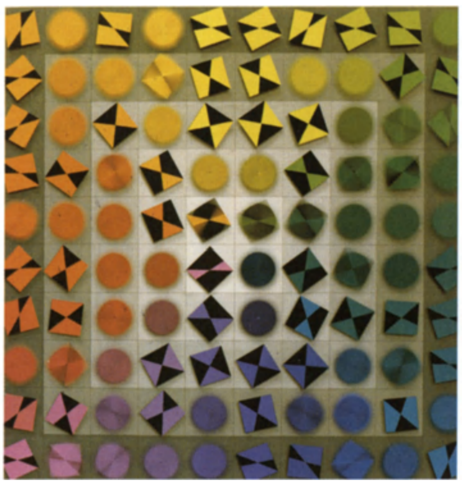
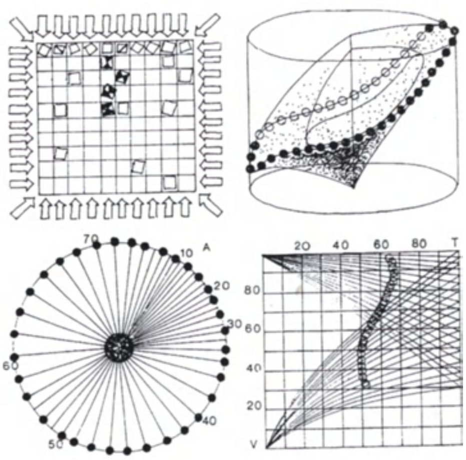


Antal Nemcsics, *The Gate of the Land of Color*, 1984
Mobile, tempera, plexiglas, 100 electromotors, 100 × 100 × 22 cm
© VBK, Vienna, 2005



Antal Nemcsics, *The Gate of the Land of Color*, sketch
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Attila Csáji and Norbert Kroó

Creating Images with Lasers: a Method for Superpositioning

Most visual art of the future will be painted with light. (László Moholy-Nagy)

Our stormy age has raised many questions, one of which involves the relationship between modern science and art. Many people think that science and art are in contradiction. This feeling is based on two arguments: first, that modern science is a threat to mankind, and art is unable to block this threat; second, that science and art are developing in opposite directions. Neither of these arguments is supported by fact.

Science and art have, perhaps, never been as close to each other as they are now. Both are creative disciplines, both have the tendency to synthesize. Many scientists are involved in some kind of art, and some of them even consider science to be a special form of art.

Many today aim to build bridges between the two disciplines, although scientists approach the problem from a different direction than do artists.

Patterns

According to Norbert Wiener, originator of cybernetics, "One of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is essentially an arrangement. It is characterized by the order of the elements of which it is made rather than by the intrinsic nature of these elements."[1]

When we look at a pattern, processes in our brain are induced that allow us to perceive the pattern. Similarly, patterns induce processes in other biological systems or machines. Both the formation and recognition of patterns are connected with dynamic processes (fig. 1).

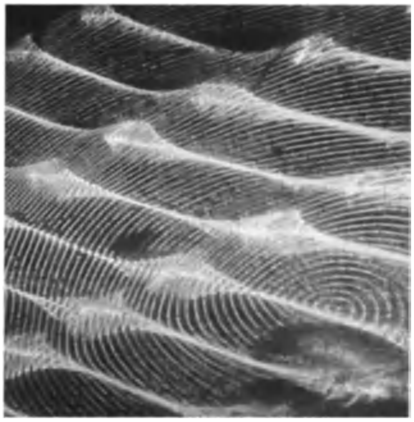

Fig. 1:
In Wave Fields, multi-laser-interference picture, transformed by various optical elements, 1980

Coherence

The roots of coherence lie in the dual nature of all elementary particles; this means they can be defined either by their properties as particles with mass, momentum, and kinetic energy; or defined as waves (with wave vectors), which oscillate with well-defined frequencies. This is true for photons, phonons, spins, and bosons as well as plasmons, neutrons, and electrons. The dual nature of elementary particles is the basis of the theory of complementarity, which states that matter has two complementary "faces" that cannot be seen simultaneously. If, for example, we are interested in the particle character of matter, its corpuscular properties are observed; if we are interested in its momentum, we observe the wave properties. Physicist Niels Bohr, the founder of the quantum model of atoms, used this principle of complementarity, as did his colleagues in the various fields of biology, psychology, anthropology, and ethnology.

Much attention has been paid to the coherence of light since the end of the nineteenth century. Opticians are the most experienced in the field of coherence, since they have dealt with the concept for the longest time. What, then, is the significance of coherence? Basically, coherent light sources are responsible for producing interference when two beams of light are superposed.

With the sun as a partially coherent source of light, interference has been used to clarify several basic aspects of physics. After the discovery of lasers, the role of interference phenomena of light was better understood, since laser light sources are the best for displaying coherent properties.

Interference Patterns in Art

Interference patterns are created when an object scatters light. In each case, the pattern results from the Fourier transformation of the function describing the surface geometry of the object.

We formed FOTON-ART in the mid-1970s and launched a research program to work out methods for using coherent laser beams to create patterns. Our aim was to succeed in arranging the coherent light emitted by lasers into preplanned pictorial patterns.[2]

Light Art

When we started our research, we believed that the discovery of the laser — this new source of light with special qualities — provided insight into ideas once expressed by the Bauhaus followers. With prophetic inspiration, painter and photographer László Moholy-Nagy wrote in the early decades of the twentieth century that most visual art

1. H. Haken, *Pattern Formation by Dynamic Systems and Pattern Recognition* (Berlin: Springer, 1979) p. 2.
2. See Norbert Kroó, *Új Írás XX,* no. 5 (1980), 83; Attila Csáji, Új Írás XX, no., 6 (1980) 86.

Attila Csáji
born 1939 in Szepsi. Attended the Pedagocical Academy in Eger 1960-1964. Studied modern optics and laser technology at the Department of Physics of Budapest Technical University, and holography at the Media Laboratory at MIT. From 1977 he researched the visual possibilities of the laser-superpositions-method. Gesture painting, non-figuration, conceptual graphic design; analysis of visual possibilities of coherent laser beams.

1980 Hungarian National Gallery
1988 *Laser Photos & Holograms,* MIT, Cambridge USA
1989 Palace of Art, Budapest
1995 *4th International Video and Experimental Film Festival,* Szigetvár
1997 Jakobi Galéria, Kassa (Košice), Slovakia
2000 City Cultural Center, Hajdúszoboszló

Group shows
1984 *Lichtblicke – Erste Weltschau der künstlerischen Holographie,* Frankfurter Filmmuseum
1985 *Exhibition of International Holography,* Madrid
1994 *1980s – Art in Hungary,* Ernst Museum, Budapest
1996 *Segments,* Vigadó Galéria, Budpaest
1996 International Modern Museum, Hajdúszoboszló
2000 *Light and Space,* Kunshalle, Esthonia

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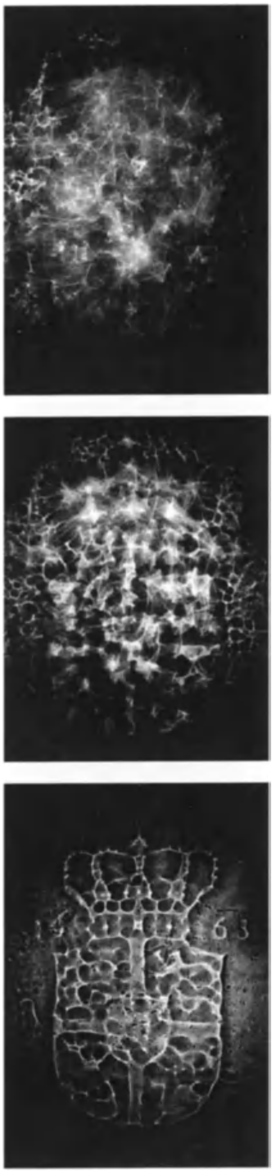

Fig. 2a-c:
Figurative metamorphic laser process, 1987. The coat of arms of Denmark emerges from interference patterns.

of the future would be painted by light. The concept of using disembodied light in art was very stimulating to the Hungarian avant-garde, and numerous works of this sort became part of the international art scene. Pianist Sándor László constructed a "light organ" designed to accompany music with colored light patterns. Sculptor and composer Nicolas Schöffer is best known for his metallic mobiles and sculptures, in which light plays an important role. Schöffer recognized that the most original characteristic of our technical civilization is the principle of dynamics, and his works of arts were machines that metamorphosed before our eyes. This became the basis for Kinetic Art.

Hungarian György Kepes, a founder of the New Bauhaus in Chicago and an artist who worked with light, wrote that revolutions, which keep changing the concept of form and the playful flirtation with shapes and techniques, must give way to more serious commitment. Kepes founded the Center for Advanced Visual Studies at the Massachusetts Institute of Technology to advance new technologies and relationships among new scientific discoveries and art. Since artist and Nobel Prize winner Denes Gábor invented holography in Hungary, holographic studios were operating there earlier than they were in its more technologically advanced neighbor, Austria.

The Hungarian National Gallery staged FOTON-ART's first show in January 1980. The total number of visitors to the exhibit reached approximately 300,000. Following the success of our exhibit at the National Gallery, we patented the technique of light art and its tools in January 1980.[3] The tools comprise a flexible lens-and-prism network that lines up along a laser beam. At the core is a transparent disc that carries the visual information. A key feature of the procedure lies in the coordinated use of manual and computerized technology. We first made drawings of the motifs, reduced them photographically to the desired size, projected them onto metal or some other material, then cast them from a clear plastic material. The resulting transparent disc contained the composed pictorial information in plastic form. A motif captured on the transparent disc could be anything from a flower to a human head, from a Coke bottle to a business logo, depending on how the surface was adjusted. We called this plastic disc the "objective picture." The coherent laser beam transforms this plastic objective image into interferences, which are correlated with the optical system and its setting. In this way, we could not only change the size of the motifs on the disc, but also alter their shapes. We could project the motif as it was designed, or we could transform a plastic motif into characteristic interference patterns. The method was especially suitable for making the relationship between perception and physical laws tangible. We achieved pure laser interference through what we called "pre-holographic images." We used this method to reproduce the Danish coat of arms at the Bela Center in Copenhagen (fig. 2a-c).

Organic and continuous visual changes helped to create the transition between the world, as perceived by the naked eye, and the precise, mathematically definable light interferences. This meant that in the pre-holographic pictorial transition, the objective image and the interference patterns could be perceived simultaneously, but mixed in varying proportions. This metamorphic process held infinite possibilities in the forms created by pure laser light.

Our Experiences

Using our method, we were able to create a variety of shapes and movements that seemed to exist on various levels of material organization. We first expressed this in our program called Cell Crystals (1980), which presented an exotic world, a journey into the secrets of nature.

The concept of evoking the hidden aspects of nature appeared in our work again and again. This concept also gave rise to *The Fifth or the Sixth*, the first Hungarian laser animated film, which we made in 1984 at Pannonia Film Studios. By showing living cells forming out of star clusters, and infinite space arising from crystals, the film presented paradoxical correspondences between microcosm and macrocosm (fig. 3).

We want to create new traditions, but only after re-experiencing already existing traditions. We used these methods in the theater for burlesques, dramas, and modern dance concerts. The key element of each spectacle was the method of superpositioning, which resulted in different transformations; we also used scanners and three-dimensional light/dynamic elements.

We worked extensively with the modern dance group Budapest Táncegyüttes, led by Antal Kricskovics. For their premiere, we designed *Relations*, lighting to accompany the show, which continually changed the atmosphere. Dance is an art form that uses the most fundamental movements, and light is one of the greatest experiences of man. Here, these two phenomena met by way of the laser (fig. 4).

The method we used in Veronica's scene in a play entitled *The Mount of Olives* created an entirely different character. The director of this biblical drama wanted Veronica to go insane, and in her madness, to project visions onto her veil. Our task was to create these visions by means of laser light. First, we marked the actor's position and movements, with the size and position of the veil as she was holding it. Next, all other lights were extinguished, leaving only the light of the laser to set off Veronica's figure onstage. The laser light slowly narrowed, pointing to the veil, whereupon whirling shapes appeared. These shapes were chaotic, representing the reflections of

3. A. Csáji, N. Kroó, and J. Tóth, Hungarian patent no. 182.793.

madness. Then, slowly, they began to merge into the reflection of a head. At times, the rays creating the head would collapse again into chaos. At last, the rays came forth, more clearly defined as Christ's head (fig. 5), which became larger than Veronica; it covering the entire scene and the stage, finally engulfing Veronica herself.

Conclusion

The revolution of science and technology is something that cannot be slowed or stopped, regardless of the consequences. Possibly civilization is suicidal or — forever seeking to realize new dreams — driven to search for matter, tools, or energy in order to reshape the world. Once human beings searched for the philosopher's stone. We now know that this stone is not a material object, but rather represents existing ideas. Our ability to continuously adapt and transform reality means that we can always find new ways to govern the changing world.

"The Method of Superpositioning," *Leonardo*, vol. 25, No. 1 (1992) 23-28.

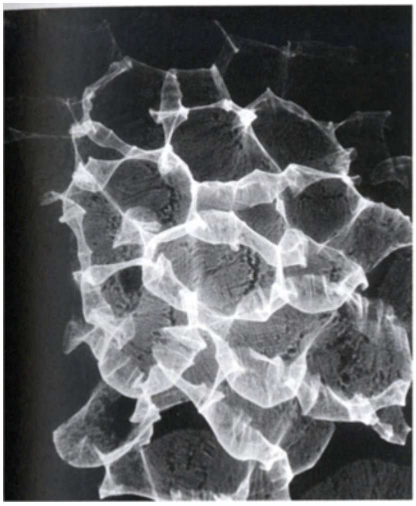

Fig. 3:
The Fifth or *The Sixth*, a laser animation film, Budapest 1984.
The imagery in this film continually transforms from one state to another, from star clusters to living cells, from crystals to infinite space.

Fig. 4:
Relations, laser light art, 1983

Fig. 5:
The Mount of Olives, laser-light art and drama, 1985. Through the manipulation of laser-light beams and the phenomena of interference, the head of Christ has filled the entire scene of this biblical stage play.

Norbert Kroó, born 1934 in Budapest. Studied physics at Budapest University, 1953-58. Since 1958 collaborations with KFKI of the Hungarian Academy of the Sciences. He worked in Sweden 1968-71 and as a vice-director in Dubna. 1971 head of department at KFKI. Since 1981 scientific director of the Research Department of Solid-State Physics. Professor at Budapest University and at the Technical University Budapest. His fields of research: solid-state physics, optics, and neutron physics. He published more than 200 papers and owns more than 30 patents. He lives in Budapest.

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Éva T. Bortnyik and Csaba Tubák

Éva Tubák-Bortnyik
born 1945 in Cluj, Romania. Studied painting in Cluj. Lives in Vienna.

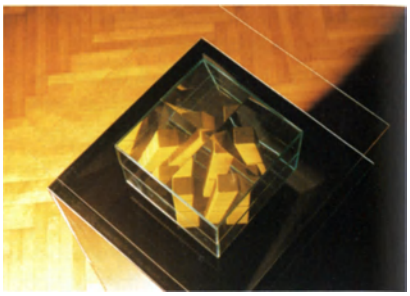
Csaba Tubák
born 1943 in Cluj, Romania. Studied business administration in Cluj. Computer expert (software development). Lives in Vienna.

Joint exhibitions and film screenings

1982 *d'Atelier Symposion,* Paris
Festival of Experimental films, Budapest
1983 *Einstellung-Ausstellung,* Großweikersdorf
1984 *Exakte Tendenzen,* Schloß Buchberg, Buchberg am Kamp
Begegnungen, International Symposium, Breitenbrunn
Österreichische Filmtage, Wels
1985 *Raumkonzepte Buchberg,* Fészek Galéria, Budapest
Collegium Hungaricum, Vienna
1988 Fészek Galéria, Budapest
1989 *d'Atelier Symposion,* Szombathely
Symmetrie, National Gallery, Budapest
1992 *Hungarian Experimental Films,* Galerie National du Jeu de Pomme, Paris
1993 *Rend és Káosz,* Academy for Fine Arts, Barcsay Hall, Budapest
A-Symetrie, Kilátó Galéria, Budapest
1994 *Ann-Art,* International Symposium, St. Anna-See
1996 *4 x 4,* Leopold Bloom Galéria, Szombathely
Festival of Austrian and Hungarian Experimental Films, Budapest; Vienna
Super 8 lebt, Vienna
1999 *Perspektíva,* Műcsarnok, Budapest

The Deluded Eye, 1996

The light guided by the plane lens system seems to break the rules of perspective by touching the spatial composition made of geometrical forms. The deluded eye gives up its instinctive attempt to "correct," only to discover that it has become one of the active creators of the work.

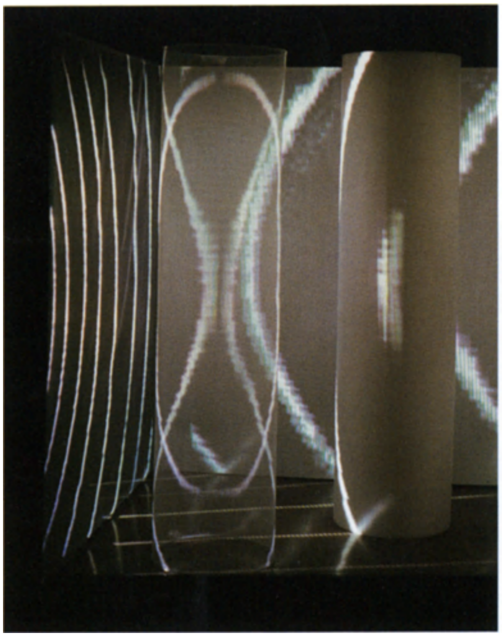


Éva T. Bortnyik and Csaba Tubák
The Deluded Eye, 1996

Transit VI, Video Installation, 1996

Two video players show films in synchronicity. They project onto a box installed in the darkened space, whose walls are punctured with a network of holes. Two same-size cylinders, one white and one translucent, are also set up. Hidden from view, the projectors form a right angle, making it possible to see both a front and side projection of the film at the same time. Since the spectator does not see the installation from the angle of the room's diagonal axis, he sees two very different images of the same film.

As the machines run, back light is allowed to escape through the holes in the black walls. During the projection, these streaks of light become sources of light, giving off active energy. The surfaces are moved by hand, providing a counterbalance for the strictly geometrical characteristics of the work. Whereas the stationary or slowly moving streak of light produces a sharp image, the accelerating one widens; the form dissolves and loses its sharpness as well as its luminous intensity at the same rate of acceleration. During the projection, the holes in the walls passively transmit the light, as an external force. The objects placed in the dark environment intercept the streaks of light. However, the spectator does not realize that the objects are being illuminated, but instead falls prey to the illusion that they are giving out light themselves. At the beginning of the projection, the viewer's eye instinctively tries to follow the movements of the streaks of light. Yet the eye soon realizes that the visual experience lies in the interplay of space, time, and light. Sometimes the spatial experience dominates; at other times, the perception of movement has a stronger effect, or the aesthetic impact of the light comes to the fore. The musical soundtrack is the fourth factor reinforcing the visual effect; at the same time, it helps to filter disturbing elements from the world outside. Manipulating the speed of the projection increases the overall effect of the spectacle. The material was recorded in real time, but is played back over a longer period of time.



Éva T. Bortnyik and Csaba Tubák, *Transit VI,* 1996, video installation

Peter Weibel

Viennese Formal Film

In 1925, Arnold Schönberg, founder of the New Viennese School of Music, wrote to Josef Matthias Hauer, the actual inventor of the dodecaphonic system:[1]

For instance, I have also observed numerical symmetries in my own work, such as the First Quartet, where so much that is divisible by five unconsciously occurs. Or in the Serenade, where the theme consists of variations of two times fourteen tones in eleven bars, and the entire movement is only seventy-seven bars long on purpose; or in the sonnet with its fourteen, eleven-bar lines.

In 1928 he wrote about the third movement (composed in 1920) of the *Serenade Opus 24*:

The numerical relations are the only interesting things about this piece. They are deliberately used here as the basis for construction.

On the genesis of his twelve-tone technique in 1937:[2]

After 1915, the goal of my work was always to consciously base the construction of my work on a thought that guarantees unity, which would not only give rise to all the rest of the thoughts but also determine their accompaniment, the "harmonies."

Schönberg found this basic unifying principle, which is bound to the classical forms of counterpoint, in the twelve-tone technique. The word counterpoint is a derivation from *punctus contra punctum*, which can mean "point against point" or "note against note," or (1) whole notes against wholes, (2) two notes against one, meaning half notes, (3) four notes against one, meaning quarter notes, or (4) syncopation. In the serial technique, we will again find the four classical forms of counterpoint (prime, inversion, retrograde, retrograde inversion). In the twelve-tone technique, the twelve tones of the chromatic scale (the twelve half tones of the octave) appear in a particular, unchanging succession throughout the entire piece. In this constructed succession, none of the twelve tones can be repeated before all of the others have had their turn. All twelve tones have the same rights; there is no longer a central keynote. Each one of the twelve chromatic-scale tones can be used as a point of departure for both the basic series and every other form of the series. The four producing types or forms of the series are the base form, inversion (mirroring), retrograde (backward movement) and retrograde inversion. There are four series of twelve tones each. Each series of notes thus has forty-eight possible forms, whereby as many different connections as possible should be created through correspondences within the series, such as symmetries (mostly of a numerical nature), analogies, arranging them into cells, etc. We can see that classic canonic forms such as retrograde canon and mirror canon are also resurrected in the series. The term "serial" came from the description of the *Composition with Twelve Notes Related Only to One Another*. Yet it was in Webern's work that the series first took on the aspect of a function of intervals — a hierarchical function that creates permutations and proclaims itself in an arrangement of intervals. So it was thanks to Webern's decisive steps that new music began.

In contrast to Schönberg, whom one can accuse of thematic composition and romanticism, Webern recognized the inner nature of the serial technique. For him, the row is a prototype, a nucleus, from which everything else follows:

No, the twelve-tone series is not a theme in general. However, by dint of the unity now guaranteed by other means, I can also work without a theme — and thus more freely. The series provides the context.

Webern's series technique set the tone for serial and aleatoric composing. Following Webern, the series principle was extended to all characteristics of the phenomenon of sound: numerical relationships between intervals of pitch, length, volume, and tone. Serial thinking was applied to the structure of the entire piece. The law of the series governing the sequence of notes and pitches was applied to the proportional sequences of length of notes, volume, tone, etc. This led to the most important motto for the 1950s musical avant-garde: 'equal opportunities for all parameters,' which meant the 'equality of all twelve tones.' The attentive reader will probably already be aware, perhaps through the choice of words (proportion, interval, numbers, etc.), that in this discussion I am basically referring to the sources for the first structural films. Minor changes in vocabulary will make a cinematographic analysis out of this musical one. Apart from the evidence of the persons involved (Kubelka, Tony Conrad, Michael Snow, etc. are also musicians) this analysis shows that early structural films arose from musical inspiration, unlike the later structural films whose sources were based in problems

1. Hauer described himself as the "spiritual father of twelve-tone music" and published the first piece on twelve-tone music in 1920.
2. Anton Webern, *Der Weg zur Neuen Musik* (Vienna, 1960) p. 31.

Peter Kubelka, Ferry Radax
Mosaik im Vertrauen (Mosaic in Confidence), 1954-55

of visual perception. This dependence of formal film on music as a highly developed, formal (non-representative) art is already evident in the works of its greatest early master, Viking Eggeling. The fact that music was a source can be seen not just in film titles such as *Horizontal-Vertical Mass*, *Horizontal-Vertical Orchestra*, and *Diagonal Symphony*, but also in the various theoretical terms for his *Presentation of Motion Art* (such as *General Bass of Painting*), as well as in the technique he used to compose.

The founder of the Viennese School of Formal Films, Peter Kubelka, has been deeply influenced by Webern. Webern's style coined the following epithets: the courage to be ascetic, tone ascetics, serial mirror architect, musical aphorist, concise style, musical shorthand, abstraction, form molecules, permutation processes, pointillist style, and obsession with formal purity to the point of silence, etc. Webern's intention to articulate the form against a backdrop of simple principles led him to many different kinds of reductions, not only as in *Opus 24 (Concert for New Instruments)*, where the series does not consist of twelve, but four times three tones instead, and the relation between the three tones in all four cells (three groups of tones) is the same. In limiting himself to a small number of interval relations, he was expressing his preference for exploring the musical microcosm, the small form. Webern developed compositions whose brevity and concentrated dynamics led to the borders of perceptive possibilities, especially in concert halls. He was therefore accused of "cutting ties with the listener." His shortest works are *Sechs Bagatellen für Streichquartett* (Six Bagatelles for String Orchestra), *Opus 9*, *Fünf Stücke für Orchester* (Five Pieces for Orchestra), *Opus 10*, *Drei kleine Stücke für Violoncello und Klavier* (Three Small Pieces for Cello and Piano), and *Opus 11*, all limited to a total of ten bars. In its entirety, *Opus 9* (1913) is less than four minutes long.

The end of the Webern's style of compression was the reduction of music to the single note and interval. This gave rise to the "pointillist style" — composition with points (see also counterpoint) — between 1950 and 1955. This tendency towards brevity, to contraction, this way of thinking in single notes and intervals, led to a final reduction: the emancipation of the pause — an enormous renewal in the area of rhythm, "a concept which binds the note to the pause by means of exact organization. Music is not just the art of notes, but rather more of a counterpoint made up of sound and silence!" (Boulez). Webern's technique of omission led to an attitude toward the pause that had been previously unimaginable in musical history. Accordingly, the pause had a unique optical appearance in the notation system. For Webern, the pause was, for the first time, the "component of a rhythmic structure and a dynamic value at the same time" (H. K. Metzger, *Series 2/49*), because the pause and the note share a common feature: duration. Ever since Webern developed his art of note and pause, music is not only the art of sound, but also the art of silence. How important silence/emptiness have been since then, and how they led to a more open attitude toward "non-musical tones" is testified to both by the title of John Cage's first book, *Silence*, as well as his musical praxis: "He needed to attach himself to the emptiness, to the silence. Then things — sounds, that is — would come into being of themselves" (Cage). A reference to Wittgenstein's understanding of music is interesting in this context. In his *Bemerkungen über die Grundlagen der Mathematik* (Remarks on the Foundations of Mathematics), he gave special emphasis to the structural aspects of music (especially Viennese classical music) and worked out a concept of "structural hearing." This was supported by Webern, and later, Theodor W. Adorno, as well as Berg, who spoke of the "discernment" of a connection, although Webern had already insisted that it "need not be perceived." We see, therefore, that the concept of structure played a role in music decades earlier than it did in avant-garde film. This rather lengthy musical outline is justified, not simply because it is a theoretical introduction to formal film, but also because it supports my thesis that Austrian art also contains strong constructive/formal tendencies, revived in post-war Vienna — and not just the Expressionist tradition of Klimt, Schiele, Gerstl, and Kokoschka.

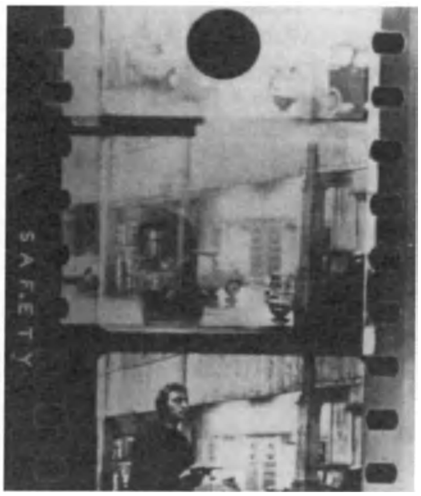
The poetry of the Vienna Group, for example, shows extreme formal tendencies. Gerhard Rühm (born in 1930), who first became active in 1954, primarily in literature, was especially influenced by Webern, and not only musically. His *Ein-Wort-Tafeln* (One-Word Panels), and his *punktuelle dichtungen* (pointillist poems), as well as 1952's *Ein-Ton-Musik* (One-Note Music) are generated from Webern's discovery of the single tone. Jazz musician Oswald Wiener was influenced by Ernst Mach, Fritz Mauthner, and the Vienna Circle, among others. International formal influences came from Dada, literary Expressionism, and Constructivism. Thus, after 1954, there were constellations, formula poems, concrete poetry, written films (Rühm, in draft only), number poems, montages, drafts for a functional language by Rühm and Wiener, and drafts for plays with a basic serial organization. Formalism also intensified in the mechanical production of poems (already laid out in montages) such as in methodological inventionism, a mechanical procedure that was supposed to make it possible for anyone to write a poem. Artist and filmmaker Marc Adrian was also involved in this. A high point of these formal tendencies was reached with the text *Der Vogel singt. Eine Dichtungsmaschine in 571 Bestandteilen* (The Bird Sings. A Poetry Machine in 571 Parts) by Konrad Bayer (based on a draft from O.

Wiener), whose skeletal prose also reveals a search for a reductionist form. In 1958 and 1959, both of the *Literary Cabarets* gave presentations, which were comparable to the later Fluxus actions and Happenings.

By the mid-to-late 1950s, a complex cultural climate (clearly not an official one) had already emerged in which new, formal paths were taken. Naturally, they occasionally mixed with contemporary trends such as existentialism, neo-verism, etc. The genesis of Viennese formal film can be observed within this cultural climate. The preoccupation with time — as a derivation from those Viennese definitions of music as a way to structure time — was already evident in the first films by the earliest representative of Viennese formal film, Herbert Vesely, before he emigrated to Germany and (cum grano salis) took to making films for television in 1955. *An diesen Abenden* (These Evenings, 1952) based on a poem from Trakl, is definitely Expressionist; however, the picture composition, editing, and sound are already very formal in style. *Nicht mehr fliehen* (No More Running, 1955, 35 mins.), with music by Gerhard Rühm, is an amazing documentary of time — literally, due to its treatment of time — and thereby of the narrative form, too. "The mosaic of images and sounds tore open the structure of the plot and created a network of circumstances and feelings — an ambivalent construction" (E. Schmidt Jr.). This construction is similar to the structure that dominates the film *Mosaik im Vertrauen* (Mosaic in Confidence, 1955), by Peter Kubelka and Ferry Radax. Veseley also employed this independently developed formalism in the movie he had begun planning in 1959, *Das Brot der frühen Jahre* (The Bread of the Early Years, 1962), based on a Heinrich Böll story.

Formal time structures are likewise a noticeable feature of early experimental works by Ferry Radax, who attended film schools in Vienna and Rome from 1953 to 1956. Radax was a cameraman for Vesely's *An diesen Abenden* in 1952, and he and Peter Kubelka filmed *Mosaik im Vertrauen* from 1954 to 1955. His 1954 film, *Das Floß* (The Raft) remained a fragment. The first part of the title, *Mosaic*, explicitly refers to the structure of the film, which is a network of relationships among documentary material (such as recordings of news shows), scenes enacted by amateurs, which were influenced by the then current neo-verism; and autonomous optical and acoustic elements. The sound: scraps of dialect, sounds from magnetophones, pistons, radio, etc. Sound and picture came together to form a new unit through montage, whose technique determined the entire structure of the film: rather than chronology, simultaneity came into play. By and large, films by Russian formalists Eisenstein and Vertov retained a narrative form, which was simply but forcefully interspersed with moments of montage; yet in this case, the entire film was constructed with montage. Montage no longer served merely to articulate meaning in a sequentially limited way, as in the expressive concept, but rather it was applied to the entire film: all parts of the film are connected. Vertov's sound-image montage was especially decisive in this process of expansion. Two courses became evident. The first was to transmit the overall structure of the montage to small working organisms, so that every tiny bit (the individual frame) follows a formal law, which would paradoxically lead to the total loss of the narrative (curiously enough, like the process of permutation, which contributed both to the discovery of the twelve-tone serial technique and its later dissolution). The alternate would be to allow the montage itself to become the narrative form. Kubelka followed the first path, Radax (and Vesely) the second. In Kubelka's work, the montage is transformed into serial

**Herbert Vesely, *Nicht mehr fliehen (No More Running)*, 1955
b/w, sound, 35 min.**



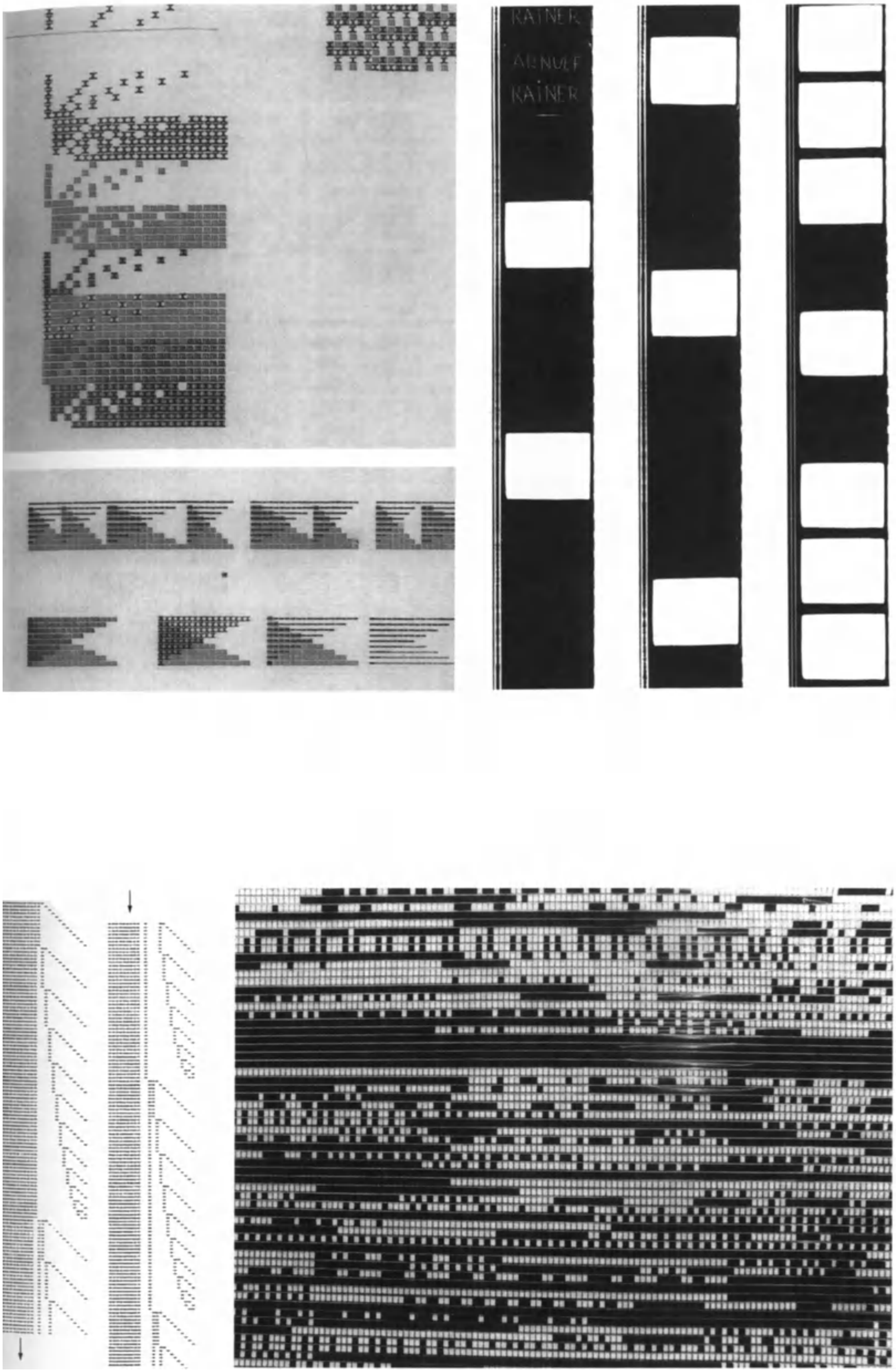
**Ferry Radax, *Sonne Halt! (Stop, Sun!)*, 1959-62
b/w, sound, 40, 35 oder 25 min. (three versions)**

technique. Radax followed and refined the narrative montage in his next film, *Sonne halt!* (Stop, Sun!, 1959-1962, 35 mm, 26 mins.), which featured Konrad Bayer, a member of the Vienna Group, as writer and actor. Bayer, by the way, had also collaborated already on *Mosaik im Vertrauen*. This formally rich and complexly organized avant-garde film expanded the very subtle counterpoint montage of image and sound with film techniques such as positive and negative images, time-lapse motion camera, short cuts, spatial and temporal breaks, etc. The fact that Kubelka turned away from narrative montage after *Mosaik* (1954-55) and followed the path already laid out in *Mosaik*, where the form of time was totally formalized by semi-narration, was based on Kubelka's strong grounding in music, especially the twelve-tone music of the Vienna School. In the reductive climate sketched out at the beginning of this article, and under the influence of the Webern discussion, Kubelka — to put it in brief, formal, technical terms (thus making it only partially valid) — transmitted and adapted twelve-tone techniques for film. This constellation was apparently more viable and typical in Vienna than in Paris or Hamburg. I can see two traditions that serve as both foundation and background for Kubelka's three purely formal films (*Adebar, Schwechater, Arnulf Rainer*): the Vienna School of Music and the films of Eggeling, Vertov, and Dreyer. Vertov was the strictest Russian formalist; he had already postulated a cinematic language, frame for frame: "Cinematic language is the art of writing with the film frame." He "mounted the film as a whole," and (diametrically opposed to Eisenstein) likewise took the path away from scenarios on his search for the cinogram. Straightforwardly, Kubelka adopted several of Vertov's statements such as "material — artistic elements of motion — are the intervals (the bridge from one movement to another), but not the movement itself." This interval theory in film is a natural counterpart to an interval theory in music. Kubelka also took on Vertov's quaternion, made up of image and sound relations, as a way to articulate meaning in film. In the search for valid compositional principles of a syntactic, formal nature for film, Kubelka proceeded analogous to music, especially to Webern's. Time in film, like that in music, was considered denumerable; the sounds, as a point in time, became a frame. Just as Webern had reduced music to the single tone and the interval, Kubelka reduced film to the single frame and the interval between two frames. Just as the law of the series and its four forms determined the succession of tones, pitch, etc., the succession and number of frames, positive and negative, colors, emotional value, movement, stillness, etc. determined the film. As in serial music, filmmakers produced as many relationships as possible (mostly numeric) between these factors. Kubelka therefore called these films "metric films." The metrification of the means of art, already laid out in Mosaik, now became a metrification of the individual frame. He moved, so to speak (like Webern), from thematic to serial organization, and, also like Webern, he regarded the series of frames as a function of intervals. From these considerations arose Vienna's first pure photo-film, *Adebar* (1957).

Amazingly enough, in 1960, Rainer was not the ultimate high point of this particular development; Kurt Kren's *48 Köpfe aus dem Szondi-Test* (48 Heads from the Szondi-Test) introduced a new development, which at first glance might be considered a repeat of the first. Kren was familiar with Kubelka's films. He had, however, already completed his first film, *Versuch mit synthetischem Ton* (Experiment with Synthetic Sound), in 1957. However, a significant change of direction — from a musical structure to a perceptive one — cannot be overlooked. The title of Kren's second film, made in 1960, referred to a psychological perception test invented by Hungarian Lipót Szondi in 1947. An abstract graphic solution for the formal act of creation (as, for instance, in the abstract play of light at the close of Rainer) is rejected here. The succession of photographs (still frames) was not meant to analyze movement or synthetically simulate it, but rather to point out the process of perception itself and its accompanying psychic mechanisms, and thus offer a subject-intended (rather than the earlier object-intended) approach.

B. Hein, W. Herzogenrath, eds., *Film als Film: 1910 bis heute* (Cologne, 1977) pp. 174-179, pp. 216-218.

Kurt Kren, *2/60 48 Köpfe aus dem Szondi-Test (48 Heads from the Szondi-Test)*, 1960 b/w, 4 min.
© VBK, Vienna, 2005



Peter Kubelka
born 1934 in Vienna. Since 1964 co-director of the Vienna Film Museum. In 1970 founder of Anthology Film Archive (J. Mekas etc.) New York. From 1980 professor of film art at the Staedel-School in Frankfurt/Main. He lives in Europe and the U.S.A.

1987 Austrian Film Museum, Vienna
Kulturzentrum bei den Minoriten, Graz
1988 Secession, Vienna
1989 Fotohof Gallery, Salzburg
1995 Kunst.Halle.Krems
1996 1822-Forum, Frankfurt
2002 Nederlands Fotomuseum, Rotterdam
2003 *Viennale*, International Film Festival, Vienna
2004 *International Festival of New Film and New Media*, Split

Films
1955 *Mosaik im Vertrauen*, 35 mm, b/w and color, sound, 16 min.
1957 *Adebar*, 35 mm, b/w, sound, 69 min. 1/3 sec.
1958 *Schwechater*, 35 mm, color, sound, 1 min.
1960 *Arnulf Rainer*, 35 mm, b/w, consisting of 4 elements: light and non-light, sound and silence, 6 min. 24 sec.
1966 *Unsere Afrikareise*, 16 mm, color, sound, 12 min. 30 sec.
1977 *Pause!*, 16 mm, color, sound, 12 min. 30 sec.
Denkmal für die alte Welt (work in progress)

References:
Gabriele Jutz, Peter Tscherkassy, *Peter Kubelka – Eine Monographie* (Vienna: 1995).
Alexander Horwath, Lisl Ponger, Gottfried Schlemmer, *Avantgardefilm Österreich. 1950 bis heute* (Vienna: 1995).

Peter Kubelka, *Arnulf Rainer*, 1958-60
35 mm, b/w, consisting of four elements: light and not-light, sound and silence, 24 × 24 × 16 frames

1

Kurt Kren

Opseography Instead of Cinematography

Kurt Kren
born 1929 in Vienna. Co-founder of Austrian Filmmakers Coop, 1968. Died 1998 in Vienna.

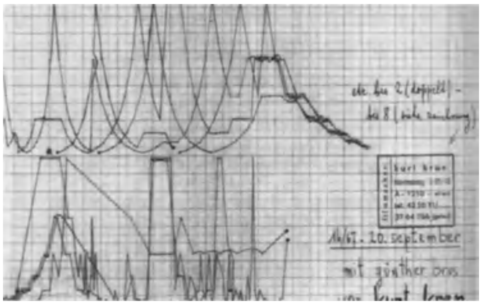
Film Screenings
1961 Galerie nächst St. Stephan, Vienna
1971 Cannes Film Festival
1976 National Film Theater, London
1979 Museum of Modern Art, New York
1988 The Collective Films of Kurt Kren, Stadtkino, Vienna
1992 *festival voor experimentele kunst*, Utrecht
1994 *personal-film-show-tour*, USA
1996 Secession, Vienna

Group shows
1970 *International Underground Film Festival*, National Film Theater, London
1974 *Projekt '74*, Cologne
1977 *documenta VI*, Kassel
film als film, Kunstverein, Cologne
1978 *Logical Art/Logische Kunst*, Secession, Vienna
1980 *Film as Film*, Hayward Gallery, London
1990 *Auf der Suche Nach Eden. Wien 1950-90*, Museum for Art and History, Freiburg
1992 steirischer herbst, Graz
Identität: Differenz, Neue Galerie, Graz
1993 *Miteinander Zueinander Gegeneinander*, Rupertinum, Salzburg
Erotische Photographien, Galerie Hummel, Vienna

References:
Hans Scheugl, *Ex Underground. Kurt Kren. Seine Filme* (Vienna, 1996).
Kurt Kren. Tausendjahrekino (Vienna: Vereinigung bildender Künstler, Secession, 1996).
Kurt Kren. Film Foto Wiener Aktionismus (Vienna: Galerie Julius Hummel, 1998).

The laws of perception and the physiology of sight, such as afterimage, stroboscopic effect, and phi phenomena (all findings from experimental perception psychology), as well as corresponding technical methods such as multiple exposure, positive and negative copy, looping, et cetera, build the groundwork for the experimental films of Kurt Kren. Kren uses film materials and the cinematographic apparatus to experiment with perception and the mental processes that accompany and enable perception. This gives Kren a place in a tradition that began in 1900 with Ernst Mach and has continued to the present. In the 1950s and 1960s, there were advanced approaches and theories of optical art in Vienna advocated by people such as media artist Marc Adrian, writer Oswald Wiener, and artists Helga Philipp and Alfons Schilling. The formal visual language of Kren's film experiments therefore resulted from two directions: one, his experiments with processes of perception (faster cuts, fast viewing, single frame series, and series of frames) and two, his experiments with film material (black frame, trailer, mass technique, positive/negative copy, et cetera).

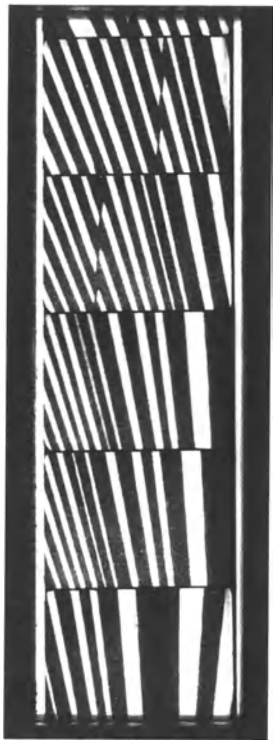
Kurt Kren, ***2/60 48 Köpfe aus dem Szondi-Test (48 Heads from the Szondi-Test), 1960***
frame plan
© VBK, Vienna, 2005



Kurt Kren, ***16/67 20. September*, 1960**
frame plan
© VBK, Vienna, 2005

Kren is not searching for the identity of image and movement, the language of motion, cinematography, or the surrogates of life. He interrupts motion, brings it to a stop; he cuts up the image, the gaze; he rips apart space and time and the way we naturally perceive them. The sliced up gaze not only slices up the flow of images, but also everything it perceives: the world, and the body through which the world is experienced. The sliced up glance, the sliced up body, and sliced up time form a logical chain. Kren's work makes reference to Vertov's thesis that the materiality of film is the actual medium, and to another thesis: that the intervals between the frames are the actual center of the film's configuration. In his films, Kren does not create moving images, but rather images of time. The perception of time can be experienced. He borrows the single frame from Vertov's language of film, not for the sake of movement, but in order to guide processes of perception. He borrows Marey's graphic method: the graphic score for dissecting time and movement in the frame, the graphic design and production methods for guiding the processes of perception. Kren's art is thus the language of seeing, the opseography; the study of the glance, of visual processes; the optical study of the processes of perception. In his films, therefore, we do not experience real space and natural time, but instead the time and space of cinematic media. This corresponds to Kren's preference for (re)filming media reality. Many of Kren's films are recordings or appropriations of already existing photographs, posters, et cetera. His films refer again and again to media reality, a secondary reality. He is not satisfied with merely showing us that film is the art of illusory movement; rather, he presents it to us as the art of illusory perception. Out of the four fundamental factors of pure cinema — movement, material, light, and perception — Kren has built an artistic universe, where he experiments in particular with the perception of motion, images and with the observation of images in motion and their material substratum.

Peter Weibel



Kurt Kren, *11/65 Bild Helga Philipp,* 16 mm, 27 m, 2 min. 29 sec., b/w, silent
© VBK, Vienna, 2005

The print of the Op Art image by Helga Philipp serves as blueprint for the film. Kren filmed the image, or parts of it, in individual image shots and without a system. On the screen, the black components appear to move, that is, the Op Art effect is carried out.

Kurt Kren, *31/75 Asyl (Asylum),* 16 mm, 92 m, 8 min. 26 sec., silent
© VBK, Vienna, 2005

Scheugl: *Asyl* was made with very complicated techniques. How did it come about?

Kren: I don't know. It was the first time I had ever lived in the country, and maybe I was a little unhappy about living there. I was always a city person. Maybe I went a little crazy there. Maybe I also saw the disunity of the whole. What I did technically: the film was shot in twenty-one days. Every day, it was processed through the camera once. There was a black mask in front of the camera with holes in it, which allowed the light to come through and light the film. The holes changed each day. All of the holes together would uncover the entire image over the course of the twenty-one days. In some sections, it's raining; in others, the sun is shining, or it's snowing. That was in the Saarland, in Germany, near the French border.

Scheugl: Contrary to your original description of yourself as not liking the country, the film's effect is quite beautiful, as if you had finally found asylum there.

Kren: The one thing is true, and the other is, too.

Scheugl: The changes in time and season that often play a role in your films — you were very closely exposed to them while you were there.

Kren: Yes, that's the schizophrenic element in it. I've always loved seasons, especially when they are changing — in spring and autumn.

Hans Scheugl, ed., *Ex Underground. Kurt Kren und seine Filme* (Vienna: PVS Publishing, 1996) p. 171, pp. 100f.

1

Marc Adrian

Film Block 0

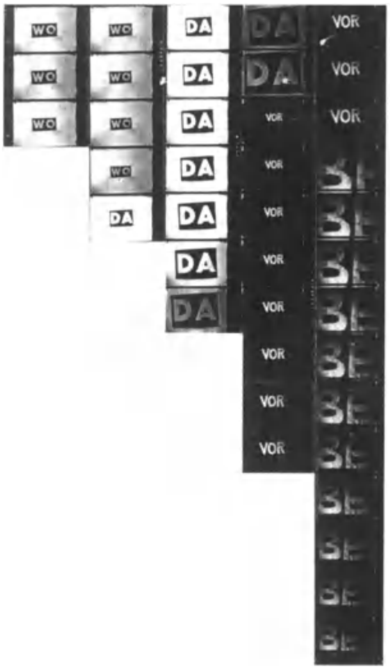
1957-1959
16 mm, b/w and color, silent,
13 min.

Black Movie, version 2
color, 198 sec.
Idea, montage: Marc Adrian
Camera: Kurt Kren
Editing: Marc Adrian, Kurt Kren

1. Mai 1958 (May 1, 1958)
b/w, 165 sec.
Camera: Kurt Kren
Director and editor: Marc Adrian

Wo-da-vor-bei
(Where.Here-Before-By)
b/w, 70 sec.
Camera: Kurt Kren

Schriftfilm (Script Film)
b/w, 328 sec.
(Concept: 1954)



Marc Adrian, *Wo-da-vor-bei*
© VBK, Vienna, 2005

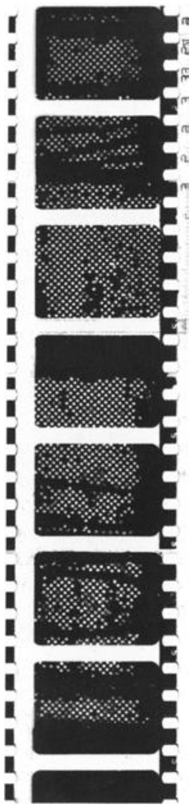
Marc Adrian, *Black Movie*
© VBK, Vienna, 2005

Film Block 1

1962-64, sound, total 17 min.
Random, 1963, 285 sec.
Text I, 1963, 154 sec.
Go, 1964, 148 sec.
Text II, 1964, 220 sec.
Orange, 1962-64, 180 sec.

Film Block 1 contains all of the films that I completed between 1962 and 1964. As in most of my works, my operational modus was methodical invention, i.e., the works are placed on a pre-drawn blueprint. In this way, all personal and aesthetic touches are rendered impossible in the final product, and total loss of control is assured. I reject every kind of teaching and entertainment in the content, as well as everything that I could possibly tell an imaginary audience: every form of significance or personal mythology must be produced by the viewer, since only total chaos can ensure the freedom of the individual. In *Random* (the first film made with the help of a computer), an actual, mathematically defined random program was developed, since no author is capable of producing a random event, not even if he does so unconsciously. *Text I* and *Text II* are also made using randomly generated mathematical series: *Text II* is a pure permutation. *Text I* was developed from a computer data storage program. Words were selected according to the requirement that they both have the same meaning and spelling in German and English. *Go* is also a permutation film. Here, it is especially apparent how pure formal structures can lead the observer's conscious mind to create meaning. *Orange* is a randomly generated montage of verbal and visual associations, which may conjure up the image and concept of an orange.

Marc Adrian in a radio interview, San Francisco 1970.



Marc Adrian
Random, 1963
© VBK, Vienna, 2005

Marc Adrian
Text I, 1963
© VBK, Vienna, 2005

Peter Weibel

Expanded Cinema: Material Films, Film Actions (without Film), Project and Concept Films

More intensely than their European colleagues, Austrian filmmakers have been involved with the expansion of film (all types of performances, with and without film). The expansion of the art of filmmaking began with a material concept: the transformation of film as illusion to film as material. The materiality of celluloid — scratches, blank and color film, overexposed material, spoilage and leftovers, edits, glued and printed celluloid (such as Peter Weibel's *Fingerprint* [1968], where fingerprints were applied directly onto glass film) — became the starting point for creating films. During a performance in January 1967, Weibel read the following statement:

In the studio Praml, 1967
l. to r.: Ferry Radax, Hans Scheugl, Peter Weibel, Kurt Kren, Peter Kubelka, Ernst Schmidt Jr.

> *The site of the film is not the screen or the cinema, but the emulsion on celluloid, and the filmmaker. Material thinking and subjectivism are the parameters of Viennese films. They do not force viewers in front of a flat reality some imagine they have represented on a flat screen. We do not polish the dusty notion of reality. Whatever is on the celluloid will be screened. This can be a stroke directly applied by the subject, the image of a person caused by illumination; this chemical corrosion on celluloid.*

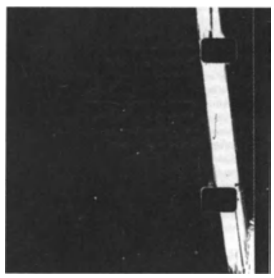
Ernst Schmidt Jr. is the master of material films (e.g., *Filmreste* [Leftover Film], 1966/67). Along with Kurt Kren and Hans Scheugl, he has done the most to extensively develop the aesthetics of material film. Expanded cinema began when Weibel took a further step and applied the principle of materiality of film to all of film technology, such as the projection process (changes in speed and light, switching on and off, moving the projector, etc.), the screen, the cinema, etc. Everything was declared part of the material of film. This led to reflection on the fundamentals of film as a medium. These experiments with the medium of film, its laws and premises, even led to a third step, a "film without film," meaning, film without celluloid. Everything could become a film. Films no longer had to be filmed. Weibel produced the first expanded movie in Austria at an event planned in conjunction with Kren, Ernst Schmidt, and Scheugl in January 1967, known as *Nivea*. For one minute, Weibel stood immobile in front of the screen, as if in a still frame, holding a Nivea ball, while blank frames were projected onto the screen. The sounds of a camera on tape could be heard. An accompanying manifesto stated:

> *if the site of the film is not the screen, houses can be projected back onto houses and bodies onto bodies. if the image and the object are the same, representation and celluloid become superfluous. houses are presented as "houses" and nivea as "nivea." once the celluloid is dispensed with, film is created without film. technological means of reproduction are replaced by directness, and that invalidates the objective character of film. it is not the state's "reality" that is reproduced, but rather, the subject and his or her direct experience prevail. (Weibel, 1967)*

This formal deconstruction of film elements, where elements could be exchanged or replaced with others (e.g., electric light with fire) or left out (e.g., celluloid) was artistically liberating and opened up a myriad of new possibilities. The identity of image and object as the identity of the site or the projection surface is a recurrent theme. During the 1967 performance, Weibel also projected an 8 mm-film onto his body ("the film is created by the filmmaker and projected back onto him," *Body Film Nr. 1*, Weibel 1967). The human body is turned into a projection screen. Subsequently, films were produced to suit this specific projection site, such as the film of a surgical operation projected onto a naked stomach, or clouds onto a hairy chest. In 1968, Scheugl made *Sugar Daddies*, for which he filmed graffiti in public toilets and then showed the film in other public toilets. In 1968, Ernst Schmidt Jr. projected a moving curtain onto the real, also moving curtain of the screen. The projectionist was asked to synchronize the movements as much as possible. This film was called *Ja/Nein* (Yes/No). Another type of identity had begun to play a role for Scheugl in 1967: the identity of the length of a piece of film and the length of a street. Wien 17, Schumanngasse is a car ride down a street, Schumanngasse, from beginning to end. The drive down the street was filmed in a single take, in approximately two minutes. The duration of the film and the drive, the length of the street and the film, real and reproduced time, the speed of the camera and the speed of the car in which the camera was transported were all identical: space became time. In 1968, Scheugl also made a film without film by substituting a strong piece of thread for the celluloid: *ZZZ Hamburg Special*. A spool of thread was placed on the winding axis of the projector, and the thread was threaded through the projector.

Hans Scheugel, *ZZZ Hamburg Special*, 1968

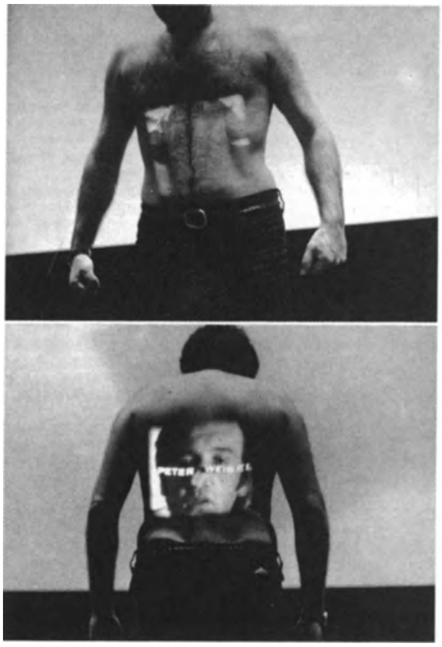
Schmidt, Jr. worked directly on celluloid before he dispensed with it altogether. In *Weiß* (White, 1968), real holes were punched into blank white film. Because of the afterimage effects, traces of the scratches could



Ernst Schmidt Jr., *Prost* (*Cheers*), 1968 even be seen in the holes. In *Prost* (Cheers, 1968), a line was drawn through a strip of film until it hit the margin (cheers!), then back again, and so on. The moving line casts light and shadows in the projection room. In Valie Export's expanded movies, the formal characteristics of film determine its relationship to reality: reality is seen as the results produced by mechanisms of representation. In *Cutting* (1968), the element, movie screen, is replaced by paper, cloth, and skin screens. Houses are projected onto a paper screen and the windows are cut out with scissors. McLuhan's sentence, "the content of the writing is the," is also cut out onscreen, and the last word, "speech," is then spoken next to the screen. In the third part, a chewing gum bubble is cut out of an undershirt. Another part is the shaving of chest, stomach, and pubic hair. Naked skin becomes a screen; hair functions as a body signal. The fifth part is a talking movie without signs: Export takes Weibel's phallus into her mouth — "this demonstrates body language as a type of non-verbal articulation" (Weibel, 1970).

1968's *Tapp- und Tastfilm* (Fumble and Feel Film) is also about the body as a screen. A central topic of the movie industry, the woman as a sex object, is considered through the means of film. The dominating character of the screen as a manipulative medium is also expressed in the 1968 film performance, *Ping Pong*. A dot appears on the screen for a brief moment. It seems to be hopping because it always appears at a different, unexpected place. The actor tries to hit the dot with a racket and a Ping-Pong ball. A dialogue between image and object, film and reality, made with the means of film. An action film — a film for action.

A joint performance with Weibel and Export, *Aus der Mappe der Hundigkeit* (From the Portfolio of Dogdom, 1968), is a response to a public news poster, *Aus der Mappe der Menschlichkeit* (From the Portfolio of Humanity). Export led Weibel by a leash around his neck along Vienna's main street. Walking on all fours, Weibel turned another feature typical in film (especially cartoons) into reality — the graphic transformation of humans into animals. "the apparently symbolic reality of film is transferred into the blazing reality of all our senses. this film performance creates reality, re-creates it out of the patchwork of ideologies" (Weibel 1970).



Peter Weibel, *Welcome-Action Lecture Nr. 1*, 1967

Valie Export and Peter Weibel during the *Tapp- und Tast-Film (Fumble and Feel Film)*, Munich 1968
© VBK, Vienna, 2005

During the years 1967 to 1970, filmmakers analyzed the relationship between reality and recording apparatus. As the quotes have already made clear, the medium for expression and representation definitively entered into the discourse on reality and experience, and opinion was that only an expansion of film as a medium allows for an expansion of reality and sensation. The aim of the work in film was "to liberate people from socialization" (Weibel 1970), "for art expands the borders of social reality" (Weibel 1969). If "grammar is what first allows sensations to arise," as Oswald Wiener writes in his critique of "Actionism," then grammar has to be explored in order to explore sensations. If reality is on our side of language, language has to be analyzed if reality is to change. If "form constrains experience," one has to escape from it. But if "experience itself is of a formal nature, then experience itself is the constraint — and forms have to be shattered in order for the experience to stop" (Wiener 1969). By smashing the forms of film, and through the search for and discovery of film's linguistic character, these filmmakers tried to liberate experience and dissolve the boundaries of reality. Unlike the Actionists, who wanted to bridge the gap between reality and sensation, they were aware that between reality and consciousness, reality and experience, there is always a registering apparatus — be it the eye, form, language, or the camera. Those artists, in doing away with constraints on experience and limits of reality, did not assume a dualism, but a triad instead: reality-medium-image of reality (consciousness, sensation, experience). During his film performance *Exit* (1968), in which fireworks, rockets, smoke, and flying objects whizzed into the audience from the screen where films were shown, sending the audience fleeing onto the streets (smoking out and fogging in the cinema), Weibel shouted through a megaphone into the movie theater:

> *fire is light, cinematography is light, cry the reactionaries, and they shall get it — the motion picture! film is misunderstood as a language of images. the image of the world that provides language reflects the state and its image of the world. the film industry is the state organization that provides those images of the world that correspond with the state's image. in rejecting the language of images, film no longer presents the state's image of the world, but changes the world...*

The longing for a changed reality smashed the images, abolished the reproduced images. Weibel was the most radical in formalizing film, by defining film as a calculation of variables, where screen, soundtrack, celluloid, speed of recording, etc. are variable elements that can be exchanged, linked in different ways, altered, replaced, and left out. This evolution of a different notion of medium and reality can best be grasped in a sequence of quotes by Weibel:

> *whether it is a negative or positive copy is a question of the emulsion and not of the real truth value (the correspondence of object and reproduction). the filmmaker works with celluloid strips, not with realities. sound and image are blank spaces (variables) occupied by the filmmaker according to his intentions. he can work directly on celluloid or with the help of the camera. the concept of reality does not exist for the filmmaker (1967). film is an aggregate of calculations and operators used to encounter reality — a system of basic configurations and rules. this aggregate is a convention that can be changed at any time. filming is the production of reality with the means of the aggregate film. from the available elements of the calculated film, e.g., celluloid, cinema, screen, position of the camera, etc., I can take an arbitrary number, in an arbitrary order, and put them to arbitrary use. one can use a mirror instead of celluloid, a string instead of a ray of light, chemical reactions instead of photo reactions, and so on (1968). film is to be understood as a function with the following variables: object, celluloid, camera, projector, screen, and so on, that is f(o, c, ca, p, s, x). expanded cinema also means expanded reality. altered media produce an altered world. expanded cinema is an exploration of reality by experimenting with light, sound, electricity, group mechanisms, gamma-rays, and reactions of enzymes (1969). film, photography, and the phonograph are extensions, elongations, expansions, of our spatial and temporal structures, structures of experience, communication, expansions of our reality and consciousness (1971).*

These metafilms (films about films), film performances, action films, material films, project films, and film installations should develop "images of a different reality or a reality different from the one in the picture represented by the state" (Weibel 1970). As the form of film expanded, the future of media art was born.

"Kunstexpansionen: Grenzkunst," *Österreich zum Beispiel*, Otto Breicha and Reinhard Urbach, eds. (Salzburg: Residenz, 1982) pp. 36-65.

1

Martin Arnold

pièce touchée

Martin Arnold
born 1959 in Vienna. Studied Psychology and Art History. Independent filmmaker, from 1988. Concept and organization of the 1990 symposium *Im Off der Geschichte*, Stadtkino, Vienna, together with G. Schlemmer and P. Tscherkassky. Numerous lectures in Europe and the U.S.A., including Cinematique, Paris, Hamilton College, Utica College, and Colgate University in New York, and University of Illinois in Chicago. Guest lectures at the University of Wisconsin, 1995. Visiting Professor at the University of Wisconsin in Milwaukee, 1996/97. Guest professor at the Academy of Fine Arts in Frankfurt, 1998/99. Professor at the University for Artistic and Industrial Design in Linz, 2000. Member of Austria Filmakers Coop, SYNEMA – society for film and media (1990) and founding member of Sixpack Film (1991).

Films
1985 *O.T.-1* (16mm, color, silent, 10 min.)
1986 *O.T.-2* (16 mm, color, silent, 10 min.)
1988/89 *O.T.-3* (unfinished)
1989 *pièce touchée* (16 mm, b/w, sound, 16 min.)
1993 *passage à l'acte* (16 mm, b/w, sound, 12 min.)
Jesus Walking on Screen (trailer, 35 mm, b/w, sound, 1 min., Camera: Johannes Hammel)
Kunstraum Remise (trailer, 35 mm, b/w, sound, 1 min.)
1994 *Brain Again* (trailer, 35 mm, color, sound, 1 min.)
In Futurum (16 mm, color, 2 min., Camera: Hammel, work in progress)
1996 *Don't – Der Österreich-film* (Commissioned for the 100 years of Cinema celebrations in Vienna; 35 mm, Filmtransfer from digital-beta-video), b/w, 3 min.)
1997 *Viennale Spot* (trailer, 35 mm, b/w, 1 min.)
1998 *Alone. Life Wastes Andy Hardy* (16 mm, b/w, 15 min.)

Martin Arnold
pièce touchée, 1984

In *pièce touchée* (16 min., 1989), Martin Arnold deconstructs one single shot of a film, Joseph M. Newman's *The Human Jungle* (1954). This shot is eighteen seconds long. In the back of a room, a man opens a door, turns off the light in the foyer, closes the door and approaches a woman sitting in an armchair in the foreground. This woman lays her newspaper aside, while the man bends over and kisses her briefly. Both smile; she gets up, the camera pans up with her and follows them with a side-angle pan shot as both actors cross and exit the room. The film's optical bank, designed by Arnold, in which each frame is reproduced from all positions (left, right, above, below), comprised two years of work and a total of 148,000 single frames. *pièce touchée* shows us a new interpretation of film space and time. It moves constantly back and forth in small and smallest blocks of frames. Opening the door and entering the room becomes an adventure for the man. Just a tiny crack at first, which repeatedly closes, then slowly broadens, finally allowing the door to open. The film appears to offer a dream-like resistance. Hardly is the man's body inside the room — the door still open — when the image is mirrored, and the door, now on the opposite side, is closed. The repeated opening and closing, opening and closing is transferred to the man, turning him into a whirling dervish, while the woman in the foreground appears to twist from her middle.

Peter Tscherkassky, *BLIMP. Zeitschrift für Film*, 16 (Spring 1991): 41-42.

It became nearly impossible to support the idea that movement studies (such as Eadweard Muybridge's photographs and zoopraxiscope demonstrations and the Lumière brothers' extended cinematographic observations of everyday or exotic situations) and movement magic (such as Georges Méliès's "trick film" and its numerous followers) existing outside of narrative development could be sufficient. Nevertheless, in all the decades since Griffith, movement studies and magic have remained essential elements of avant-garde cinema. In the case of young Austrian filmmaker Martin Arnold, "movement studies" and "movement magic" are core strategies for the deconstruction and transformation of the visual and audio conventions of Hollywood.

Scott MacDonald, *Avantgardefilm Österreich. 1950 bis heute*, eds. A. Horwath, L. Ponger, G. Schlemmer (Vienna: Wespennest, 1995) p. 285.

Four persons at the breakfast table: an American family, locked in the rhythm created by the editing table. A *passage à l'acte* develops its sharpness, its effects comparable to the non-circuitous power of heavy metal or scratching in rap music. It is Martin Arnold's first attempt to work freely with sound (in *pièce touchée*, he operated with an extremely reduced, subliminal soundtrack on a loop, which had a machine-like sound). Arnold tears apart both the black and white imagery as well as the sound of his base material. A fragment from *To Kill a Mockingbird* (Robert Mulligan, USA 1962), stripped of its conflict-laden story of racism, becomes the basis for a study of the visual and acoustic subtext of film stereotypes, an analysis of the standard family mealtime situation and familiar gestures, which have been reduced to mere poses.

Stefan Grissemann, "Metal Beat. Methoden der Verstümmelung und der Neuordnung in Martin Arnolds Film *passage à l'acte*," *BLIMP. Zeitschrift für Film*, 22/23 (Spring 1993): 10-11.

1

Gert Pfurtscheller

Planning and Imagination of Movements

The motor system is responsible for planning, executing, and controlling movements. It is made up of the central and peripheral nervous systems, which are activated, parallel, and hierarchical. A movement is initiated by a sequence of coordinated local and temporal muscle activities originating in the primary motor cortex. Simultaneously, constant feedback is given from the muscles to the brain relaying the present state of the movement. Before the muscle can be activated, however, a neuronal activation pattern must be generated to guarantee a specific movement, for which not only information about the present state of the musculoskeletal system is needed but also input on the environment. Thus it is clear that a number of neuronal systems over many areas of the cortex are needed for the planning phase of, for example, a voluntary finger movement. The most important structures are the motor cortex, premotor cortex, supplementary motor cortex, somatosensory cortex, basal ganglia, thalamus, and cerebellum.

Although the sensorimotor structures are in different anatomical locations, they all must be preactivated before each voluntary movement, transferring their status to a higher state of excitability. They must be prepared to "design" the desired movement. The readiness of different neuronal structures can be detected on the scalp through two potential changes: the *Bereitschaftspotential* (or readiness potential), a slow negative shift of the cortex, and an amplitude decrease (desynchronization) of electroencephalogram (EEG) rhythms, which are generated in the sensorimotor areas. This desynchronization begins two seconds before movement and is localized over the contralateral sensorimotor areas.

Our group (G. Pfurtscheller, C. Neuper, M. Pregenzer, G. Florian, G. Edlinger, B. Ortmayr, T. Strein) at the University of Technology in Graz, Austria showed in a number of experiments that characteristic EEG changes are found not only during planning of movement but also during the imagination of such a movement. Since these EEG changes are regionally localized and movement-specific, they can be used for an EEG-based control system where movement-specific "thoughts" are transformed into control signals via EEG changes. In the future, patients with severe motor disabilities can use these signals for control of prostheses. Further research is needed before this can be realized. However, an important step in this direction has already been made — that is, the proof that the conscious imagination of simple movement patterns leads to measurable potential changes on the human scalp.

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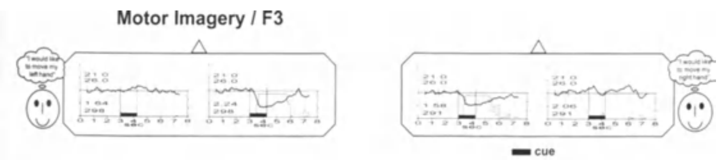
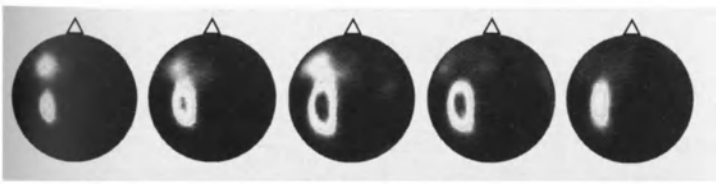
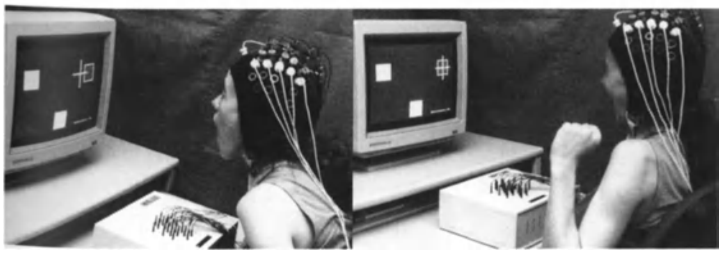


Time course and EEG power changes over the left and right hemisphere during imagination of left and right hand movement. Note the large power decrease over the controlateral side.



Sequence of ERD maps (interval 125 ms) during right motor imagery.



Experimental setup with 3 classes, where the cursor had to be moved into the indicated target.

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symmetry breaking symmetry

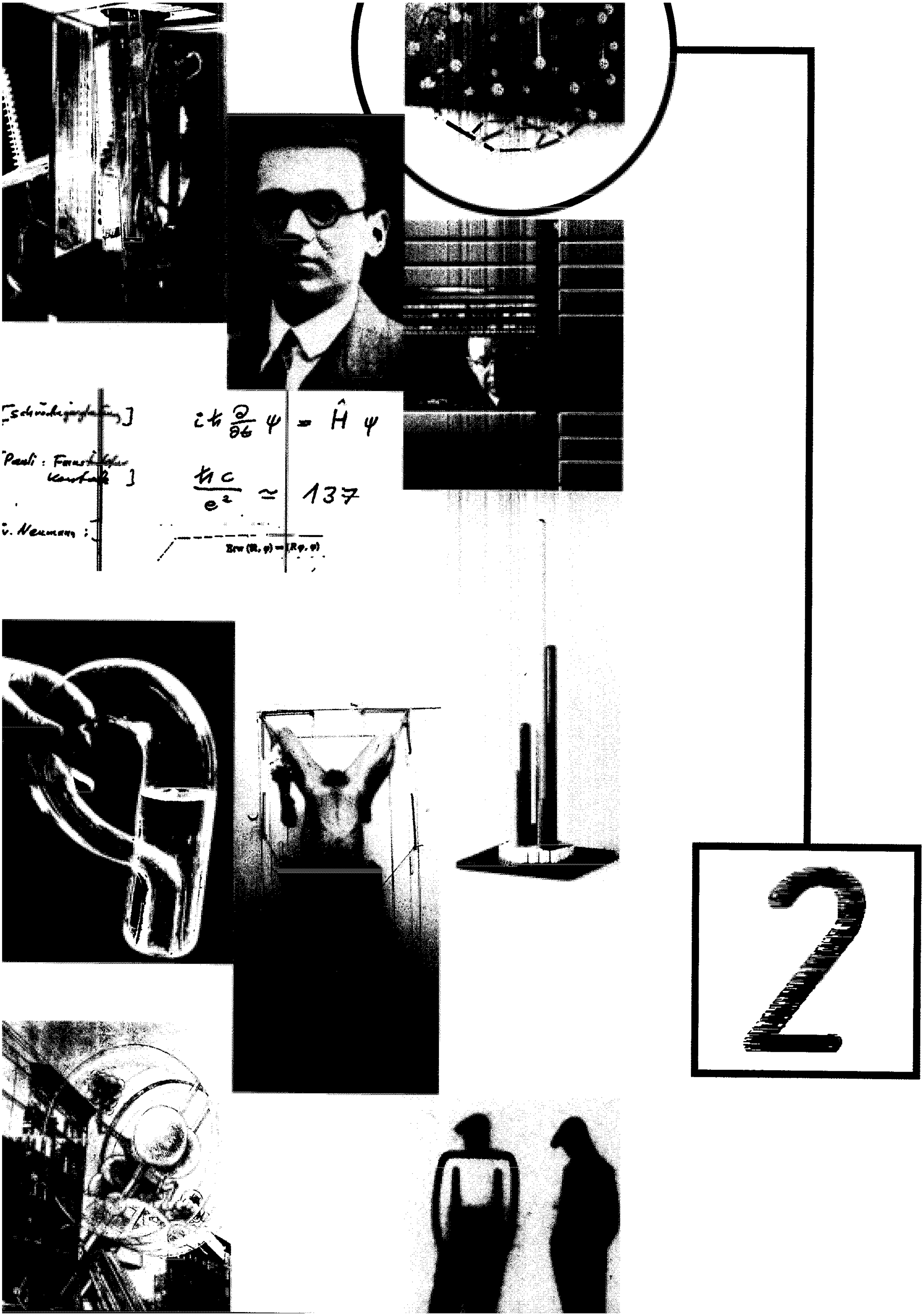
Scarcely any term connects art and science more closely than symmetry. This was already a theme in ancient times, as is found in Vitruvius, for example. On the beach of an unknown island, a shipwrecked traveler finds neatly arranged geometric figures. Can he conclude from this that there is an intelligent creator (perhaps even a god)?

Modernism re-worked this connection in a lengthy transformation process. Several highlights are found in an essay by biochemist Erwin Chargaff. Roughly stated, today the natural sciences no longer seek teleological explanations, no longer search for a creator of symmetry. More common is an examination of the structure of formal objects, e.g., the measurements of a physical theory, with mathematics honing a concept of symmetry at the beginning of this century. Symmetry became the great buzzword in quantum theory and elementary particle physics, while the older concept of natural laws became almost obsolete (Michael Stöltzner). Fullerenes (Magdolna and István Hargittai), named after architect Buckminster Fuller, are the latest and most spectacular discoveries in field where we seem to be entirely comfortable. Gauß was already familiar with the mathematics for this third way to modify carbon to graphite and diamond.

However, such helpful symmetries are rarely completely realized, but are instead broken by other interactions. Broken symmetry is not merely a disturbing side effect. Ultimately, it touches upon the fundamental fact that there are actually masses in the world in which we live. Mathematician Hermann Weyl wrote a standard work featuring numerous examples of symmetry in art and science, *Symmetry* (1952). This triumph of symmetry and invariance has recently been knocked off-kilter by both the discovery that the two sides of the brain have different functions, and the incursions on the theory of parity (1957), which states "that in nature there is no preference for the right-left-spiral or the reverse." Early on, Eugene P. Wigner pointed out that symmetry laws could only be approximately valid (Otto E. Rössler, Peter Weibel). Szaniszló Bérczi's essay explained the meaning of broken symmetry in a somewhat less well-known, transdisciplinary area of the natural sciences, the cellular automaton.

In the modern era, art also acted against a normative concept of symmetry, breaking through traditional symmetries and increasingly understanding concepts pertaining to abstraction tendencies as a structural, formal relation. Once the reference to the world of objects as an external model for the internal organization of the elements of an image has been cut through, then the circles, lines, and surfaces — which until now served to portray objects and their relationships — become autonomous. This gives rise to a freedom of form and color, which needs a new, aesthetic organization based on abstract rather than realistic principles. In this reference-free space, mathematical or geometrical models and methods, such as proportion theory, symmetry, symmetry breaking, dyssymmetry, and asymmetry, could be called upon to act as an internal model free of objects, which can be employed to organize visual elements and construct relationships among forms (Vera and Francois Molnár). This new model introduces a new stage in the forging of links between art and science, a process that is our main concern in this section: the proto-mathematical analyses of figures and forms.

Fractals are in a class of symbols and geometric constructions created by the endless reiteration of a discrete image and which characteristically display a similarity to themselves in endlessly reduced proportions. Through photography, paintings, sculptures, and installations, the artists here have investigated the many possible ways to organize the contents of aesthetic structures according to mathematical models, ranging from simple mirror symmetry to the geometry involved in reproducing similarities.



Pauli :
v. Neumann :
$i\hbar \frac{\partial}{\partial t} \psi = \hat{H} \psi$
$\frac{\hbar c}{e^2} \simeq 137$
2

2

symmetry
breaking symmetry

Erwin Chargaff

A Few Unscientific Thoughts on Symmetry

A glance at the Greek-English Lexicon by Liddell and Scott (2nd edition) will show how often the word *symmetria* occurs in the writings of the ancient Greek authors. In comparison, its use in Latin seems to have been limited; it is found, for instance, in Vitruvius and Pliny the Elder. Another term, *congruitas*, is also rarely encountered. Clearly, the Greeks were by far the more philosophical people. Symmetry is a concept much used in meditations on the beautiful or the sublime, particularly with regard to architecture. The classical temple was practically the archetype of classical symmetry. So it is all the more surprising that it was only around the middle of the eighteenth century that A. G. Baumgarten first designated aesthetics as a separate branch of philosophy, even though there have been few philosophers, either before or after that period, whose writings did not contain reflections upon the beautiful in art and nature. As has always been the case with me, the non-expert obtains real nourishment only from what I like to call the "chiaroscuro philosophers" – for example, St. Augustine, Pascal, Kierkegaard, and others not quite recognized by the professional guild. Great philosophers who are also great writers, admiring art as more than just a logical network, can be equally helpful: Schopenhauer, Wittgenstein.

In Pascal's inexhaustible *Pensées*,[1] there is, for instance, this remark, which I translate as follows:

> *To see symmetry in something at first glance is founded on whatever is so, and for no other reason, ought to be different. And it [is] also based on the countenance of the human being. It therefore follows that symmetry is only desirable on a plane, not in height or depth.*

Even in a less barbarous translation, this aphorism would not be easy to interpret. What it says, I believe, is that we perceive the symmetry of an object so readily because we are ourselves built symmetrically. This idea found its most apposite expression in a celebrated rhymed aphorism of Goethe:[2]

> *Something like the sun the eye must be,*
> *Else it no glint of sun could ever see;*
> *Surely God's own powers with us unite,*
> *Else godly things would not compel delight.*

This concept — the eye must be like the sun in order to see it — has a venerable ancestry. In the fifth century B.C., one of many Pythian sayings of the great Empedocles taught that "we perceive like through like,"[3] which began a chain of ideas that leads through the pages of Plato, Aristotle, Plotinus, Manilius, Pascal, and, finally, to Goethe. Whether Pascal was aware of the lineage of his remark I do not know; Goethe was.

Hegel, who had a low opinion of Empedocles as a philosopher,[4] repeatedly discusses symmetry as an aesthetic phenomenon, especially in his *Vorlesung über die Ästhetik* (Lecture on Aesthetics).[5] So far as I can make out, he does not go into the reason why the perception of symmetry or regularity is pleasant. However, this was the general opinion for a long time, founded as it was on the concept of art as the imitation of nature. It may have started with Greek architecture and sculpture, but some of the illustrations of Sumerian and Persian art in Hermann Weyl's superb book *Symmetry*,[6] demonstrate the great role that symmetry played in pre-classical art. It continued in that role until well into the eighteenth century, and the notebooks and theoretical writings of those who thought profoundly about space and form, such as Leonardo da Vinci[7, 8] and Albrecht Dürer,[9] are rich in reflections on harmony and proportions, mainly as regards the human body.

As an important principle in living and lifeless nature, symmetry must have been recognized long before it was formulated in writing. As an aesthetic element of art, architecture (including that of gardens), dancing, etc., it enjoyed general approbation until long after the baroque age. But the manner in which it was regarded changed over the course of the eighteenth century. The Enlightenment is a period that is generally considered to represent the triumph of reason. But like many collective terms, this one, too, conceals movements going in several, sometimes opposite directions, with some of the representatives disliking each other quite strongly: the lights of the *siécle des lumiéres* were far from illuminating one generally acknowledged center. In many respects, the Enlightenment liquidated classicism for the benefit of romanticism, which was to follow. Consider, for instance, Montesquieu, who wrote the article on taste for the *Encyclopèdie*. A somewhat longer version of this text was later published as *Essai sur le gout* (Essay on Taste).[10] One section is titled *Of the Pleasures of Symmetry*; it introduces, I believe, a funny argument. It seems that one of the main reasons that the soul experiences pleasure in seeing an object has to do with the facility employed to perceive this quality (i.e., symmetry). Symmetry, therefore, pleases the soul by saving it labor, by helping it cut the necessary work in half. However, Montesquieu then derives a "general rule," and that is where the first clouds begin to gather:

1. B. Pascal, *Oeuvres complètes*, L. Lafuma, ed. (Paris: Seuil, 1963) p. 582. In the ordinary numbering system this is Lafuma No. 580 or Brunschvick No. 28. The original quote is as follows: "Symétrie, en ce qu'on voit d'une vue, fondée sur ce qu'il n'y a pas de raison de faire autrement. Et fondée aussi sur la figure de l'homme. D'où il arrive qu'on ne veut la symétrie qu'en largeur, non en hauteur, ni profondeur."
2. J.W. v. Goethe, *The Collected Works. Selected Poems*, Christopher Middleton, ed. and trans., vol. 1 (Princeton: Princeton UP, 1994) p. 179.
3. J. Burnet, *Early Greek Philosophy*, 4th ed., Fragment No. 109 (London: Black, 1945) pp. 246, 221
4. G.W.F. Hegel, *Werke in zwanzig Bänden*, vol. 18 (Frankfurt am Main: Suhrkamp, 1971) p. 347.
5. Hegel, vol. 18, pp. 180, 320.
6. H. Weyl, *Symmetry* (Princeton, N.J.: Princeton University Press, 1952).
7. Leonardo da Vinci, *Selections from the Notebooks*, J.R. Richter, ed. (Oxford: Oxford University Press, 1952) pp. 145 ff.
8. Leonardo da Vinci, *Notebooks*, E. MacCurdy, ed. (New York: Reynal & Hitchcock, 1939) p. 206.
9. A. Dürer, *Schriftlicher Nachlaß*, 2nd ed., H. Faensen, ed. (Berlin: Union Verlag, 1963) p. 173 ff.
10. C.-L. de S. Montesquieu, *Œuvres complètes*, vol. 2, R. Gaillois, ed. (Paris: Pléiade, Gallimard, 1951) p. 1240.

11. D'Arcy E. Thompson, *On Growth and Form* (Cambridge: Cambridge University Press, 1942).
12. G.W. Leibniz, *The Monadology and Other Philosophical Writings*, R. Latta, ed. (London-New York: Oxford University Press, 1925).
13. E. Chargaff, *Experientia 6* (1950) p. 201.
14. J.D. Watson and F.H.C. Crick, *Nature* 171 (1953) p. 737.

Wherever symmetry is useful to the soul and able to support its functions, it is agreeable; but where it is useless, it is boring, for it does away with variety.

A few years later, in one of his *Salons*, Diderot describes the effect produced by the symmetrical composition of a painting as *maussade*: gloomy or bleak. There are centuries, it seems, that are symmetrically minded and others that are far from it. Our times would appear to be highly asymmetrical. Jean Cocteau, for instance, one of the foremost weather vanes of the taste of the recent past, is on record as calling symmetry "a visual pleonasm": "Beauty is asymmetric." It was clearly not always so. The contemporaries who admired Raphael's *Sposalizio* or *Disputa* must have been of an opinion very different from that of Cocteau. But we have seen that the applause had weakened even before the onset of the Romantic era.

The study of the production of symmetrical structures in natural life began in earnest with the microscopic observation of cells and cell communities. The first one hundred years of these studies are summarized in one of the greatest works in biology.

I can hardly think of a scientific book that has made so deep an impression on me as D'Arcy Thompson's marvelous treatise, *On Growth and Form.*[11] This book was written at a time when the chemical facets of evolution, development, and heredity had not yet begun to be identified. I have often asked myself why the publication of this kind of book cannot be imagined at present, and my answer has been that now we know too much. (Quite apart from the fact that the appearance of such a man as Thompson is necessarily a very rare event.) The "we" who know so very much cannot be concentrated into one writer; and a handbook written by many hands will never offer the sovereign and exquisite overview encountered in Thompson's great work.

Thompson's book is in many respects an old-fashioned book: its greatest emphasis is on the description of the phenomena rather than on their explanation. He was, of course, guided by his love of mathematics and his knowledge of physical and colloid chemistry, but all-important was his reverence for and admiration of nature's indescribable versatility.

Thompson approached the problem of symmetry in biological systems through the observation of cellular forms and the principle of least action, which governs them. The notion of nature as an economical housekeeper, however, may not be unrelated to contemporary habits of metaphysical thought: it was commonplace in the eighteenth century, when the idea of a mechanically minded God, a competent watchmaker, was prevalent. There were other periods when the abundance of nature, its awe-inspiring extravagance, was more strongly emphasized than its parsimonious frugality. Science being the dominating mythology of our times, it seems impossible to imagine ourselves among the ancients, at a time when the woods and rivers could barely hold all the dryads and naiads that populated them. The nymphs are, of course, now dead and gone; how many of our own ingrained dogmas will survive two thousand years cannot be predicted.

As far as I am aware, Thompson does not consider the question of symmetry in higher organisms, such as the formation of two symmetrical organs. It is not easy to understand how instructions to form two eyes, two arms, etc. can be imprinted on the DNA of the embryo. Why are we only partially symmetrical? In what manner does the command to grow two kidneys differ from that to produce only one liver? One cannot help having the impression that the present understanding of the transmission of hereditary traits still is excessively one-dimensional.

Thompson repeatedly invokes the principle of least action, ascribing its first formulation to Fermat. In contemplating its consequences, one may sense a profound question looming in the background, a question once posed by Leibniz. In a late essay, *Principes de la Nature et de la Grace* (Principles of Nature and Grace, 1714), Leibniz wrote, "Nothing happens without sufficient reason... The first question that must be asked is, why does anything occur, rather than nothing?"[12]

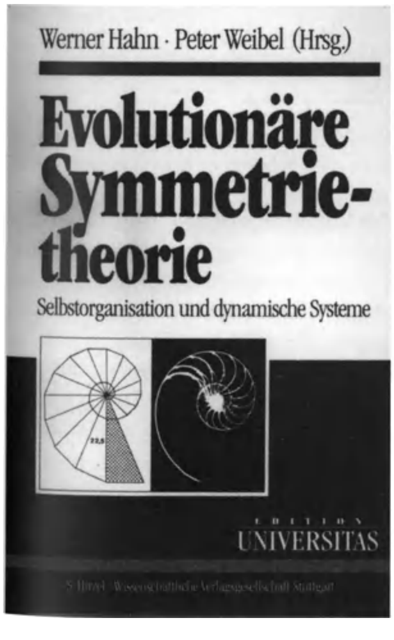
As it is obvious that doing nothing requires less action than doing something, Leibniz's ostensibly metaphysical question would seem to invalidate the principle of least action, unless there is a sufficient reason for the expenditure of energy. Where this reason ought to be sought, I cannot say. Similarly — if we exclude teleological arguments — although there may be good reasons why certain organs are symmetrically duplicated and others are not (wouldn't we be better off with two livers?), I cannot state those reasons. The question asked by Leibniz may not be answerable on purely scientific grounds.

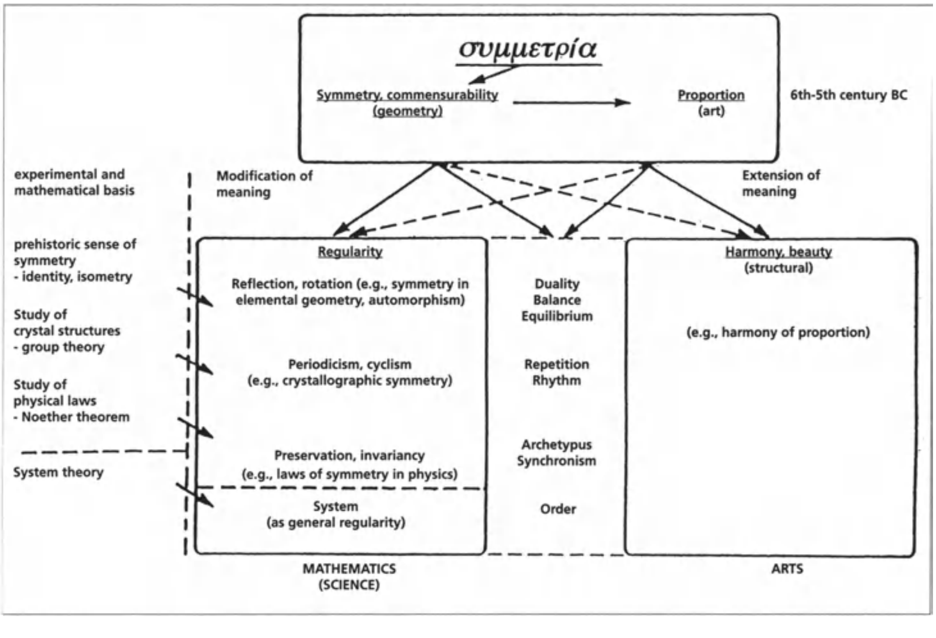
In mediating the processes of life, one encounters another phenomenon perhaps as equally important as symmetry, but less obvious than it. It is what I have often referred to as complementarity. When I discovered it in DNA,[13] I spoke of base complementarity. It is now generally called base pairing, in reference to the double-helical model of DNA.[14] Adenine is complementary to thymine, guanine to cytosine, the total purines to the total pyrimidines, the 6-amino bases to the 6-keto bases. In the process of comparing scale models of nitrogen components, which are in equal molecular quantities in DNA, they appeared to complement each other, producing structures of equal size. I could not help thinking of that ancient symbol of complementarity, the design used by the Chinese to depict the interaction of Yin and Yang, the dual forces governing the universe.[15] There may be instances (like that symbol, a circle divided equally by a wavy line) in which complementarity possesses features of an inverted symmetry; but I do not think that this is generally the case.

What I do think is that the biological consequences of complementarity — as perhaps also those of symmetry — will, on further investigation, turn out to be more important and far-reaching than is believed at present. The rather asinine notion of information transfer has for the moment blocked many other avenues of thought in biology.

15. C.P. Fitzgerald, China, *A Short Cultural History* (New York and London: Appleton-Century, 1938) p. 34.

Symmetry, vol. I, no. 1, 1990, pp. 23-26.





The evolution of the symmetry concept
in: Dénes Nagy, *Quasidynamische und dynamische Symmetrien,*
in: Werner Hahn and Peter Weibel (eds.), *Evolutionäre Symmetrietheorie. Selbstorganisation und dynamische Symmetrie,* Edition Universitas, S. Hirzel, Wissenschaftliche Verlagsgesellschaft Stuttgart, 1996, p. 222.

2

Magdolna and István Hargittai

The Concept of Symmetry in Modern Chemical Research

Dedicated to Eugene P. Wigner

Magdolna Hargittai, born 1945. Professor of structural chemistry at the Hungarian Academy of Sciences. Main fields of research: classification of molecular structures, high temperature chemistry, coordination chemistry. More than 50 publications in the field of structural chemistry. Published a two volume work on stereochemical appliances of the electron disfraction of gas-phases together with István Hargittai.

István Hargittai, born 1941. Professor of chemistry and head of the Department of Chemistry at the Budapest Technical University. Guest professor at various universities in the U.S.A. Main field of research: the molecular structure and their models. Author and publisher of 20 books half of which deal with structural chemistry, the other half belongs to the field of problems of symmetry. Publisher of the magazines *Structural Chemistry* and *The Chemical Intelligencer*.

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Magdolna and István Hargittai, *Symmetry through the Eyes of a Chemist* (Weinheim: 1986).
Magdolna und István Hargittai, *Symmetry: A Unifying Concept*, (Bolinas, CA: 1993).

The knowledge that symmetry as observed in nature cannot be fully traced back to geometrical symmetry is a well-known fact.[1] In their epistemological essay on chirality,[2] K. Mislow and P. Bickart report their discovery, stating: "When one studies the phenomena of nature, one is inevitably forced to describe a state of logic while acknowledging the necessity of inaccuracy." This material symmetry, without the exactness of geometric symmetry, is also applicable to material objects and abstractions, with an infinite number of implications.[3] Symmetry proposes a harmony in proportions — which Weyl spoke of as being a seemingly vague idea.[4]

The human ability to turn non-geometric into geometric phenomena was quite beneficial in detecting symmetry in such places where it was inherent even in its most fuzzy variations.[5, 6] In accordance with this thought, Weyl refers to Dürer: "Dürer sees his canon of the human figure more as a model from which the artist should deviate, rather than strive to achieve."[4]

The vagueness and fuzziness of a comprehensive interpretation of symmetry allows us to speak of various grades of internal symmetry, enabling us to say that one thing is more or less symmetrical than another thing. Such a statement would be inconceivable in terms of a strictly geometric approach, which would only allow for the differentiation between the symmetrical and asymmetrical. Therefore, there must be a number of other criteria that would enable us to decide if something is symmetrical or not, and if so, to what extent.

Appropriate criteria may vary from problem to problem and from time to time. At present we are witnessing how science has restricted itself to researching only a few ordered systems, where a symmetrical way of looking at things has by no means become less significant. On the contrary, its applicability has widely, profoundly increased. This is also true of the tendency to quantify, and remains not only true for symmetry,[7] but also for closely related phenomena such as chirality.[8] Collections of recently published essays have elaborated upon the comprehensive and compounding character of the symmetry concept in a strongly interdisciplinary and multidisciplinary manner.[9-12]

Chemical Symmetry

Chemistry[13] is one of the sciences in which the symmetry concept has increasingly gained importance. This is not only the case in fields such as spectroscopy and crystallography, but also recently in the seemingly 'inaccurate' field of organic synthesis. So-called antisymmetry emerged as a promising field of research for modern chemistry, for example in its description of the electron's atomic and molecular orbitals, the interaction of electrons during a chemical reaction, and of molecular vibration.

During the past two decades, research on chemical reactions has offered fertile ground for the application of the symmetry concept.[14-19] Groundbreaking thoughts on symmetry and its applicability to chemical reactions can be attributed to Wigner and Witmer.[19]

The Wigner-Witmer Laws deal with conserving the angular momentum of rotation, as well as with the angular orbital momentum in dual-atom molecular reaction. Even though symmetry is not expressly mentioned here, its presence is implied through the principle that conserves angular momentum. Here we would like to stress the fundamental influence Eugene Wigner's work has had on the study of symmetry[20] and the application of group theory[21] in physics. The actual breakthrough in understanding the role that symmetry plays in determining the course of a chemical reaction was only made recently. Key figures in this discovery were Woodward and Hoffmann, Fukui, and Pearson, among others.

The central idea of their work is that symmetrical phenomena play just as important a role in chemical reactions as they do in the construction of molecular orbits or in molecular spectroscopy. It is even possible to establish symmetry-based "selected rules" for the 'allowedness' [sic] and 'forbiddenness' [sic] of chemical reactions; this can also be done with spectroscopic conversions. At first glance, it seems logical that the rules of symmetry are only applicable to symmetrical molecules. However, even symmetrical reactants can only be derived from related symmetrical base molecules through a process of 'simplifying.' As Woodward and Hoffmann emphasize, it is possible to "trace them back to their highly inherent symmetry."[14] That is indeed a necessary criterion for deciding when the principles of symmetry should be applied.

Predominant Contexts

Symmetry is a concept of immeasurable value in creating connections that are of significant use in education and research. Everyday phenomena and observations of our natural surroundings are possibly related to abstract ideas and results.

Fig. 1 illustrates two segments of the stonework in a sidewalk located in a commercial quarter in Leuven, Belgium. The stones laid in concentric circles can be used to explain point groups, which we could regard as being derived from molecular structures. The other stonework, with seemingly endless rows of stones, represents an illustration of groups in space, e.g., for symmetries in the structures of crystals.

1. For a long time, symmetry has been connected with the traits of geometric figures. For example, Russian crystallographer E.S. Federov once provided the following definition: "Symmetry is the ability to repeat geometric forms and their components. Or, more precisely, the ability to bring their traits together in accordance with their original position, even if they are found to be in another position." Canadian mathematician and geometer H.S.M. Coxeter agrees with Federov when he writes, "If we say that a figure is ‚symmetrical,' we mean that at this particular point a transformation based on congruency takes place, leaving the borders intact and only permuting its singular components."
2. K. Mislow/P. Bickert, Israel J., Chem. 15:1 (1976/77).

Fig. 1: Stonework in Leuven (Belgium) representing the symmetry of point groups (above) and the symmetry of space groups (below). (photo: Hargittai)

Fig. 2 shows two stamps: the United Nations stamp for the World Food Program (for global nutrition) (a) offers two heterochiral oriented hands (both the right and left hands are positioned in the exact same way and are mirrored); the other stamp (b) shows a homochiral pair of hands (two right hands). Louis Pasteur was the first to suggest that molecules could be understood as chiral shapes, which can be seen in relation to the left- and right-handedness (mirror image) orientation of the molecules. In his promising experiment from 1848, Pasteur recrystallized salt derived from Tartaric acid, thus producing two types of crystals that were mirror images of one another. The most simple chiral (hand-like, -handed) molecules contain a carbon atom surrounded by four other atoms or groups of atoms at the points of the tetrahedron.

(a) (b)

Fig. 2: Two stamps: examples for heterochiral (left) and homochiral (right) pairs of hands (Hargittai/Hargittai) (13)

Chirality can be defined as the absence of symmetrical elements of the second kind. While equality (identity) and simple rotation are elements of the first kind, mirrored revolutions (rotations) characterize figures that can appear in the left-handed (left rotation) and the right-handed (right rotation) components; therefore, these can be attributed to the second kind. One example is single mirroring, which requires the existence of two enantiomorph components (mirrored isomers) within one figure.

Pasteur employed the term "dissymmetry" to the missing symmetrical elements in a figure of the second kind. Pierre Curie[22] offered a generalization, which said that a crystal is dissymmetrical if precisely the symmetry elements upon which the existence of specific physical characteristics depended were missing: "Dissymmetry causes this phenomenon." A phenomenon is existent and can accordingly be examined if certain elements of symmetry are not accessible within this system.

The reason why only L-amino acids (and the corresponding D-nucleotides) occur in all living organisms, without any type of opposite form (mirror image), has been the subject of several speculations. There may have been a coincidental situation in the past, at some particular point in history, which caused this condition. Pasteur thought that life itself was a product of the universe's dissymmetry. Until 1957 there was no plausible reason to believe that the laws of physics were not completely indifferent to left and right. At that time, it was discovered that different types of radioactivity are predominantly left-handed. The difference between

3. I. Hargittai, "Limits of Perfection," Computers Math. Applic. 12B: 1 (1986), and I. Hargittai, ed., *Symmetry: Unifying Human Understanding* (New York: 1986) pp. 1-17.
4. H. Weyl, *Symmetry* (Princeton, NJ: 1952)
5. I. Hargittai, "The Joy of Symmetry," Computers Math. Applic. 17: 1067 (1989), and I. Hargittai, ed., *Symmetry 2: Unifying Human Understanding* (Oxford, 1989) pp. 1067-1072.
6. I. Hargittai, "Real Turned Ideal through Symmetry," *Symmetrie in Geistes- und Naturwissenschaft*, R. Wille, ed. (Berlin/Heidelberg/New York: 1988) pp. 131-161.
7. H. Zabrodsky/S. Peleg/D. Avnir, "Continuous Symmetry Measures," J. Am. Chem. Soc. 114: 7843 (1992).
8. A.B. Buda/K. Auf der Heyde/K. Mislow, "On Quantifying Chirality," Angew. Chem. Int. Ed. Engl. 31: 989 (1992).
9. I. Hargittai/M. Hargittai, *Symmetry – A Unifying Concept* (Bolinas, CA, 1993).
10. I. Hargittai, ed., *Symmetry: Unifying Human Understanding* (New York, 1986).
11. I. Hargittai, ed., *Symmetry 2: Unifying Human Understanding* (Oxford, 1989).
12. W. Hahn, *Symmetrie als Entwicklungsprinzip in Natur und Kunst* (Königstein, 1989).
13. I. Hargittai/M. Hargittai, *Symmetry through the Eyes of a Chemist* (Weinheim, 1986) [also New York, 1987].
14. R.B. Woodward/R. Hoffmann, *The Conservation of Orbital Symmetry* (Weinheim, 1970).
15. R. Hoffmann, Angew. Chem. Int. Ed. Engl. 21: 711 (1982).
16. K. Fukui, Science 218: 747 (1982).
17. R.G. Pearson, *Symmetry Rules for Chemical Reactions, Orbital Topology, and Elementary Processes* (New York: Wiley-Interscience, 1976).
18. E.A. Halevi, *Symmetry and Reaction Mechanism: The OCAMS View* (Berlin, 1992).
19. E. Wigner/E. Witmer, Z. Phys. 51: 859 (1928).
20. E.P. Wigner, *Symmetries and Reflections. Scientific Essays* (Bloomington, 1967)
21. E.P. Wigner, *Group Theory and its Applications to the Quantum Mechanics of Atomic Spectra* (New York, 1959)
22. P. Curie, "C'est la dissymetrie qui crée le phenomene," J. Phys. 3: 393 (Paris, 1894).

23. I. Hargittai, ed., *Quasicrystals, Networks, and Molecules of Fivefold Symmetry* (New York, 1990).
24. I. Hargittai, *Fivefold Symmetry* (Singapore, 1992).
25. R.B. Fuller, *Synergetics: Explorations in the Geometry of Thinking* (New York, 1975).
26. D.L.D. Caspar/A. Klug, "Physical Principles in the Construction of Regular Viruses," Cold Spring Harbor Symposia on Quantitative Biology 27: 1 (1962).
27. H. Kroto, "C 60: Buckminsterfullerene, The Celestial Sphere that Fell to Earth," Angew. Chem. Int. Ed. Engl. 31: 11 (1992). The discovery was first reported by H.W. Kroto, J.R. Heath, S.C. O'Brien, R.F. Curl, and R. E. Smally in Nature 318: 162 (1985).

left and right on a sub-atomic level was brought into connection with the appearance of inefficient forces between electrons and elementary particles in the atomic nucleus.

At this time, the tremendously important and fundamental difference between left- and right-handed versions of biologically active chemical substances was increasingly acknowledged.

Fivefold Symmetry

Recently, fivefold symmetry[23, 24] has played a discernible role in chemistry, particularly within molecular chemistry and research on solids. Both the fullerene and quasi-crystals are notable examples of this.

Buckminster Fuller (1895-1983) was not a chemist. He was, to put it in his own words, an engineer, inventor, mathematician, architect, cartographer, philosopher, poet, cosmologist, comprehensive designer, and choreographer. He stressed the importance of synergy, providing chemistry with the following: the way an entire system acts is unpredictable as far as the behavior of its individual components is concerned.

Chemists discovered that they had to recognize synergy because they found that every time they tried to isolate one element out of a complex, or to separate atoms or molecules from compounds, the isolated parts and their separate behaviors never explained the associated behaviors at all. It always failed to do so. They had to deal with the whole unit in order to be able to discover the group proclivities as well as integral characteristics of parts. Chemists found the universe already in complex association and working very well. Every time they tried to dissect it or isolate elements of it, the individual parts were physically divested of their associative potential, so chemists had to recognize that individual elements could not predict the associative behavior of the whole; they found there was an old word for it: synergy.[25]

Physical geometry was at the heart of Buckminster Fuller's philosophy of nature. He often cited Avogadro's Law to elaborate on chemistry's affinity to synergetic geometry. According to Avogadro's Law, the same volumes of gases under the same circumstances all contain the same amount of molecules. Fuller believed that Avogadro's Law illustrated that chemists accepted volume as having a material character, not only as an abstract concept. The icosahedrons (a regular polyhedron with twenty areas, Platonic body) and fivefold symmetry were both exceptional factors in Fuller's work. The polyhedron's specific meaning was further emphasized through the knowledge of virus structures, discovered by Casper and Klug,[26] who stated:

> *The solution we found was actually influenced by geometrical principles that Buckminster Fuller applied in constructing his air hall... The similarity of the air hall's design... to icosahedric viruses occupied our thoughts as we worked on the polio virus. Fuller was a pioneer in the development of physics-oriented geometry based on principles suitable for construction.*[26]

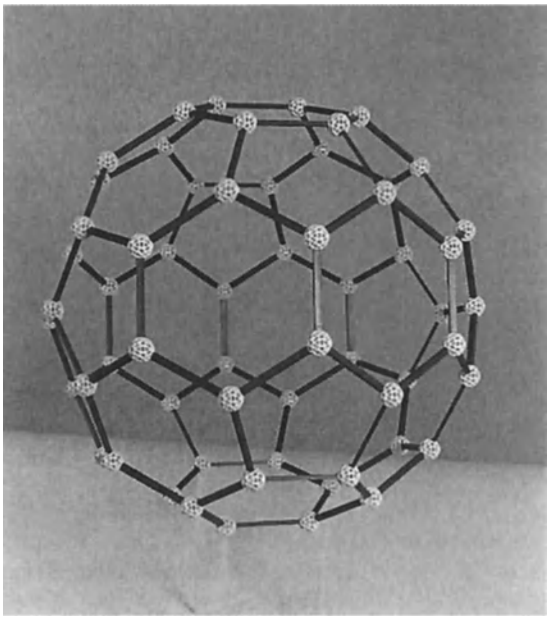
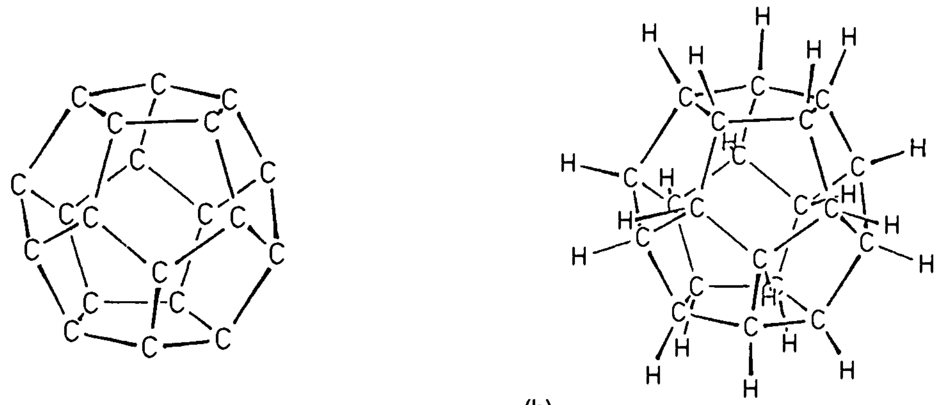


Fig. 3: Blunt Icosahedrons, a zoom tool model: Buckminsterfulleren, C60. (photo: Hargittai)

More than two decades after the first publication of the above-mentioned findings on viruses, H.W. Kroto and his colleagues,[27] during a laser beam graphite evaporation experiment, noticed a relatively large amount of a material composed of sixty carbon atoms, and began paying close attention to the extraordinary stability of the C60 molecules. Searching for the reason why this particular structure appeared, they turned to Fuller's work to aid their research. This finally brought them to a highly symmetrical, blunt icosahedric structure (see fig. 3).

Of course, mathematicians have always known that a polyhedron with an even number of points can always be bordered by any number of hexagons (with the exception of a single hexagon) when twelve pentagons are inherent within the structure. The blunt icosahedron without points is composed of twelve regular pentagons and twenty hexagons, making it a semi-regular, so-called Archimedean body. All such carbon compounds with a molecular structure of twelve pentagons and a large number of hexagons (the exception is a single hexagon) are called fullerenes. C60 is also known by the technical term fullerene (named after Buckminster Fuller).

The substances gain stability at the same rate that the pentagon is separated from the hexagon. The smallest fullerene consists of twelve connecting pentagons and is called a dodecahedron or fullerene 20 (see fig. 4). It is extremely stable and to date has not yet been observed. Curiously enough, the perhyrofullerene 20, better known as dodecahedron, C20H20 (fig. 4b) was discovered some time ago. Chemists anticipated its high stability based on the assumption that it was a geometrical form[28] to begin with. Later, it became possible to synthetically produce perhyrofullerene 20.[29]



(a) (b)

Fig. 4 a + b: dodecahedron, C_{20}, and dodecahedron $C_{20}H_{20}$
Werner Hahn and Peter Weibel (eds.), *Evolutionäre Symmetrie-theorie. Selbstorganisation und dynamische Systeme,* Edition Universitas, S. Hirzel, Wissenschaftliche Verlagsgesellschaft Stuttgart, 1996, pp. 231-240.

Back to the fullerene once more: after Krätschmer and his colleagues[30] succeeded in producing measurable amounts (a few grams) of it, research on this molecule accelerated. In the December 1991 issue of Science, it was crowned "molecule of the year." The discovery of the Fullerene was awarded the Nobel Prize for Chemistry in 1996.

28. H.P. Schultz, "Topological Organic Chemistry. Polyhedranes and Prismanes," J. Org. Chem. 30, 1361, 1965.
29. R.J. Ternanszky/D.W. Balogh/L.A. Paquette, "Dodecahedrane," J. Amer. Chem. Soc. 104: 4503 (1982).
30. W. Krätschmer/L.D. Lamb/K. Fostoropoulus/D.R. Hoffmann, "Solid C60: A New Form of Carbon," Nature 347: 354 (1990).

2

Victor Vasarely

Pictures with Antisymmetry

Victor Vasarely
Born 1908 in Pécs. Studied at the Academy of Art and the Mühely Academy in Budapest. Died in Paris in 1997.

1933 Ernst Múzeum, Budapest
1944 Galerie Denise René, Paris
1954 Palais des Beaux-Arts, Brussels
1958 Rose Fried Gallery, New York
1963 Kestner Gesellschaft, Hannover
1964 Kunsthalle, Bern Gemeente Museum, Den Haag
1965 Pace Gallery, New York
1973 Museo d'Arte Moderna, Mexico City
The Goodman Gallery, Johannesburg
1978 Vasarely Center, New York

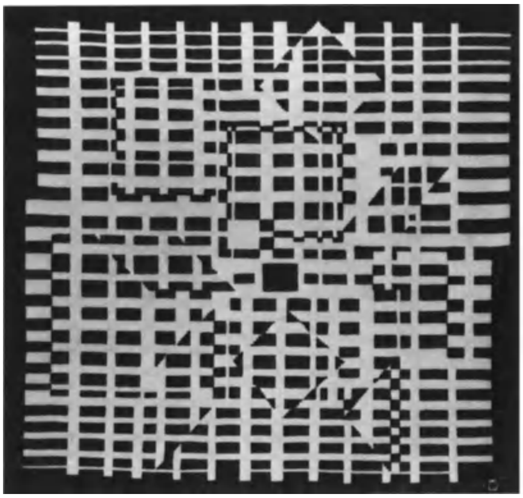
Group shows
1947 1. Salon des Réalités Nouvelles, Musée d'Art Moderne, Paris
1950 *From the Twelfth Century to Our Days*, Kunsthaus, Zurich
1953 *Arte Astratta Italiana e Francese (École de Paris)*, Galleria Nazionale d'Arte Moderna, Rome
Young European Painters, The Solomon R. Guggenheim Museum, New York
1955 documenta I, Kassel
1956 *Moderne französische Tapisserie*, Kunsthalle, Bern
1958 *Painting and Sculpture Acquisitios*, Museum of Modern Art, New York
1959 documenta II, Kassel
1960 *Kinetische Kunst*, Kunstgewerbe-Museum, Zurich
1961 *Le mouvement*, Stedelijk Museum, Amsterdam
1962 *School of Paris*, Tate Gallery, London
1963 *Internationale Graphik-Ausstellung*, Moderna Galerija, Ljubljana

References:
Victor Vasarely, *Vasarely* (New York: 1978).
Gaston Diehl, *Vasarely* (1982).
Eva Hárs, *Vasarely* (1983).

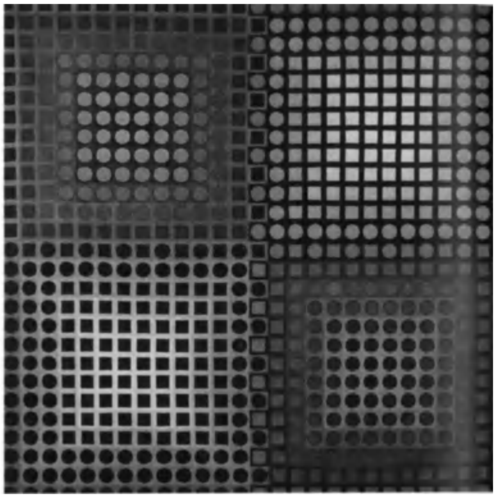
Rich, dominating, as well as subtle symmetries characterize Victor Vasarely's graphic art. Even when simple and penetrating symmetries are present, they don't appear overwhelming, as sometimes minute variations are introduced. Often antisymmetry is stressed.

Antisymmetry transforms objects possessing two possible properties from one value to another. Vasarely's favorite antisymmetries are between colors – most notably black and white – and between shapes, for example, a square and a circle. These two kinds of antisymmetry are often coupled in his work. Four powerful examples, all in black and white, are quoted in the illustrations from the artist's period between 1945 and 1970.

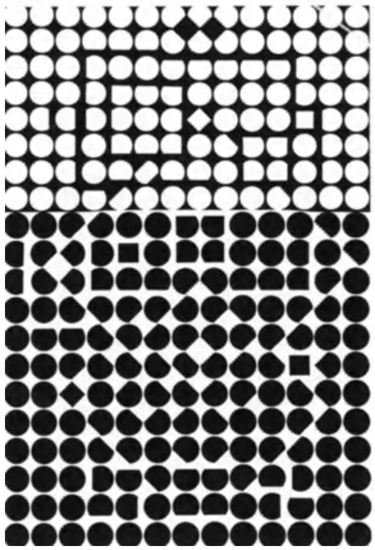
István Hargittai, Comp. & Maths. with Appls. 12B, no. 1/2(1986):301.



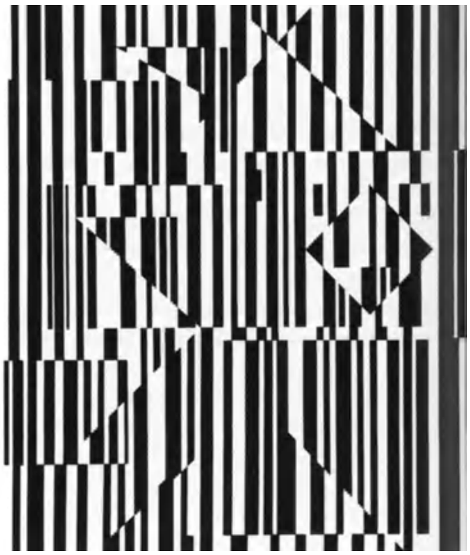
Victor Vasarely, *Caracas*, 1957
135 × 128 cm
© VBK, Vienna, 2005



Victor Vasarely, *EG-1-2*, 1967
256 × 256 cm
© VBK, Vienna, 2005



Victor Vasarely, *Andromeda*, 1955-58
195 × 130 cm
© VBK, Vienna, 2005



Victor Vasarely, *Taymir II*, 1956
Acrylic on canvas, 135 × 120 cm
© VBK, Vienna, 2005

Vera and Francois Molnár

Making and Breaking Symmetry in Visual Art

Francois Molnár, born 1922 in Szentes, Hungary. Studied painting at the Academy of Fine Arts, Budapest, and the École des Beaux-Arts, Paris. Studied experimental psychology. Has lived in Paris since 1947, did research in aesthetics at the experimental psychology lab at the Sorbonne. Co-founder of the Groupe de Recherche d'Art Visuel. Research at the Institut d'Esthétique et des Sciences de l'Art at the University of Paris.

Fig. 1: Translational symmetry (after A.L. Loeb)[1]

Fig. 2: Raphael *Marriage of the Virgin,* 1504

The Problem of the Perception of Symmetry

Perceived symmetry only rarely coincides with the symmetry defined in mathematics. Often what is considered by analytical science to be symmetrical is, in fact, far from symmetrical in our perception. Likewise, many objects judged symmetrical are not, according to the mathematical definition of symmetry.

The pattern in Fig. 1 is undoubtedly symmetrical according to the mathematical definition, since it presents a series of translations. All these equivalent points are related by translation: by the simplest direct isometry operation that leaves a figure invariant. This operation is called a symmetry operation. However, this pattern would be perceived as asymmetrical by normal human beings. Raphael's famous painting *Sposalizio* (Fig. 2), often referred to as a classical example of symmetrical composition, is obviously not symmetrical. The relation between the two sides of the picture is not isomorphic. We cannot detect any translation, any rotation or guided reflection in respect to an axis of symmetry.

Likewise, patterns made up of simple geometrical forms can seem more or less symmetrical without being symmetrical in the strict mathematical sense. Besides, from a strict mathematical point of view, the expression "more or less symmetrical" does not have much meaning. A figure is either symmetric or asymmetric regardless of how many symmetric operations may be performed on it. On the other hand, as far as human perception and judgment are concerned, to evaluate the hierarchy of symmetry is a legitimate procedure. One symmetrical pattern can be perceived as more symmetrical than another. In a first analysis, one can base the perceptive evaluation of symmetry on the number of symmetrical axes without taking into account whether one is aware of the number of these axes. Psychologically symmetry is in any case a continuous variable. A picture may be rich or poor in symmetry depending on how many types of symmetrical operations may be performed on it without affecting it. The letter A, for instance, will remain unchanged only if reflected in one axis. The letters S, I, H, or O possess twofold symmetry: these appear the same after 180° rotation. The number of symmetrical axes is undoubtedly only one of the intervening variables in the perception of symmetry. The reflection around the vertical axis seems to provoke a stronger perception of symmetry than the reflection around the horizontal one. Thus the spatial position of the pattern influences the perception of symmetry. Another important variable concerning the perceptual symmetry is the context.

In spite of at least a century of intensive research, psychologists are still unable to link the level of perceived symmetry to the physical elements of the picture. In statistical processing of a picture the skewness of a one-dimensional distribution can be measured, but skewness means degrees of deviation from symmetry. Thus, skewness measures asymmetry. The same concept may be applied to a two-dimensional distribution, and the asymmetry of a shape may also be measured on a continuum. In this approach, the parameter for symmetry is considered an analogy of the "third moment" of the statistical distribution of the elements.[2]

1. A. L. Loeb, *Color and Symmetry* (New York: Wiley, 1971).
2. L. Zusne, *Visual Perception of Form* (New York: Academic Press, 1970).

The Problem of the Aesthetic Aspect of Symmetry

Besides harmony and rhythm, symmetry is one of the most indistinct concepts in the aesthetic vocabulary. Moreover, the semantic field of these three words have a very large intersection. Symmetry, from Plato to Vitruvius and Alberti, was a concept that had very little relation to its actual meaning. In Plato's system, symmetry of a phenomenon is the result of "commodulatio", comodulation: joining all the elements with the whole by means of a standard measure called "modulus." Vitruvius, the Roman theoretician of architecture, used the word almost in the same sense. Symmetry, he said, consists in the agreement of the measure between the distinct elements and the whole.

Alberti shared this opinion at the dawn of the Renaissance. Associated with order and unity, symmetry becomes an important aesthetic category. Diderot treats it as such. Today, it remains an aesthetic category, at least in the mind of certain theoreticians of visual art. Some decades before Diderot, Alciphon, the "minute philosopher" of Berkeley's, declared that "beauty is a fugacious charm which is felt." Indeed, one might ask: what quality is felt? It is "symmetry and proportion as they please the eye."[3] But what does this symmetry, which is so pleasing to the eye, signify?

This is one of the main problems for scientific aesthetics and for many artists who are conscientious of the inherent difficulties of modern art. There are several well-defined ways to carry out research in this field. We do not want to follow the promising way chosen by MacGillavry in her *Symmetry Aspects of M. C. Escher's Periodic Drawings*.[4] Nor can we choose the royal route of topology laid down by the painter and topologist A. Hill.[5,6] This researcher, in two excellent studies, showed that the painter Mondrian, the sworn enemy of all kinds of symmetry, created symmetrical works all his life. In fact, Mondrian's asymmetrical works transform themselves into symmetrical ones in a certain topology. But as soon as one adds a distance to the topology, Mondrian's paintings become asymmetrical again.

The human body is undoubtedly symmetrical at a first glance. But the left side of our body is not identical to the right side. The apparent symmetry of the human face is lightened by an asymmetry of the details. There are differences in these details that make up an interesting face. Nothing is stranger, more bizarre, or uglier than those symmetrical faces fabricated artificially by copying one side of the face opposite itself in a mirror-symmetrical fashion.

It is relatively easy to study the aesthetic effect of symmetry linked to perception by patterns built up of simple geometrical forms organized or randomly arranged (random patterns). Such are the patterns which have been constructed by Green[7] and by Julesz[8] to study perception and by Morellet or by the authors to study the aesthetic effect.

Fig. 3 shows more or less symmetrical random patterns constructed by Julesz in 1965. Certainly "de gustibus et coloribus non disputandum." However, the experts are in agreement with the majority in the belief that strictly symmetrical figures are less satisfying aesthetically. In another context — for example, ornamental art — symmetry would be, on the contrary, judged as attractive. Concerning the purely aleatory, random pattern, there is hardly any interest either from an aesthetic or a perceptive point of view: perception demands a certain level of physical organization. Faced with white noise, the perceptive mechanism itself introduces a minimum of order by grouping several elements together according to certain rules — rules that psychologists are beginning to know and at the heart of which symmetry seems to play a role.

3. K. E. Gilbert and H. Kuhn, *A History of Aesthetics* (Bloomington: Indiana University Press, 1954).
4. C. H. MacGillavry, *Symmetry Aspects of M. C. Escher's Periodic Drawings* (Utrecht: Bohn, Scheltema and Holkema, 1976).
5. A. Hill, *Programme Paragram Structure in Data* (London: Faber and Faber, 1968).
6. A. Hill, "A View of Non Figurative Art and Mathematics and an Analysis of a Structural Relief," in Visual Art, Mathematics and Computers, ed. F. J. Malma (Oxford: Pergamon Press, 1979).
7. B. F. Green. Jr., "The use of high-speed digital computers in study of form perception. In form discrimination related to military problems," ed. J. W. Wielfee and J. H. Taylor (Washington, DC: National Academy of Sciences, 1957).
8. B. Julesz, *Foundation of Cyclopean Perception* (Chicago: University of Chicago Press, 1971).

Fig. 3:
Symmetrical pattern (a) two-layered symmetry with imbalances (b) two-layered, completely unbalanced symmetry (after B. Julesz)

The two pictures presented in Figs. 4 and 5 are works of art that can please or displease a spectator according to his or her personal taste. However, they are undoubtedly works of art as they have been exhibited several times in museums or avant-garde art galleries and reproduced in art reviews. These pictures are not symmetrical either perceptually or mathematically even after close examination. Nevertheless, after short contemplation they cannot be judged as being totally asymmetrical. Each of these paintings is made up of 171 rectangles at regular intervals in 9 columns of 19 rows. This arrangement of rectangles has a certain symmetry, even a twofold symmetry (Fig. 6). The pattern represented in Fig. 6a may be considered, in a certain context, as a work of art by its simplicity and not by virtue of its physical properties or its physical features. For reasons that we cannot develop here, this regular picture extracted from its context does not have a great aesthetic value. To render the image more aesthetic the constituent elements (the rectangles) are displaced according to a sine line whose parameters are arbitrarily chosen and arranged symmetrically around a vertical axis (Fig. 6b).

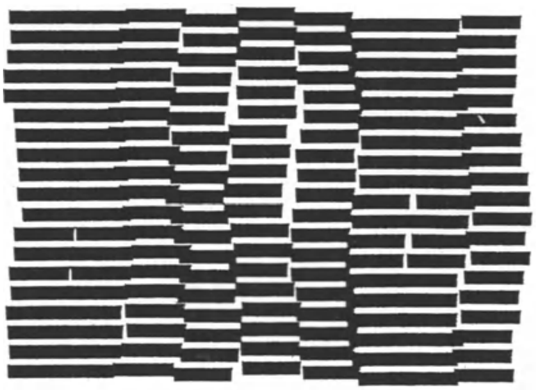


Fig. 4: Vera Molnár, *Hommage à Gabo I*

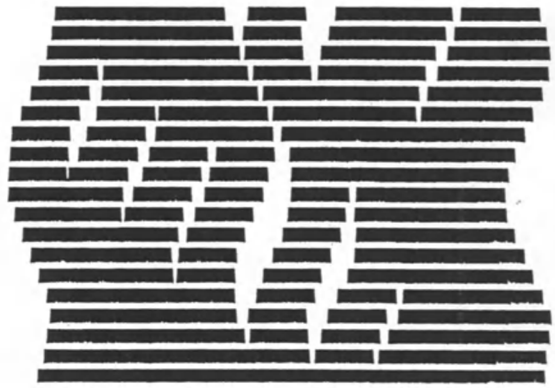


Fig. 5: Vera Molnár, *Hommage à Gabo II*

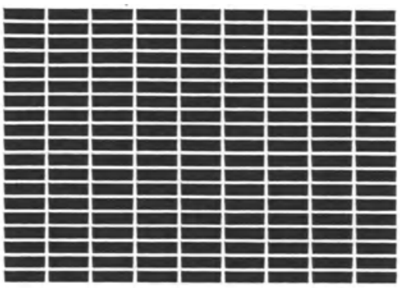


Fig. 6a: Regular distribution

Fig. 6b: Symmetric sinusoidal distribution

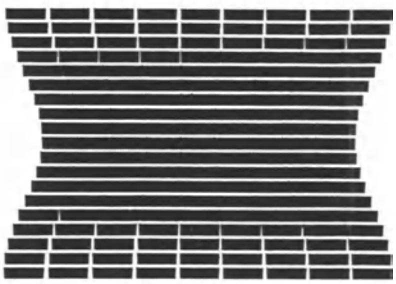


Fig. 6c: Symmetric sinusoidal distribution with variable amplitude (between a = –8 and a = 8)

The pattern that is organized this way obviously loses its simplicity and becomes displeasing — aesthetically negative even in a decorative context. In order to lighten the sudden change around the vertical axis, we decrease the amplitude of the sine curve progressively to the amplitude 0, then make that amplitude increase in a symmetrical way (Fig. 6c). If we note a_0 the first amplitude, the following ones may be written

$$a = a_0 \left| 1 - \frac{2k}{n-1} \right|$$

where n is the number of columns and k the rank of the column we consider (n is odd).

The picture thus obtained is perfectly symmetrical around its horizontal and vertical axes. It acquires a certain aesthetic and decorative value that is nevertheless judged insufficient to construct a work aesthetically autonomous. It should be pointed out that the successive changes introduced in the organization of Figs. 6a–c have modified their aesthetic content without affecting the number of axes of symmetry. To break the aesthetically prejudicial monotony of the picture, we introduced a certain quantity of well-controlled disorder, displacing the rectangles in an aleatory way.

The main aim of this operation is to destroy the symmetry of the pattern. The picture hence obtained (Fig. 6c) is not symmetric. The right side of the image is the exact reproduction of the left side. According to our arbitrary rule of construction, each rectangle of the picture could be deviated at random, horizontally and vertically, by between 0 and 6 elementary units (the size of a unit, the point, was variable). Any position of a rectangle then had a 1/36 chance of materializing. With a probability of P=0.027, the chance that 76 pairs of rectangles selected at random take identical positions in relation to the central axis was practically nonexistent, although the pattern seems at first glance — "without scrutinizing" — symmetrical. A closer examination will reveal that obviously each rectangle is not an exact reflection of another rectangle, in relation to the axis of symmetry. It is important to observe that in increasing the size of the elementary unit of the displacement, we modified the level of symmetry without altering the probability structure of the pattern. The picture obtained in this way is still not aesthetically satisfactory.

In our efforts to break a carefully established symmetry, in order to obtain higher aesthetic results, the next and provisionally last step consists of the manipulation of the phase of the sine. Our original sinusoidal distribution was extending over a period of 2π. To obtain a sinusoidal distribution symmetrical with respect to a symmetry axis for a period of 2π, we have used the function

$$y = a \sin\left(t - \frac{\pi}{2}\right)$$

where a is the amplitude. Then we have begun to modify the phase of the sine that governs the distribution of elements in displacing, in a systematic or random manner, the phase of each column. This operation modifies the perceptual organization of the pattern that produces a kind of aesthetically satisfactory, hidden symmetry.

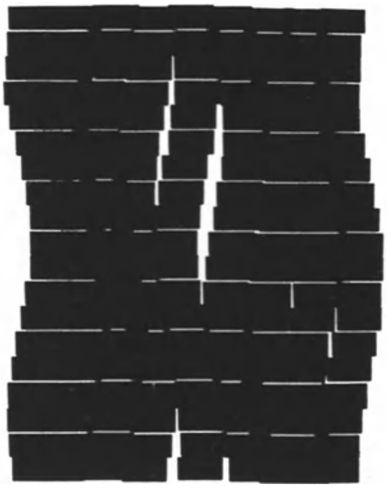


Fig. 7: Vera Molnár, *Hommage à Gabo III*
© VBK, Vienna, 2005

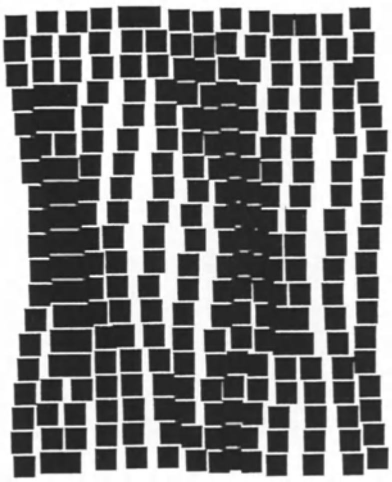


Fig. 8: Vera Molnár, *Hommage à Gabo IV*
© VBK, Vienna, 2005

By modifying the variables studied above and by systematically or randomly varying others, such as the proportion of constituting elements or the distance separating them, we obtain images aesthetically satisfactory like those, for example, shown in Figs. 4, 5, 7, and 8.

Computers & Mathematics with Applications 12B, no. 1/2 (1986): 291–301.

Vera Molnár

the approach i take in all my investigations as a painter is the following: by superimposing color forms over each other it is possible to achieve an assemblage that becomes something else, something "more" than a mere intersection of forms on a surface. if we continue these investigations, what evolves is sometimes a particularly visual phenomenon that evokes the deep pleasure we call "art."

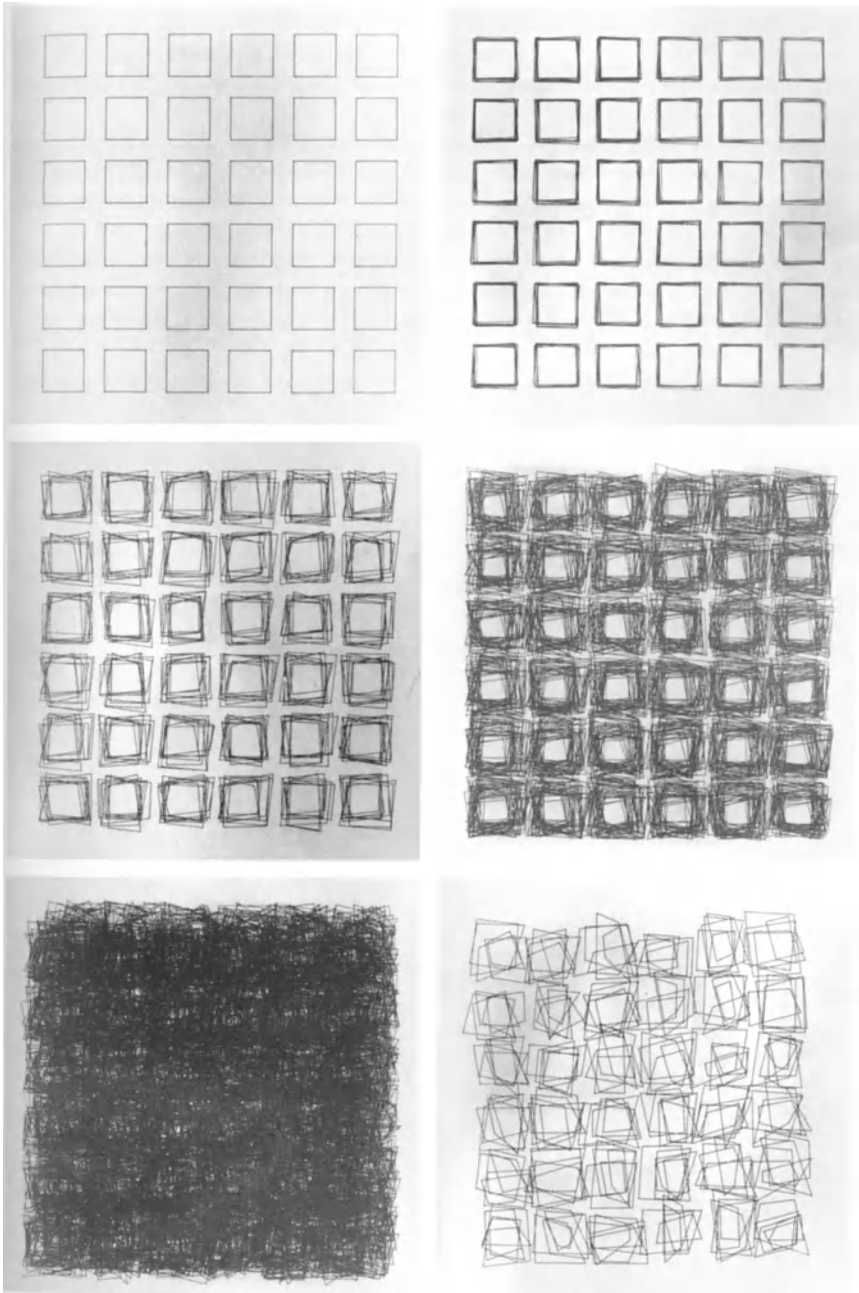
i use simple forms because they allow me to monitor the creation of the image structure step by step and that also offers me the possibility of determining the exact moment at which "evidence of art" becomes visible. in order to enable this systematic exploration, i use a computer.

1983

Vera Molnár, *Computergraphik* (Saarbrücken: Galerie St. Johann, 1990).

Vera Molnár
born 1924 in Budapest. Studied at the College of Applied Arts, Budapest. Professor at the Sorbonne. Lives in Paris.

1976 Polytechnic of Central London, London
1979 Fiatal Művészek Klubja, Budapest
1984 Galerie 30, Paris
1988 Galerie E, Zurich
1990 Vasarely Museum, Budapest
1992 *Zufall als Prinzip*, Wilhalm-Hack-Museum, Ludwighafen
1994 *Europa. Das Jahrhundert der Avantgarde in Mittel- und Osteuropa*, Kunst- und Ausstellungshalle der BRD, Bonn
1995 *Karo-Dame*, Kunsthaus, Aarau
1996 *Histoires de blanc & noir*, Musée de peinture et de sculpture, Grenoble
1998 *Ungarn. Avantgarde im 20. Jahrhundert*, Neue Galerie der Stadt Linz
2000 *Art concret*, Espace de l'Art Concret, Mouans-Sartoux
2004 *Vera Molnár. Als das Quadrat noch ein Quadrat war*, Wilhelm-Hack-Museum, Ludwigshafen



Vera Molnár, from *36 Squares, 8928 Quadrilles (Géométries du Plaisir)*, 1986
30.5 × 30.5 cm each

Tibor Gáyor

Tibor Gáyor
born 1929 in Rákospalota. Studied civil engineering in Budapest. Lives in Budapest.

1975 Neue Galerie, Graz
1976 Szent István Király Museum, Székesfehérvár
1977 Galerie Gamma, Utrecht
1980 Pécs Galéria, Pécs
1983 Galerie Circulus, Bonn
1986 Ernst Museum, Budapest
Museum of Modern Art, Vienna
1993 Bilderarchiv, Szombathely
1996 Albrecht Dürer Gesellschaft, Kunstverein Nürnberg
1999 Éri Galéria, Budapest
2001 *Dora Maurer – Tibor Gayor*, Art Museum, Győr

Group shows
1971 Trigon 71, Neue Galerie, Graz
1977 Geometrica 77, Tulln
1981 *Linie*, Pécs Galerie, Pécs
1982 *Exakte Tendenzen*, Galerie Modern Art, Vienna
1994 *Gáyor, Hencze, Hetey, Konok, Maurer*, Viziváros Galéria, Budapest
2004 *Made of Paper*, Műcsarnok, Szombathely

I deliberately substituted the square — instinctively used, for a long time — with other proportions, which deviated only slightly (5/6, 5/7, 7/8, 7/10, etc.); I also often used the 45° folding axis. The result was an unpredicted wealth of gradually changing folding formations that fully underscored planar/modular serialization.

The formations I am particularly interested in are the ones that have what appears at first glance to be a despicable two-facedness, which aroused additional pseudo-perspective illusions of three-dimensionality and volume in the viewer, above and beyond my intentions.

Operative rules were imposed on the system, which is based on the 4/4 divided square. These rules are easier and shorter to read on the images than they are to verbally explain. In accordance with a reproduction on the surface of the paper, I first kept the scope of the folds generally constant at 180 degrees, i.e., each unfolded, hatched part of the sketches returns to the basic plane after half a rotation. And this circumstance, which temporarily ignored the spatial situation due to representational difficulties, greatly benefited comprehensibility.

The most important conclusions that evolved from the completed system were the following:

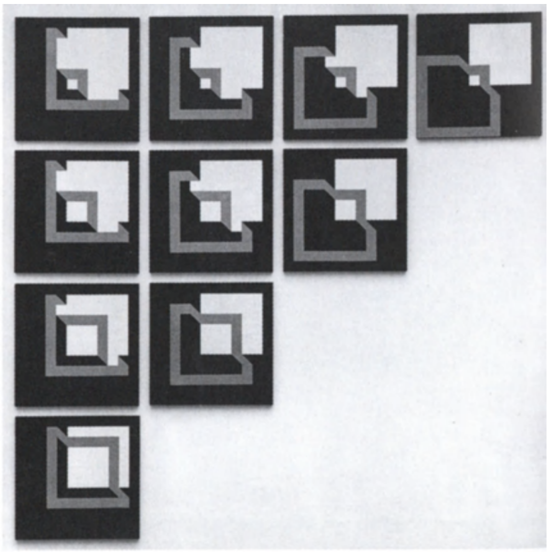
• It was proven that the stipulated rules (square, 4/4 grid, 45° orientation of the folding axes, etc.) act to generate planar and three-dimensional formations;

• The visual transparency of the system (indeed, probably also its aesthetic value) depends on the complete accuracy and unambiguity of the operative rules, which take all details into consideration. Although its extension and refinement does slightly multiply the number and differentiation of the formations, it is only possible to obtain an interpolated assessment of the information created by means of the minimal rules in this way;

• In the case of a computer application, there is theoretically nothing to prevent differentiating between the basic form and the rules, if they can be formulated. The objective, to make the laws comprehensible and legible, is hardly achieved, but the consistent pursuit of this idea does lead to some extremely exciting speculations.

1981
Tibor Gáyor, *Faltcollagen, 1972-1986* (Vienna: Museum of Modern Art; Budapest: Ernst Museum, 1986) pp. 23-26.

Tibor Gáyor, *Q 8-Demontage Spiral,* 1974
Exhibition view: Beyond Art, Budapest 1996



Tibor Gáyor, *Q 8-K2D*, 1977
Collage on chipboard, 90 × 90 cm

Hildegard Joos

Many of Hildegard Joos's friends will be surprised at the great range and diversity of her oeuvre, considering that she was one of the first of her generation to dare to produce such works.

In Vienna, it is traditional to realize precise concepts in art and architecture. It is necessary that the city, with its important social and cultural impetus for Europe, becomes aware of the existence of the people who will carry on and renew this heritage.

The fact that the Secession is honoring Joos and her work ought to be interpreted as a sign that people are becoming aware of values that can be described in constructive, methodical, rational, and logical art — a vocabulary of this era that exemplarily points to the objective of human endeavor.

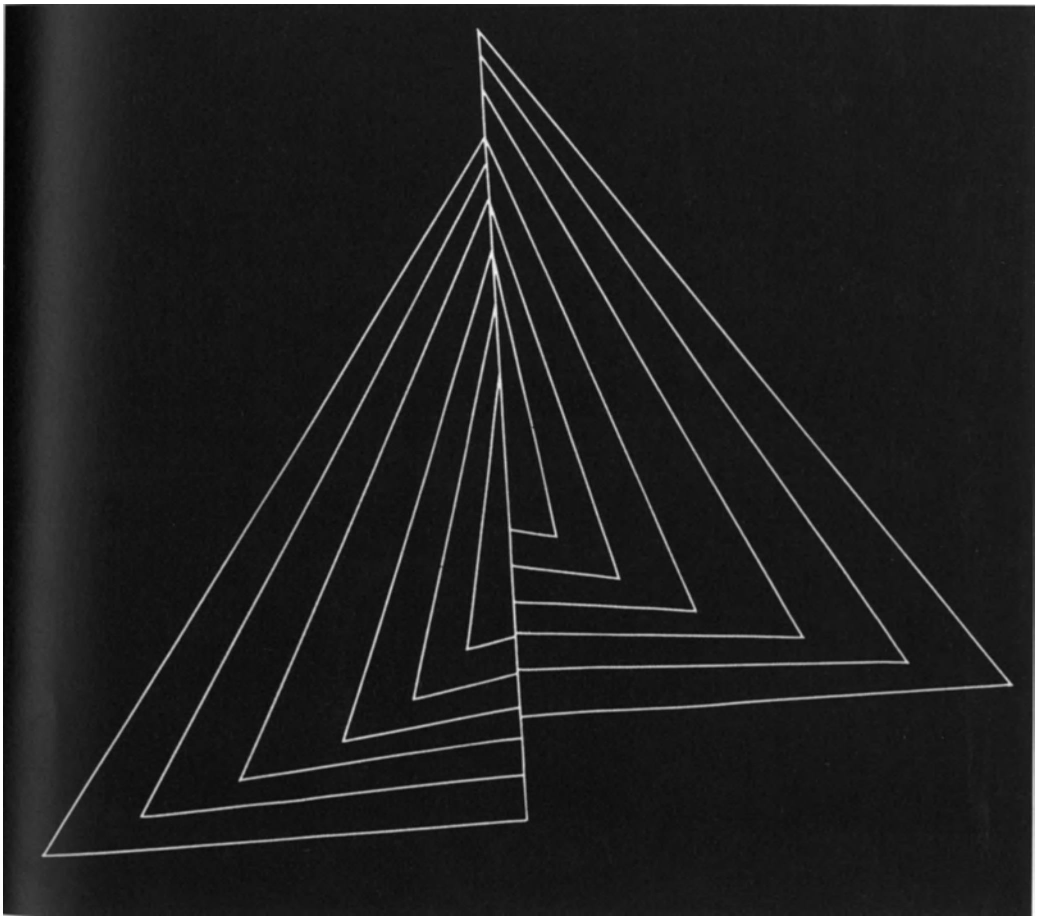
Richard Paul Lohse, *Hildegard Joos, Malerei und Graphik 1959-79* (Vienna: Viennese Secession, 1980).

Hildegard Joos
born 1909 in Vienna. Studied at the Women's Academy, Vienna, and at the Academy of Art, Vienna. Died 2005 in Vienna.

1965 Galerie Jeune, Paris
1967 Secession, Vienna
1968 Palazzo Artelli, Triest
1975 Galerie Grohmann, Munich
1980 Secession, Vienna
1984 Museum of Modern Art, Vienna (with Harold Joos)
1989 Neue Galerie, Linz (with Harold Joos , A. Glück)

Group shows
1960 Grand Palais, Paris
1963 Musée d'Art Moderne, Paris
East Side Gallery, New York
1971 Royal Academy, London
1977 *Geometrica 77*, Tulln
1995 *Doppelbilder*, Galerie Lang, Vienna
2003 *Mimosen - Rosen - Herbstzeitlosen. KünstlerInnen. Positionen 1945 bis heute*, Kunsthalle, Krems
2004 *Gegen-Positionen. Künstlerinnen in Österreich 1960-2000*, Museum of Modern Art, Stiftung Wörlen, Passau
Paula's Home, Lentos, Linz

References:
Mimosen - Rosen - Herbstzeitlosen. KünstlerInnen. Positionen 1945 bis heute, exhibition cat. (Krems: Kunsthalle, 2003).
Des Eisbergs Spitze. Museum auf Abruf, Berthold Ecker, Wolfgang Hilger (eds.) (Vienna: 1998).



Hildegard Joos, *Shifting, 1970*
Acrylic paint on canvas, 128 × 114 cm
© VBK, Vienna, 2005

2

Simon Hantaï

Simon Hantaï
born 1922 in Bia near Budepest. Studied at the Academy of Fine Arts in Budapest, 1942-48. In 1948 he left Hungary and settled 1949 in France. Interested in Surrealism; experiments with new techniques like collage, frottage, grattage, and already the pliage, 1950-53. In 1953, first exhibition at Galerie L'Étoile scellée in Paris, introduced by André Breton. In 1954 contact with Jean Fournier, director of Galerie Kléber in Paris. Hantaï's exhibition "Alice in Wonderland" at Galerie Kléber in 1955 marks his break with Surrealism; he is now tending towards a lyrical expressionism. In 1960 he found the technique of folding and creasing the canvas ("la pliage comme methode"). Exhibition at Galerie Kléber with his "Mariales", 1962. In 1967, exhibition at Galerie Jean Fournier, Paris. His text *Silences rétiniens* is published, explaining his "folding as a method." Large-format pictures are shown at ARC, Musée d'art moderne in Paris, and at Pierre Matisse Gallery in New York, 1970. Series of "Blancs", 1972-73; Series of "Tabulas", with nods in the canvas; 1972-73. In 1976 exhibition at Musée National d'art moderne in Paris; shooting of the film *Silences rétiniens* by Jean-Michel Meurice. In 1979 he moved to Paris. In 1982 his "Tabulas lilas" are represented in the French pavilion, Venice Biennial; exhibition "Tabulas lilas at Galerie Jean Fournier. After that Simon Hantaï left the artistic scene. In 1998, exhibition "Laissées et autres peintures" at Renn espace, Paris with fragmants of large, cut "Tabulas" from 1981. Donation of his works to the Musée d'art moderne de la Ville de Paris, 1998.

References:
Retrospective, Simon Hantaï (Paris: MNAM, Centre Georges Pompidou, 1976).
Simon Hantaï (Venice: Venice Biennial, 1982).
Anne Baldasari, *Simon Hantaï* (Paris: Centre Georges Pompidou, éditions du MNAM, 1976).
Georges Didi-Huberman (ed.), *L'Étoilement, conversation avec Hantaï* (Paris: éditions di Miniut, 1998).

Cher Georges,
vous m'avez parlé d'étoilement. Une grande toile, pliée, à l'envers un nœud à la rencontre d'une verticale et d'une horizontale.
Sur l'autre photo: commencement de l'ouverture, du dépliage. Un noeud apparait. Après: totalement ouverte et accrochée à Bordeaux. C'est l'une des deux *peintures grandes, séparées et liées par étoilement? Pas un soleil. Quoi d'autre, alors?*

Pas oublier qu'il s'agit de pliage. Mise en œuvre d'un processus qui prend en charge, à un moment: 1960, une limite arrivée dans la peinture et rien d'autre que ça; les ciseaux et bâton trempé.
La toile cesse d'etre écran de projection, *deviant matériau, coupant en elle-meme etc.*
l'invaginée   l'involuée   la montagne applatie
le peint et le caché   pliage et dépliage

entre-voie   entreligne   entre-nœuds   entre-coups
entrée   entre-bailleuse   entrelacs   entre-chercher
entreclos   entrelacé   entre-nœuds
–je déraille. Revenons à l'étoilement.
dialectique   ouvert éclatement   spacialisant
diffuseur   dilacération
nœud: plus ou moins grand. *(Ça change tout. C'est meme le seul élément par lequel depuis 1973 les modifications sont produites dans mon travail.) Agrandissement essentiel. Point d'appui matériel pour le non-peint. Un mètre carré de bleu est plus bleu que quinze centimètres carrés de blau (M[atisse]). Ainsi mes agrandissements métriques qui paradoxicalement donnent les modifications structurelles non métriques. Ce n'est possible que par le pliage. Remanié autour des restes de quelque chose d'irréductible.*

Revenons encore à l'étoilement
nœud   donne ça   deplié
vide qui sépare et lie
étoiler   étoilement   cièl étoile
croisée   entrecroiser
entrecroisement   en croix

montagne applatie sous/par les pieds   intervalle
ras de terre   fer à repasser (D[uchamp])   l'entre-deux
l'entre   la fissure   entaillure   liaison
déliaison

Simon Hantaï in his studio amid his *Tabulas*, 1975

– arretons. Vous connaissez la musique.
Pouvoir, maitres, privilège, triomphe etc.
mise en parenthèse.   Et phantasme aussi?   Ah ce fan.
Dans la langue hongroise, il y a des jolies choses là-dessus.
La photo noire de cette peinture, gardée
Il n'ya rien de plus important...

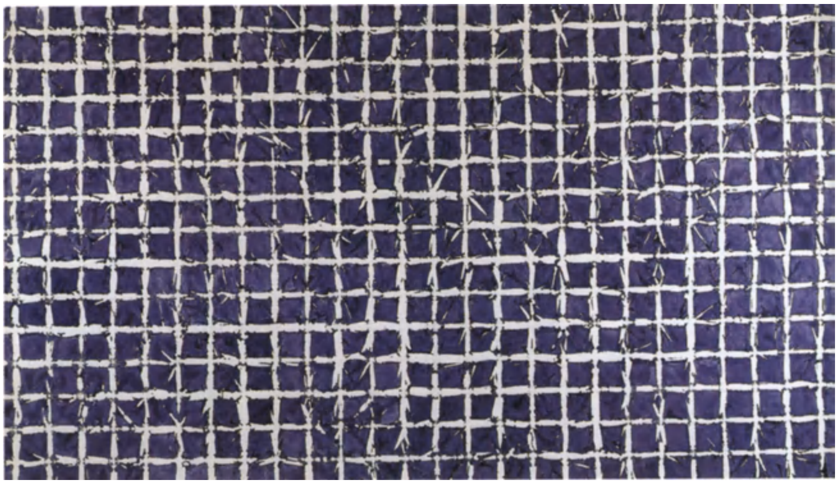
Letters from Simon Hantaï to Georges Didi-Huberman, February 1997 – January 1998
Simon Hantaï. Werke von 1960 bis 1995, Westfälisches Landesmuseum für Kunst und Kulturgeschichte (Münster: 1999) pp. 70-71.

Blanc, before unfolding, 1974

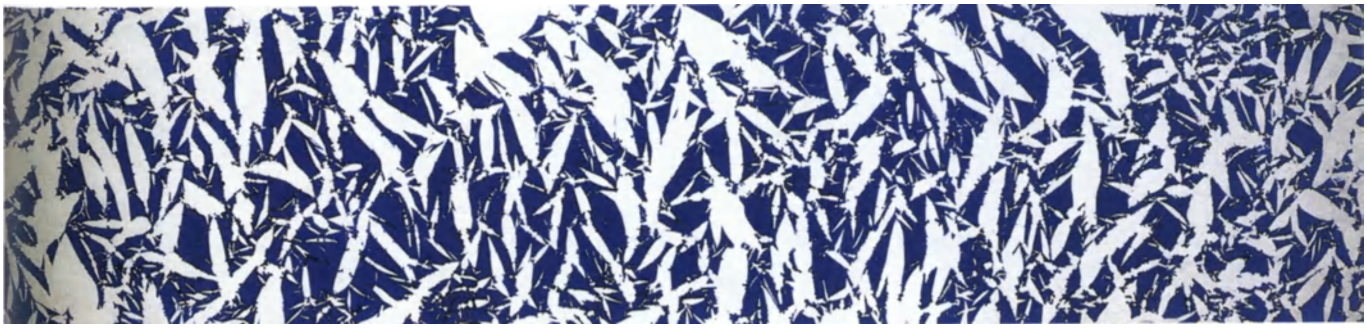
Tabula, before unfolding, 1976

Hantaï, unfolding a canvas, 1981

Simon Hantaï, *Blanc*, 1974
Oil on canvas, 236 × 208 cm



Simon Hantaï, *Tabula*, 1974
Acrylic paint on canvas, 215 × 385 cm



Simon Hantaï, *Étude*, 1969
Acrylic paint on canvas, 116 × 482 cm

2

Péter Türk

Elements and Moments in the Creation of My Pictures

Péter Türk
born 1943 in Peterzsébet. Studied at the Pedagogical Academy, Eger. Lives in Budapest.

1968 Pedagogical Academy, Eger
1987 *Psychograms and Phenomena*, Jozsefváros, Fészek Club, Budapest
1991 Óbuda Galéria, Budapest
Kenyér, Víz, Óbudai Társaskör Galéria, Budapest
1996 *Under Its Shadow I Delighted to Sit*, Kiscelli Museum, Budapest

Group shows
1978/80 *Hungarian Constructivism 1920-77*, Amsterdam; Arnheim; Munich; Düsseldorf; Aalberg
1980/81 *Tendenciák 1, 3, 6*, Óbuda Galéria, Budapest
Erweiterte Photographie, Secession, Vienna
1989 *Szimmetria*, Hungarian National Gallery, Budapest
Más-kép, Ernst Múzeum, Budapest
1991 *A 60-as évek*, Hungarian National Gallery, Budapest
1993 *Symmetry*, Víztorony Galéria, Budapest
1996 *The Butterfly Effect*, Műcsarnok, Budapest
SZÜRENON 69-96, Vigadó Galéria, Budapest
1997 *Ünnepi évkör*, Szombathelyi Galéria, Szombathely
Hommage à Gémes Péter I, Dovin Galéria, Budapest
2002 *Vision – Image and Perception*, Műcsarnok, Budapest

1. The shadow of a treetop, when the sunlight casts it onto paper

In a concrete sense, the shapes of shadows are the basic elements and motifs of my work. In an abstract sense, the cool, protective shade is, to me, God's proclamation of himself, the experience of his presence, sharing in his mercy, the revelation of his love.

2. The paper with small "basins," created by unfolding

When I scratch the fractured lines of a fold into the offset paper with my bone knife, thus creating the "depths" and "heights" of the paper, the paper is prepared to identify with the surrounding space. Beneath a densely foliated tree, it somewhat belatedly reaches the beginnings of Creation.

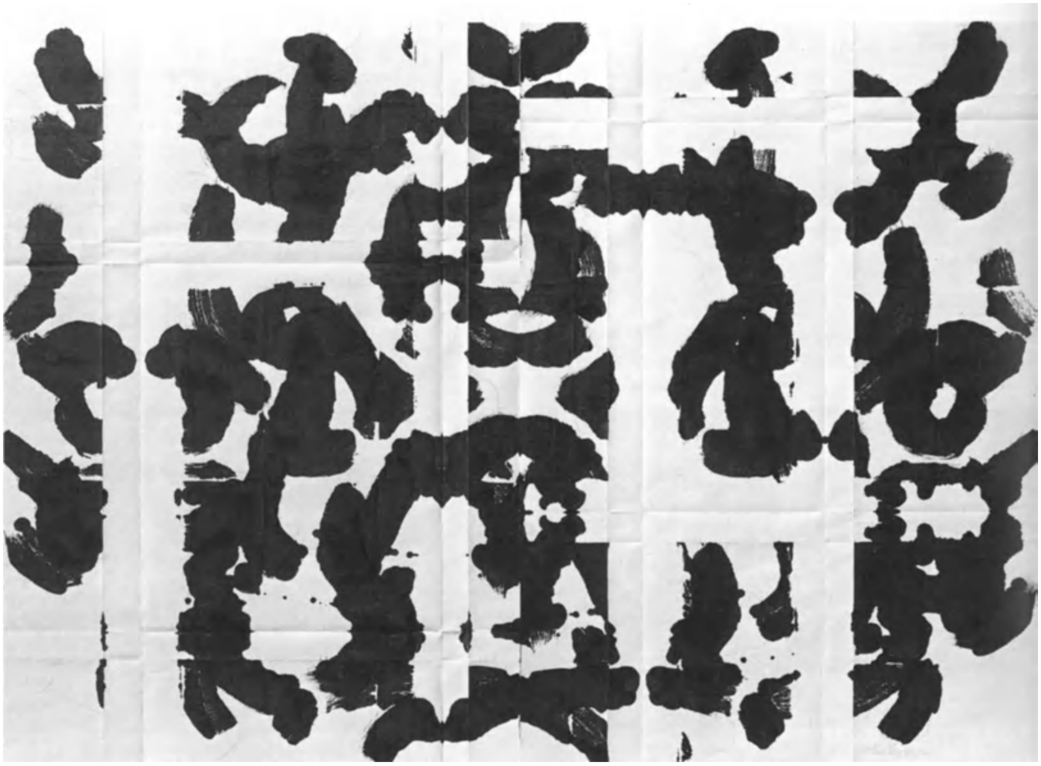
3. The paint that wants to capture the shadow

Matt enamel. Actually, I was looking for something else and owe this to the help of a friendly salesperson. It is exactly the right thing for me. It absorbs the light and reflects it back as softly as silk: it almost isn't a paint at all. Someone even thought that it was good quality Chinese ink. It is exactly the right thing for the very reason that you tend to "paint" with it (it is available by the kilo in tins), and it gives you the liberating courage you need for an almost impossible undertaking.

The shadows that I have to "grasp" with the paint are inviolable, like light; they are reflections of light of varying intensity. They are rhythmically moved as the leaves swing up and down, and vibrate, with changing outlines and lights, like a devoted, living, little universe.

4. I fold the two halves of the painted paper together, then I open them again, and a picture of symmetry appears.

You have to paint quickly, because the paint dries fast. In one or two glances I capture the delicate pattern of the shadow, considering the possibilities of the coarse hairbrush, and then 'make a note' of the most interesting potential connections. It is good and comforting to be in communion with the invisible effect. It is invigorating to be deep within the secret, to dwell there. (It is possible to see these discoveries from a productive, inner viewpoint). I fold both halves of the paper, and the symmetry appears, the symbol of the whole. The holy stands out against the conventional. The whole is just as regular as a leaf on a tree. The message of light is the light itself, holiness illuminating itself.



Péter Türk
Sitting in the Shadow of My Hot Desire, B 7, 1994
Folded paper, enamel matt
70 × 100 cm

5. I smooth the paper, the symmetrical picture begins to move, disintegrates, becomes a plethora of little images.

It is strange. The picture is already determined by the preceding impulses; essentially it is finished, but it cannot be seen yet. The asymmetrically folded paper, with its basins smoothed into the tenths of millimeters and all of its depths and heights, swings the symmetrical colored sign of the whole along a common axis of symmetry above itself.

I unfold the paper and its surface begins to expand in the direction of its own original borders (70 x 100 cm). An opportunity lasting just a few moments, and yet so much happens. Now the picture can unfold in an inviolable way. Here is a story that aims to detach itself with well-meaning rigor from the area of human, artistic influence. An autonomous creativity that nevertheless likes to be seen in human hands. It is necessary to make a very fine distinction here. My limits of responsibility are very sensitive, I must not cross them. I must admit that I do not make anything here: I marvel at the birth, the appearance.

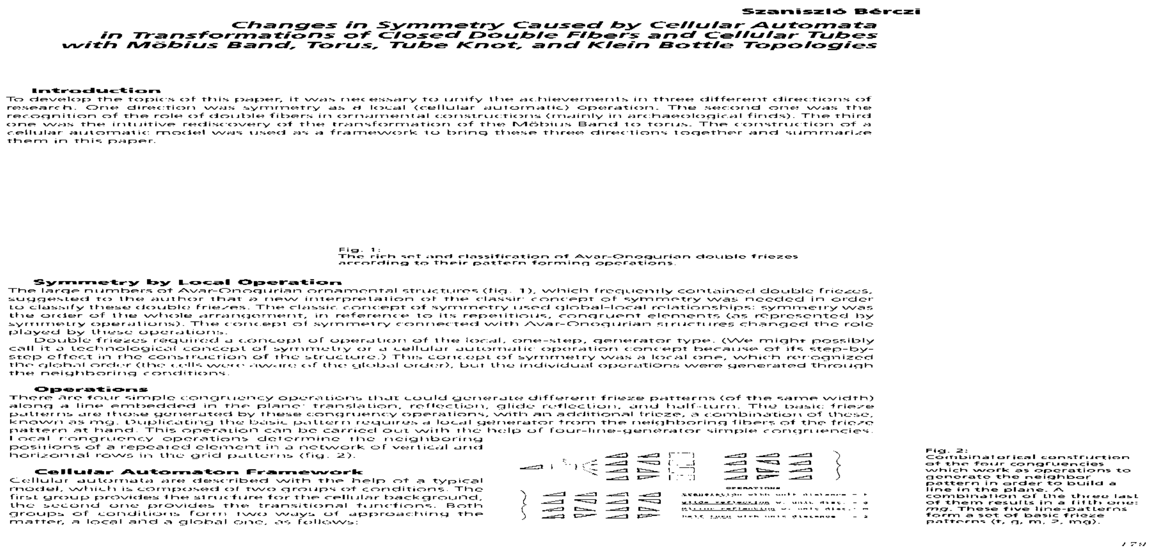
I find the essence of beauty in how the complete whole changes, adapting to the capricious formations as playful love, giving them meaning, holding them together in eloquent unity, and including me in this harmony as well.

This, then, is the way to understand the element that resembles the Rorschach test, which appeared unexpectedly in these works and then "concealed" itself again. My soul (the psyche) reacts naturally and looks toward the deeper spiritual origin (the pneuma) that embraces my existence.

The picture is finished. I feel the pleasant sense of having perhaps followed the call of God, who would be very pleased if I could see him. And then I turn away from the picture and look around, look at something or someone. I become intoxicated with his works and now even with the picture I have just left, from which I was able to avert my gaze at the right moment.

God is a purely spiritual being and the archetype of all spiritual existence. Actually, it is only by starting with God that it is possible to comprehend what the secret is that constantly addresses us — because it is at the same time the secret of our own being.

Péter Türk, *Forró vágyam árnyáwkában ürni* (Budapest: Kiscelli Museum) 1996.



Szaniszló Bérczi

Changes in Symmetry Caused by Cellular Automata in Transformations of Closed Double Fibers and Cellular Tubes with Möbius Band, Torus, Tube Knot, and Klein Bottle Topologies

Introduction

To develop the topics of this paper, it was necessary to unify the achievements in three different directions of research. One direction was symmetry as a local (cellular automatic) operation. The second one was the recognition of the role of double fibers in ornamental constructions (mainly in archaeological finds). The third one was the intuitive rediscovery of the transformation of the Möbius Band to torus. The construction of a cellular automatic model was used as a framework to bring these three directions together and summarize them in this paper.

Fig. 1:
The rich set and classification of Avar-Onogurian double friezes according to their pattern forming operations.

Symmetry by Local Operation

The large numbers of Avar-Onogurian ornamental structures (fig. 1), which frequently contained double friezes, suggested to the author that a new interpretation of the classic concept of symmetry was needed in order to classify these double friezes. The classic concept of symmetry used global-local relationships: symmetry was the order of the whole arrangement, in reference to its repetitious, congruent elements (as represented by symmetry operations). The concept of symmetry connected with Avar-Onogurian structures changed the role played by these operations.

Double friezes required a concept of operation of the local, one-step, generator type. (We might possibly call it a technological concept of symmetry or a cellular automatic operation concept because of its step-by-step effect in the construction of the structure.) This concept of symmetry was a local one, which recognized the global order (the cells were aware of the global order), but the individual operations were generated through the neighboring conditions.

Operations

There are four simple congruency operations that could generate different frieze patterns (of the same width) along a line embedded in the plane: translation, reflection, glide reflection, and half-turn. The basic frieze patterns are those generated by these congruency operations, with an additional frieze, a combination of these, known as mg. Duplicating the basic pattern requires a local generator from the neighboring fibers of the frieze pattern at hand. This operation can be carried out with the help of four-line-generator simple congruencies. Local congruency operations determine the neighboring positions of a repeated element in a network of vertical and horizontal rows in the grid patterns (fig. 2).

Cellular Automaton Framework

Cellular automata are described with the help of a typical model, which is composed of two groups of conditions. The first group provides the structure for the cellular background, the second one provides the transitional functions. Both groups of conditions form two ways of approaching the matter, a local and a global one, as follows:

OPERATIONS

Fig. 2:
Combinatorical construction of the four congruencies which work as operations to generate the neighbor pattern in order to build a line in the plane. A combination of the three last of them results in a fifth one: *mg*. These five line-patterns form a set of basic frieze patterns (t, g, m, 2, mg).

Péter Türk, *Improvisation for TwoHands*, 1986
b/w photograph

Walter Obholzer

Walter Obholzer
born 1953 in Ebbs, Tyro. Studied at the Academy of Arts in Vienna and Budapest. Lives in Vienna.

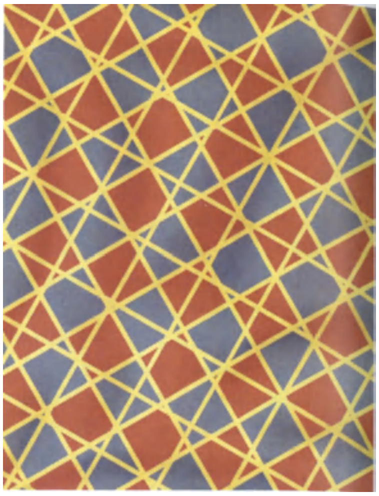
1991 Galerie Thaddäus Ropac, Paris
Kunstforum, Munich
1992 Galerie Metropol, Vienna
1993 Kunsthalle, Innsbruck
1994 Salzburger Kunstverein
Neue Galerie, Graz
2000 Secession, Vienna

Group shows
1988 Venice Biennial
in situ, Secession, Vienna
1989 *Brennpunkt Wien*, Badischer Kunstverein, Baden
Moskau-New York-Wien, Messepalast, Vienna
1990 *Hedendaagse Kunst uit Oostenrijk*, Eindhoven
1991 Biennale, Sao Paulo
1993 *Der zerbrochene Spiegel*, Wiener Festwochen, Museums-quartier, Vienna
1995 *Pittura/Immedia*, Neue Galerie, Graz
2002 *New Art from Vienna*, Massachusetts Museum of Contemporary Art, North Adams, MA
2003 *Poetic Justice*, International Istanbul Biennial
2004 *Ausgewählt*, Galerie Kugler, Innsbruck

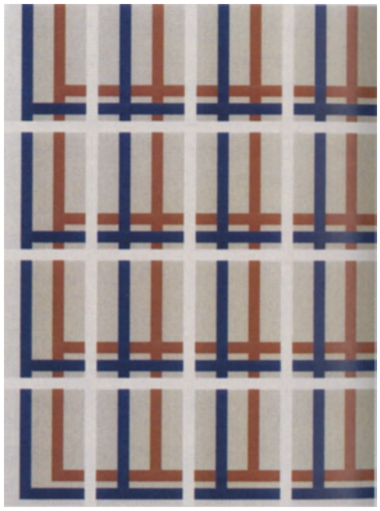
References:
Hans-Ulrich Obrist, *Gespräch mit Walter Obholzer* (Vienna: Galerie Metropol, 1992).
Walter Obholzer (Salzburg: Salzburger Kunstverein, 1994).

At first glance, Obholzer's work could be taken as a tacit corroboration of the notion that painting need not be more than a sophisticated, tasteful adornment of life. In other words, if art offers or evokes something known as 'visual pleasure' (which may be not very different from 'intellectual pleasure'), it is in a certain way regarded as a valuable addition to life. Visual pleasure offers a brief breather from the mundane, albeit often vacuous experiences and rituals of everyday life. When Obholzer celebrates the decorative or the ornamental, it is always within the scope of geometric abstraction, where the analytical decisions in favor of a particular form and structure seem to promote the seductive forces of design. And it is this sensuousness that connects him most strongly to an aesthetics of modernism. It would be remiss to see Obholzer's language of painting as somehow 'post-modern,' as his work avoids seeing history in any self-aware or 'critical' way. On the other hand, his pictures certainly allude to a certain history of painting. But this is a referential language that does not seem to participate in what has so far been a cynical politics of simulation and appropriation. To put it another way, there seems to be an enduring faith in the validity of renewing form within a strictly delimited vocabulary. Thus, Obholzer's works seem to be both clinical and intuitive. Due to the fact that they are predetermined and yet spontaneous, they can be related to the traditional dilemma expressed in much of modern painting. Here, the structure of repetition becomes a kind of release, a force that releases vision into a realm of fleeting and yet genuine pleasure. Obholzer's work is invested with a poetic plainness that is elevated to sublime simplicity.

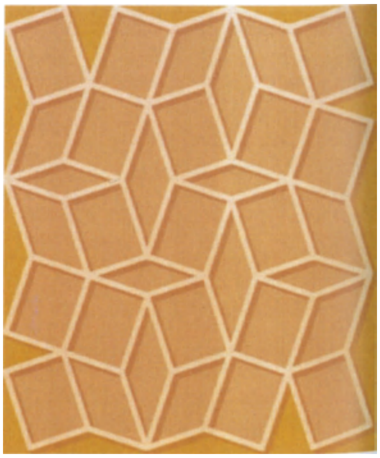
Joshua Decter, "Die Kunst von Walter Obholzer: Die ursprüngliche Lust – abhandengekommen", *Walter Obholzer* (Salzburg: Salzburger Kunstverein, 1994) p. 3-4.



Walter Obholzer, *Box*, 1993
Tempera on aluminium, 44 × 32 × 6 cm



Walter Obholzer, *Grids & Charm*, 1993
Tempera on aluminium, 44 × 32 × 6 cm

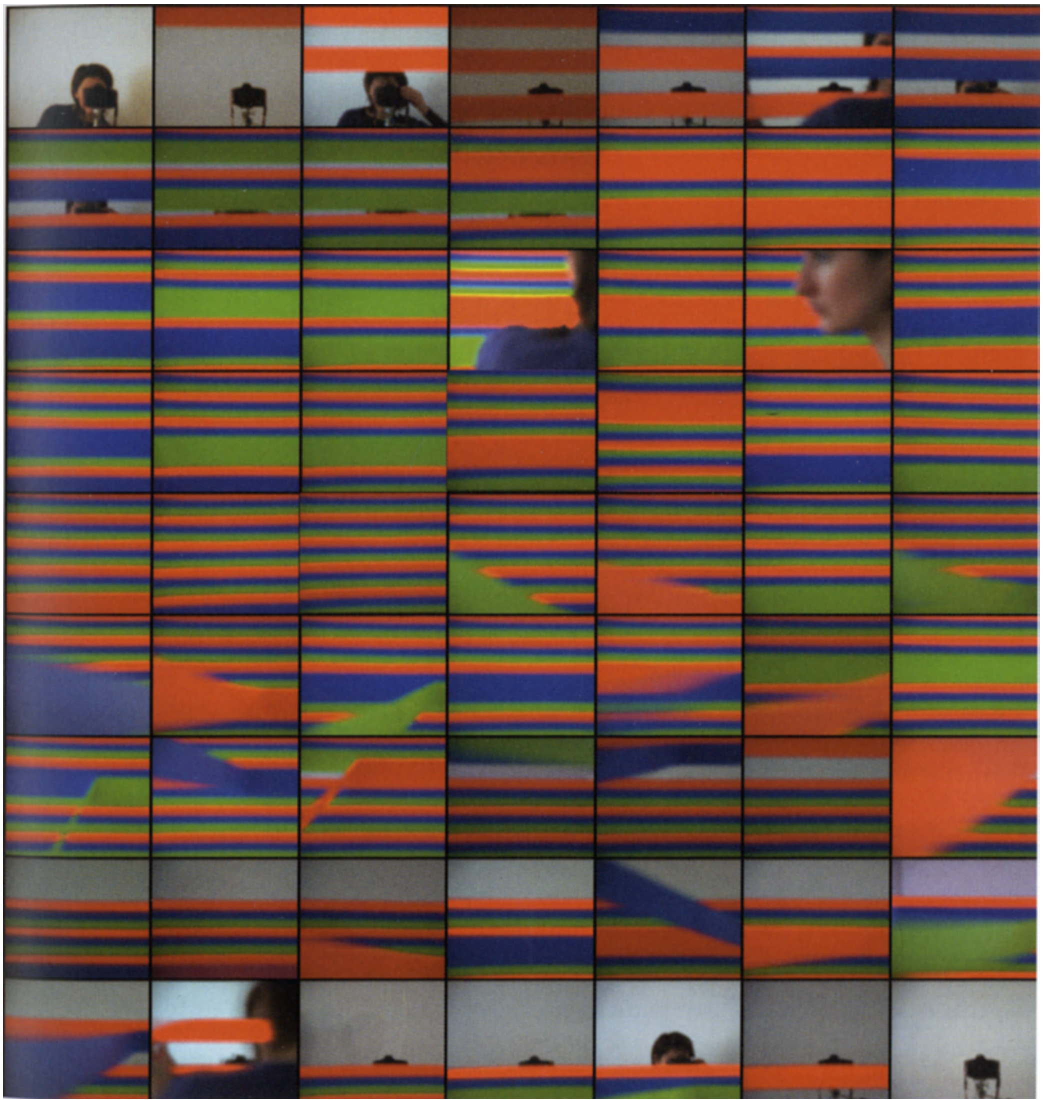


Walter Obholzer, *Otaku*, 1996
Tempera on aluminium, 148 × 113 × 6 cm

Sabina Hörtner, *Untitled*, 2001
Edding marker on cardboard, 135 parts, 50 × 65 cm each, Neue Galerie Graz

Sabina Hörtner's work is based on the drawing that reacts to spatial situations and counteracts, extends, changes, or negates manifest architectural space by way of illusion. For this purpose, she employs a structure composed of horizontal and vertical lines that are combined in clusters of various colors, which creates a kind of grid that recalls three-dimensional, computer-generated models. These are the essential pillars of her interventionist practice — the basic unit of three-dimensional space, the intervention of the illusionary, two-dimensional drawing, and the association with virtual spatial constructs taken from the field of data processing media.

Andreas Spiegl, "Das Manifeste im Angesicht des Virtuellen," *Sabina Hörtner* (Vienna, Graz: Casablanca Galerie, 1996).



Sabina Hörtner, *Untitled*, 1998
CD-Rom installation, *Voorbij de kunst*, MUHKA, Antwerp, 1998

Sabina Hörtner
born 1967 in Bruck/Mur. Studied painting at the Technical Highschool (HTBLA), Graz (with G. Lojen); Academy of Art (with B. Gironcoli), Vienna. 1995 diploma. Lives in Vienna.

1996 Galerie Grita Insam, Vienna
2000 *6 7 - 6 13 - 6 30*, para/site art space, Hong Kong
2001 Neue Galerie, Graz
2002 *808-20*, Rupertinum, Salzburg
2004 *update retrofit 2004*, Galerie Grita Insam, Vienna
17/21-04, Medienturm, Graz

Group shows
1990 *Zwischenstand*, Stadtmuseum, Graz
1994 *Styrian Window*, Neue Galerie, Graz
1995 *Raum annehmen IV*, Galerie Grita Insam, Vienna
1999 *Open Studios*, ISP, New York
2000 *Eye Liquids*, Liquids, Toronto
New Austrian Spotlights, Marmara University, Istanbul
Do Paintings Dream of Veronese Green?, Elga Wimmer gallery, New York
2001 Biennale Intergraf Alpe Adria, Udine
2002 *Reale Malerei*, Kunst Raum, Dornbirn
2003 *Abstraction Now*, Künstlerhaus, Vienna
Heimspiel I, Galerie Schafschetzy, Graz
2004 *Der Widerstand der Fotografie*, Camera Austria, Graz

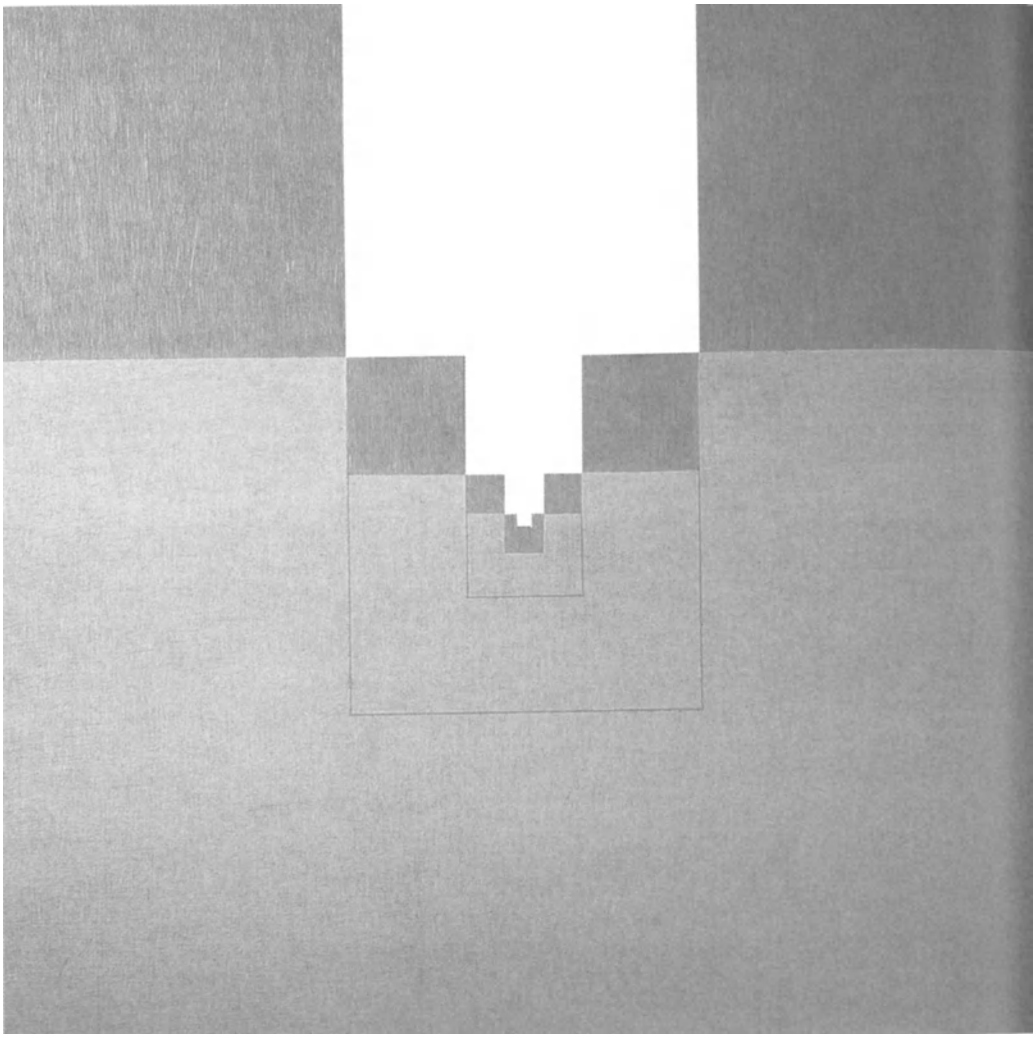
References:
Sabina Hörtner (Vienna: Casablanca Galerie, 1996).
Sabina Hörtner. 01 00 99 98 97, (Vienna: Triton, 2001).
Ulrike Lederer, Hannes Priesch (eds.), *Death in the Studio* (New York, 2002).

János Saxon Szász

János Saxon Szász
born 1964 in Tarpa. Diploma at the Technical University Budapest (T. Csiky, J. Fajó), 1988. Lives in Budapest.

1982 Zrinyi Ilona Gymnasium, Nyíregyháza
1988 M-Galéria, Budapest
1991 Kassák Múzeum, Budapest
1992 Csokonai, Budapest
1994 Városi Galéria, Nyíregyháza

Group shows
1988-91 *Meditáció-kiállitássorozat*, Eger; Győr; Paks; Budapest
1989 *Konstruktive Druckgraphik aus Ungarn*, Vöcklabruck; Passau
Vision d' Europe, Eiffel Turm, Paris
Galerie Claude Dorval, Paris
1993-94 *Lappangó Elem csoport*, Eger; Coesfeld; Győr; Budapest
1995 Pécs Biennial
1993-96 MADI Kiállitások, Győr; Budapest; Paris; Maubege; Milano; Szombathely; Zaragoza; Barcelona; Madrid
1997 *Olaj, vászon*, Műcsarnok, Budapest
1999 *Dátum*, Műcsarnok, Budapest
2002 *New End of Painting*, Galéria Jána Koniarka, Trnava



János Saxon Szász, *Meditative Structure*, 1995
Oil on wood

My pictures are only paintings in the sense that I use the techniques and materials of painting in creating them. They are spiritual signs, components of my series of cosmic prints, which I have been processing for almost a decade.

With our own sensory organs and the physical aids available to us we can only comprehend a fraction of the total cosmos, of the energy field universe composed in and expanded into empty space. For me, the possibility of perfect cognition is to be found in the fabric of intellectual order. The micro- and macroworlds are made of uniform structural detail tending toward the infinite, an irregular mass of energy flowing apart. The boundaries of the various structures are the gates to the dimensions that correspond to the individual cosmic energy levels.

Let us base our observations on two materials with different characteristics: a fabric and a crystal. The wind penetrates the fibers of the fabric's structure, whereas the sublime structure of the crystal is able to withstand it. The real dimensional structure of molecular movement is the boundary, which is why, for example, we can fill a crystal vase with water. In order to attain a new level of freedom of matter and mind, we must deepen our knowledge of dimensional structures. The example shows that the next microstructure floods our crystal consciousness almost as freely as a ray of light passing through the interwoven fabric of our brain fibers.

Gates of Dimensions, **1996**

Szaniszló Bérczi

Changes in Symmetry Caused by Cellular Automata in Transformations of Closed Double Fibers and Cellular Tubes with Möbius Band, Torus, Tube Knot, and Klein Bottle Topologies

Szaniszló Bérczi, born 1950 in Szeged. Main research: planetology and cosmopetrography (moon rocks), symmetry and structure in botany, mineralogy, archeology and molecular chemistry, cellular automates.

References:
Gruber, Bérczi, Zoop (eds.), *Symmetry in Science IV. Biological and biophysical systems,* (New York: Plenum Press, 1990).
Szaniszló Bérczi, *From Crystals to Planetary Bodies* (Budapest: Academic Press, 1991).

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There are four simple congruency operations that could generate different frieze patterns (of the same width) along a line embedded in the plane: translation, reflection, glide reflection, and half-turn. The basic frieze patterns are those generated by these congruency operations, with an additional frieze, a combination of these, known as mg. Duplicating the basic pattern requires a local generator from the neighboring fibers of the frieze pattern at hand. This operation can be carried out with the help of four-line-generator simple congruencies. Local congruency operations determine the neighboring positions of a repeated element in a network of vertical and horizontal rows in the grid patterns (fig. 2).

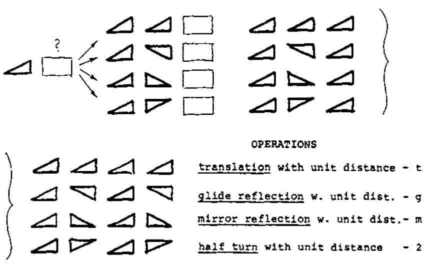


Fig. 2:
Combinatorical construction of the four congruencies which work as operations to generate the neighbor pattern in order to build a line in the plane. A combination of the three last of them results in a fifth one: *mg*. These five line-patterns form a set of basic frieze patterns (t, g, m, 2, mg).

Cellular Automaton Framework

Cellular automata are described with the help of a typical model, which is composed of two groups of conditions. The first group provides the structure for the cellular background, the second one provides the transitional functions. Both groups of conditions form two ways of approaching the matter, a local and a global one, as follows:

A. Cellular background

(Aa) Local characteristics of the mosaic cell system determine the shape of the cells, as well as their connections and relations to the neighboring cells.

(Ab) Global characteristics of the mosaic cell system determine the surface and the combination of the local relationships needed in order to form a whole.

B. Transitional functions

(Ba) Local transitional function for the mosaic cell elements that are individual automata (discrete function in space and time that gradually alters the conditions of the cells).

(Bb) Global transitional function for the whole surface populated by the mosaic cell system (it forms a series of discrete, gradual developments for the surface, as a consequence of the sum total of the local transitional functions of all cells). Although points a and b are not independent of each other, the advantages of the cellular automaton can be traced back to the ability to separate the local and the global image with regard to its conditions and operations as well as the connections shown between the local and global characteristics of the phenomenon.

The Indirect Construction of Cellular Automaton Models: The Indirect von Neumann Problem

The classic way of developing a cellular automaton model was first to construct of the Aa and Ab background and the Ba local transitional function. Then followed the deduction of the global transitional function Bb, which was the primary goal of the construction. We may call this method the direct way to construct the model. (According to von Neumann, the primary goal of cellular automaton construction was to discover a self-reproducing structure based in global transitional functions.) Unlike von Neumann's direct method, the method in this paper is indirect. As soon as we have opened up the background by determining points Aa and Ab, we formulate the Bb global transitional function as a sequence of stages of discrete transformational steps in the mosaic cell system, and finally we construct the Ba local transitional function for the cells themselves. In this work here, the global transitional function consists of two steps and three conditional stages. We introduce them as the following symbols: V – – R (V – for cut, – for motions, R – for sequencing). But before developing the cellular automaton system, however, we want to explain the problem in the usual way.

Crystallography of the Möbius Band

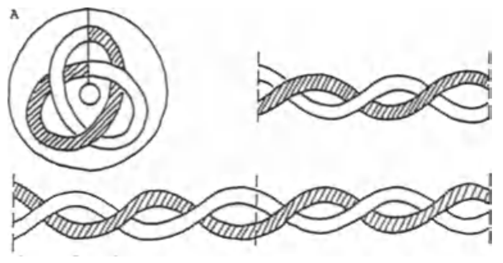
It is well known that a Möbius Band can be made when a finite, long, evenly wide band is cut in a normal way at each end, twisted at one end, and then put together again at its middle axis. This twist, or half-turn, transforms a normal band into a Möbius Band. Let us assume that the band was adorned with a frieze pattern. What kind of frieze pattern remains unaltered after undergoing the transformation just described?

Fig. 3:
Double frieze patterns which are suitable for the Möbius Band (black colored patterns in the double frieze matrix) and three examples. The drawings do not mark the edges of the cells only the repeating abstract element of the pattern represents the cells themselves.

It is important to note that the band contains transparent patterns of cells, which means that both sides of a cell feature the same pattern. As a band is transformed into a Möbius Band, the half-turn acts as a glide reflection for the neighboring cells at the place where it has been reattached. After constructing a Möbius Band out of a normal band, we can conclude that frieze patterns should function as a glide reflection generator in order to fit onto the Möbius Band. This is a local requirement for the cells. But there is a global requirement, too — a numerical one. A normal band must have an even number of cells in order contain a glide reflection. The above-mentioned transformation procedure (cutting and attachment) used to construct a Möbius Band out of a normal band requires that, after the half-turn, one cell must be eliminated at the point of reattachment, because the operation destroys the local order. After a half-turn, there will be two cells with the same (translational) position, and so these two neighboring cells are lacking the necessary glide reflection. To correct this mistake in the order of the pattern, we have to 'cut out' one of these two cells, in situ. That is why the global condition for the number of cells in a Möbius Band structure is as follows: the Möbius Band must contain an odd number of cells with g (glide reflection type) generators. Considering the case of an mg structure, too, we should be aware that it is not the number of cells, but rather the number of units (pairs of cells) on a Möbius Band that are suitable for glide reflection, which should be odd. Of the basic double frieze and frieze patterns, the ones that can fit onto a Möbius Band are shown in black (fig. 3).

Transforming the Torus (or Tubular Knot) to a Möbius Band

In reversing the Möbius-Band-to-torus transformation (i.e., in the torus-to-Möbius-Band transformation), the cell mosaic patterns on the surface are the initial requirements. These patterns are the ones that create a correct double frieze pattern on the Möbius Band after the Möbius-Band-to-torus reversal.



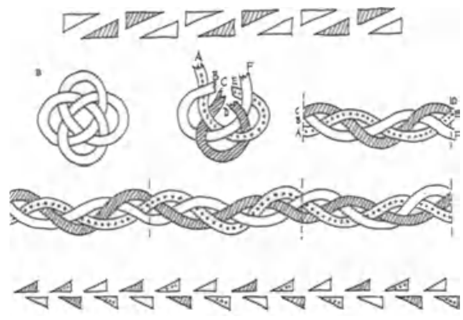


Fig. 4:
Wound frieze pattern representation of the woven structure of the two simplest knot-structures.

The group structure of a knot can be easily understood, when we regard the knot as a representation of a frieze pattern woven from a single strand and twisted around a central point. Fig. 4 shows the two simplest knots with their corresponding frieze patterns:

4.A: The simple knot is the representation of frieze pattern 2 (generated by a half-turn), which is wound around a point. The radius vector crosses two strands at once, but altogether, one strand is twisted around twice, in accordance with to the corresponding alternation of frieze pattern 2 (the half-turn). The twelve repeated elements (analogous to the sections between strand crossings) of the corresponding frieze pattern show that they are not commensurable with an odd number of cell units in the double frieze pattern in the tubular knot of this structure, if the tubular knot can be divided into cells according to a double frieze pattern that can be transformed by the inverse Möbius-Band-to-torus transformation.

4. B: The knot with C4 rotational global symmetry (Carrick Band coaster) is the shortest frieze pattern representation of type g (glide reflection) structure wound around a point. The radius vector crosses three strands at once, but, altogether, one strand is wound around it three times, according to the alternation in the woven frieze pattern g (containing three colors). The twenty-four repeated elements (analogous to sections between strand crossings) of the corresponding frieze pattern show that the frieze pattern of the knot structure may not be commensurable with the structure of the double frieze pattern of the tubular knot of this structure, if its cells are divided so that the double frieze pattern can be transformed by inverse Möbius-Band-to-torus transformation.

Constructing a Klein Bottle with Two Möbius Bands

If we take two Möbius Band double friezes and glue them at their edges, one to the other in a mirrored, symmetrical position, the result is a familiar topological surface: the Klein Bottle (see fig. 5). Two parts must be duplicated. First, the Möbius Band cellular background has to be duplicated with a mirror reflection. Second, the appropriate patterns have to be duplicated. In this operation, pairs of cells work as generators.

On the other hand, the pattern may be duplicated in two ways. In the case of normal duplication, the pattern of the duplicated pair is in phase with the original one. A modification of this normal case is that the duplication may be out of phase. If t, g, m, and 2 lines are duplicated, there is one way (three for mg) to shift a duplicated pattern by one cell unit. This variation results in new duplicated Möbius patterns on the Klein Bottle (fig. 6).

Symmetry. Culture and Science, vol. 4, No. 1 (1993) pp. 50-68.

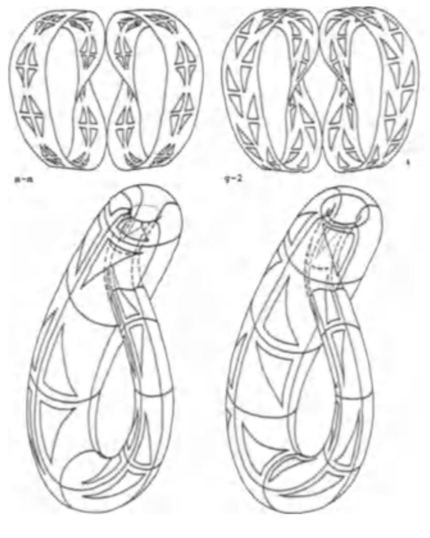


Fig. 6:
Doubled double-frieze patterns on Möbius Bands form patterns on the Klein Bottle which may be produced by gluing a pair of Möbius Bands in a mirror-symmetric position. The two examples show the initial and the final situation for such operations, accomplished according to the deformation sequence shown in fig. 5.

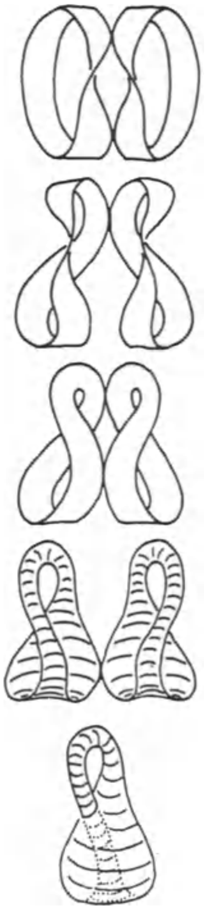


Fig. 5:
Construction of a Klein Bottle by mirror reflection of a Möbius Band.

2

Michael Stöltzner

Symmetry and Natural Laws

Michael Stöltzner, born 1964. Studied philosophy, Russian and physics with a main focus on mathematical physics in Tübingen, Trieste and Vienna. His fields of work are on scientific theory of physics, the fundamental principles of the quantum theory, the philosophy of the Vienna Circle as well as Kant's term of teleology. Lives in Vienna.

Everyone feels subjected to the laws of nature. Once he begins to practice philosophy of nature, he will endeavour to conceptualise this feeling of subordination ... In contemporary natural science the term no longer plays a role; it is only used if scientists become philosophical. I cannot imagine that a representative of physics or chemistry would call one of his discoveries a new law of nature.[1]

Today the words "model," "effect," "equation," and above all "symmetry" have indeed replaced the classical terminology to a large extent. In introductory textbooks, however, Matthias Schramm's pointed remark is hardly proven. There one reads about "Hooke's law of the spring," "Boyle-Mariotte's gas law," "Coulomb's law of electrostatics," etc. Admittedly, education in the natural sciences tends to historicise. But, in the cited examples the classical terminology is primarily an expression of the fact that in physics, at its smallest and largest dimensions, the concept of natural law is entirely marginalized. During the past 100 years, the search for natural laws in these fields has been supplanted by the search for symmetries.

This development began with Maxwell's equations which unified all electromagnetic phenomena that previously had been expressed in four single laws, among them Coulomb's. Einstein's special relativity of 1905 followed almost immediately from a symmetry principle. Independently achieved mathematical progress made it possible to give a more precise formulation of the symmetry concept and to rigorously prove some very general results. Most importantly, Emmy Noether's theorem of 1918 linked the symmetry of the equations of motion – their invariance under certain transformations (so-called one-parameter groups) – with the well-known conservation laws of physics, i.e., energy, momentum, angular momentum.

Already in quantum mechanics, group theory played a key role. This tendency was reinforced by elementary particle physics which for more than two decades was – on the theoretical level – almost tantamount to the quest for the fundamental symmetry group whose representations contained the observed particles. In the same manner as had happened for the periodic system of elements, hitherto unknown particles that corresponded to unoccupied places in the representations were found to have the predicted properties. But even in the legendary standard model SU(3)xSU(2)xU(1), the symmetries are not in the least so perfectly realized as in atomic physics; some masses even differ by a factor of ten. In fact, all predictions have to take into account various other effects, such as virtual processes, which can be treated only by means of perturbation theory. As these approximations are typically highly dubious from a mathematical standpoint, group theory can only provide the framework for the study of concrete models. Moreover, mass as a physical property only originates from spontaneous symmetry breakings which means that not all symmetries of a theory can be realized at the level of vacuum representations. Within the standard model, mass generation is realized by a specific gauge boson, of which one mode becomes massive through the mechanism. This is the famous Higgs-particle, currently hunted by hundreds of physicists in Geneva and other large accelerators. But symmetry breaks have become a generic feature also in other branches of physics, for instance, in solid state physics. While a single atom or molecule is rotation-invariant, in a crystal certain directions are preferred, those connecting the atom with its nearest neighbors in the crystal lattice. Thus, if water freezes, the symmetry of the molecules is broken. This linkage of symmetry breaks and phase transitions is quite a general characteristic of natural processes which – so I shall argue – is responsible for many basic properties of our universe.

Presentday cosmology holds that during the first three minutes of the universe, primordial phase-transitions occurred whose outcomes determined that we nowadays observe matter instead of anti-matter, stable atoms – three fundamental forces of very different strength, etc. In particular, the values of the fundamental constants of nature were fixed by these processes. Modern big bang cosmology implies that the universe originated in a space-time singularity, such that at very early instances it had a size comparable to elementary particles. Thus, three scales can be paralleled: cosmology, energy (or length), and mathematical generality. Early epochs correspond to high energies (or small distances) and more "fundamental" theories consisting of more unified symmetries and larger symmetry groups – or even more general types of symmetry, such as supersymmetry or quantum groups. Accordingly, many physicists conceive of their subject as a pyramid of different theories that is crowned by the often desired universal Theory of Everything (T.O.E.) that should permit – at least in principle and only restricted by the computational power available – deduction of the theories of the lower levels and their fundamental constants.

In light of several concrete examples that figure in the debates about universality, Walter Thirring has formulated a considerably more modest point of view by which the apparently forgotten term "natural law" is reinstated.[2]

1. Matthias Schramm, "Roger Bacons Begriff vom Naturgesetz," in: Peter Weimar (ed.), "Die Renaissance der Wissenschaften im 12. Jahrhundert" (Zurich/Munich: Artemis 1981): 197.
2. Cf. Walter Thirring: "Do the Laws of Nature Evolve," in M.P. Murphy and L.A.J O'Neill (eds.), *What is Life? The Next Fifty Years. Speculations on the Future of Biology*, Cambridge: Cambridge University Press): 131-136; and Michael Stöltzner & Walter Thirring: "Entstehen neuer Gesetze in der Evolution der Welt," Naturwissenschaften 81 (1994), pp. 243-249; from a more philosophical perspective, cf. my "Levels of Physical Theories," in: W. DePauli-Schimanovich, E. Köhler, F. Stadler (eds.): "The Foundational Debate," Vienna Circle Institute Yearbook 3, Dordrecht: Kluwer, 1995): 47-64.

(i) The laws of a lower level are not completely determined by laws of the higher level, even though they do not contradict the latter. What seems to be a fundamental fact on one level may seem entirely accidental if seen from a higher level.

(ii) The phenomena of lower levels depend more on the particular circumstances they refer to than on laws of higher levels. Laws of the higher level, however, may be necessary to resolve internal ambiguities on a lower level.

(iii) The hierarchy of laws has evolved in the course of the evolution of the universe. Newly created laws initially did not exist as laws, but merely as possibilities.

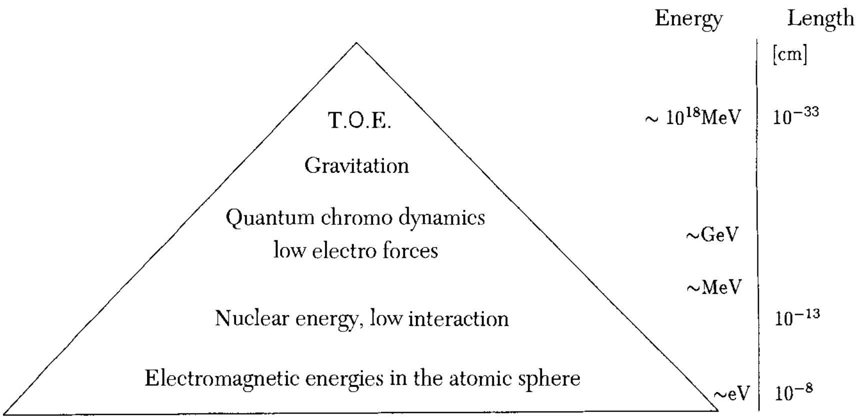


Fig. 1: The pyramid of natural laws as seen by T.O.E. advocates.

Thus, more general laws or more general symmetries typically do not suffice to deduce by pure mathematics all those initial conditions of fundamental constants (e.g., the electron mass) which are necessary to obtain a satisfactory explanation of a certain phenomenon at the lower level. As explanation I define the giving of sufficient reasons as to why the phenomenon occurs in that particular way. Thus, a successful explanation may also have irreducible factual parts, such as constants of nature, as long as they can be determined experimentally. Since Hempel and Oppenheim, modern philosophers of science have considered an explanation as finding certain covering laws from which the explanandum can be deduced. But, this notion of explanation has proven insufficient to properly assess statistical theories. Wesley Salmon has thus argued that, apart from statistical correlations, an explanation should also specify the causal process from which these correlations emerge.[3] The Higg's mechanism, if true, would provide an example of such a process causing a phase transition. As Salmon frankly admits, his concept of explanation might be too restrictive. For the purpose of assaying symmetry breakings and fundamental constants, to my mind, this additional requirement should be slightly weakened in the sense that the mechanism has only to specify a certain set of possibilities. In any case, explanation requires consistency with accepted higher-level laws. The proposed relaxation allows an appropriate dosage of higher level and lower level contributions to an explanation. The part of the lower level is particularly high if the admissible scenarios, viz. the "possible worlds," are of a very different kind, such that a small variation in the value of a fundamental constant would yield drastic changes, e.g., rule out the existence of carbon-based life. Of course, one can never exclude that one day an explanation will be reached by reduction to a higher level. But it seems to be more reasonable than dreaming the dreams of a final T.O.E. to treat cosmological phase transitions and primordial symmetry breakings as historical events in the evolution of the universe. To give some examples, if our four-dimensional space-time resulted from a symmetry breaking within a higher dimensional space which made all other dimensions collapse into the inner symmetries of elementary particles, string theorists still cannot tell why these dimensions were spared. Also the stability of matter around us is accidental from the point of view of quantum field theory because it crucially hinges on the fact that the electron is the lightest elementary particle. In other worlds, the concepts of atomic physics would be utterly meaningless because they would consist out of a superdense plasma.

If, accordingly, laws of nature or some concepts occuring in them emerge as the result of a primordial phase transition, one might contemplate if there are mathematically consistent laws, e.g., the Einstein equations in five dimensions, which could have held true at earlier epochs, but which ceased to be laws after a further phase transition collapsed this fifth dimension. Can laws thus pass away? It appears to me that the empiricist

3. Cf. Wesley C. Salmon, *Scientific Explanation and the Causal Structure of the World* (Princeton: Princeton University Press, 1984).

has to grant this possibility, in particular if there are no traces left in our present universe which permit reconstructing them. The alternative would be to bestow existence to all possible worlds. Let me condense this into a fourth thesis:

(iv) The influence of higher levels on the laws and circumstances emerging from them might disappear and we might not be able to reconstruct the higher level at all from our present universe.

This thesis is also motivated by examples and has a pragmatic status because, in order to rigorously prove that a law has passed away, one would need a law governing this process. Perhaps the law could also contain a constant that quickly approaches zero after a short time.

Let me return to the problem that is behind thesis (i)–(iv). In the quantum theory of large systems (solid state physics) or in quantum field theory (particle physics above all), the state of the system is highly non-unique. On the level of the basic equations or symmetry groups, a considerable arbitrariness remains because very different scenarios are consistent with this higher level. In some cases the admissible scenarios can be classified to such an extent that the decision can be made by the measurement of one or two parameters. But, the higher we climb up in the pyramid, the less hope there is of finding concepts or conditions that structure the set of possible scenarios. And, the more we approach the initial singularity of our universe where all concepts of present physics, such as temperature, go to infinity, the less we have to go on in reconstructing this initial state. But, as the examples have shown, this selection problem already exists in the transitions between well-known levels of the pyramid. Quite generally, experimental predictions are only possible if the state, e.g., the vacuum, is specified. This does not literally mean that every experiment has its own state. On the contrary, states or classes of states specify a whole theory or model, as they express, for instance, the type of interaction assumed, while for single experiments only special parameters have to be fixed in accordance with the general type of the state.

To recapitulate two important lessons of the preceding considerations. First, fundamental constants or, more generally, the results of symmetry breaking phase transitions may represent a genuine part of a satisfactory explanation. Second, the state of a system – which sometimes may be characterized by a fundamental constant or as the outcome of a phase transition – is a major ingredient in the specification of a theory. Both points suggest the question to which I shall now turn. Are fundamental constants or the fact that a certain state is realized in our universe, themselves laws of nature or at least essential parts thereof? In order to answer this question, a short look at the history of the terms "natural law" and "symmetry" seems appropriate because the neat separation between the levels of the equation, which in our century merged into the study of symmetries, and the contingent boundary conditions or circumstances was a major characteristic of Newtonian physics. But, I will argue, the use of the term was always more modest pointing to Newton's three leges which are axioms in present-day terminology. The application of the term "natural law" which I shall propose allows us to answer the above question positively under certain conditions. Physicists, accordingly, still have a chance to discover natural laws, but these discoveries are not as great as fundamental groups or as laws used to be in the nineteenth century.

Newton's *Principia* still determine our use of the term. A key virtue of his approach was to emphasize the formal aspect, especially that mechanics was about second order differential equations, while the question of the essence of gravity was – at least within "natural philosophy" – ignored. Moreover, teleological and theological considerations were restricted to the peculiarity of the initial conditions. Why, among the infinitely many possibilities, was the orbit of the earth so close to circular? Yet precisely theology and teleology stood in the foreground when the term natural law came into use because it emerged from a juridical metaphor. In his seminal paper on *The Genesis of the Concept of Physical Law* Vienna Circle member Edgar Zilsel[4] elucidates this analogy:

> *In a well-governed state there will be laws which are, for the most part observed by the citizens … Let us suppose now the government to be omnipotent and the police to be omniscient. In this ideal case the behavior of the citizens would completely conform to the demands of the lawmaker and laws would always be observed. With such an ideal state nature was compared in the seventeenth century. The observable recurrent associations of physical events … were interpreted as divine commands and were called natural laws.*[5]

> *This picture reaches back to the two most influential books of the Middle Ages, the Bible and the Corpus Juris. The authors of the Old Testament … were inspired by the emotional idea that nature, being ruled by the Lord, must behave as it does, and they restricted themselves to the vaguest indications as to how nature behaves. The same idea of "must" participated in the formation of the modern concept of physical law, but it was supplemented by the exact description of the empirical facts.*[6]

4. Actually, Edgar Zilsel (1891-1944) counted himself among the Circle's periphery. For an overview of his life and principal interest, see Section 3 of Nadja Rottner's contribution in "Beyond Art." Some of the few scholarly studies can be found in Rudolf Haller, Friedrich Stadler (eds.): *Wien—Berlin—Prag. Der Aufstieg der wissenschaftlichen Philosophie* (Vienna: Hölder-Pichler-Tempsky, 1993).
5. Edgar Zilsel: "The Genesis of the Concept of Physical Law," Philosophical Review LI (1942), 246f.
6. ibid., 249.

The concept made its way into the *Corpus Juris* via the stoic idea of *ius naturale*. Throughout Greek science, even in Archimedes, the term "natural law" does not occur. Although Archimedes discovered the law of buoyancy, he did not present it as a law, but in the deductive manner of Euclid's geometry, as if it were a mathematical theorem. "In a mathematical treatise, however, there is obviously no room for the law metaphor."[7] In this respect the science of antiquity is akin to modern theoretical physics in which mathematical concepts, such as symmetry, have replaced "natural law." While in Euclidean geometry, symmetry plays a more restricted role than Euclid's modern students would expect, in Archimedes, one finds some prominent arguments proven by symmetry, for instance, in his proof of the lever law from the axiom of equilibrium or in his reversion of the ray path in optics.[8] Archimedes's axiomatic way of reasoning became paradigmatic for mechanics (then usually called geometry) until Newton. In deriving the law of the free fall, Galileo, for instance, used "proportion" at places where the contemporary reader would definitely put "law." To Galileo, it is simply meaningless to define v=s/t; the only thing he compares are proportions. This makes some of his arguments extremely clumsy. Only Kepler introduces the term "law" – still cautiously – but his motivation was theological in the first place because, for him, the laws of nature were nothing but the divine principles of mathematical beauty which, presumably, were even known to the planets.[9] It was Descartes's division between a purely mechanistic nature (res extensa) and the res cogitans which bears the innate idea of God in its breast which prepared the soil for the Newtonian conception.

Zilsel considered the Middle Ages as a rather infertile[10] epoch for natural science. This is rather surprising in view of the fact that one of the logical empiricists' heroes, Pierre Duhem, had uncovered many unknown medieval roots of modern science, which led him to a pronouncedly continual conception of the history of science. As Zilsel's main project was to locate the sociological origin of modern science in the encounter between Renaissance humanists and craftsmen – a thesis that today seems to be commonly accepted – one might ponder whether he, on the contrary, overemphasized discontinuity when interpreting the concept of natural law.

Matthias Schramm pursues an intermediate strategy and already detects in Roger Bacon (c. 1214 until after 1292) all three characteristic traits of natural laws, namely, to represent a rule that is "1. universal, 2. unconditional, 3. constitutive for nature."[11] Interestingly, Bacon was not referring to the Bible but directly to a physical problem posed by Aristotle.[12] From a modern perspective, universal validity is the most important point. In Bacon's *lex naturae universalis* this idea is already present and it dominates the question of whether the law of nature ultimately originated in God. Schramm concludes:

> *We do not intend the absolute validity of the rule when we consider the expression "natural law" as a somewhat warped metaphor; for, which law would not be transgressed? Roger Bacon conceives the analogy at another point: Just as the laws of the social sphere restrict the tendencies of the individual according to a superior measure, to the end that the community exists and does not fall apart, the laws of the general nature compensate the specific tendencies of the particular natures, restrict them and constitute the world which exists only because the laws hold universally and prevent its destruction.*[13]

Natural laws thus restrict the particularities of the world to warrant its stability. Yet in modern terms, stability is, at bottom, a property of the solutions of differential equations, while symmetries are a property of both the equations and the solutions although the symmetrical groups do not always match. The same equation may have stable and unstable solutions – a feature that often depends on a parameter, although the set of possible solutions may not be exhausted by a reasonably small set of such parameters. But, if one can find a clear and simple distinction between the stable and the unstable solutions, such as the fact that the stability of matter hinges upon the fact that the lightest particle in the universe is fermionic, this might have satisfied Roger Bacon. More generally, if one uses the term "natural law" in the classical sense as a universal rule-like restriction of particularities, I believe both the values of fundamental parameters and the distinction of certain states are more suitably called a law than just being listed as mere subsidiary conditions to other (higher level) laws. Of course, such a suggestion abandons the Newtonian point of view that, in this respect, still prevails throughout post-Newtonian physics. Yet, general relativity, quantum mechanics, chaotic systems unmistakeably taught that even the most cherished concepts are subject to revision. This might hold equally for concepts such as symmetry, whose reputation has increased only in our century, almost to the point of being identified with the idea of a world formula.

There are, of course, at least two dangers in this relaxation of the concept of natural law. First, there are arguments, such as the anthropic principle which, in its weak version, reads: "The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirement that the universe be old enough

7. ibid., 245.
8. Cf. Matthias Schramm: "Symmetrie—zur Geschichte von Wort und Sache," in: Inga Hosp (ed.): *Symmetrien, Dynamik, Strukturen—Bozner Treffen* 1990 (Bozen: Athesiadruck, 1991).
9. Zilsel, op.cit., 267.
10. ibid., 255.
11. Schramm: "Roger Bacons...,"197.
12. It is also ascertainable that Bacon's terminology 'lex' stems form Avicenna's physics.
13. Schramm, "Roger Bacons...," 203f.

for it to have already done so."[14] This version of the principle is consistent with calling these values, at least in a weak sense, natural laws. But, in order to avoid relapsing into the tautology "The world is as it is" it should be emphasized that this rule must be formulated explicitly and universally. The strong version of the anthropic principle is, however, most problematic in view of the history of natural law: "The universe must have those properties which allow life to develop within it at some stage in history."[15] This metaphysical version opens the flood gates of uncritical natural teleology and a physico-theology that is close to absurdity.[16] Second, weak natural laws are even more provisional than all others. Moreover, only few constants and phase transitions should be elevated to this level. Otherwise one is in danger of prematurely renouncing possible reductions to a higher level. Certainly, nobody would believe that material constants which cannot be deduced because of a lack of computational power were natural laws. But it seems, after all, desirable to possess a background theory which allows a certain control over the specific features in the sense that it specifies the places where the undeducible particularities, states or constants, enter. Such a framework, of course, will never appease the dreamers of finality. Instead, its choice framework will be motivated by pragmatic and aesthetic criteria. And at this point, symmetry is once again a useful guide, not for supplanting the laws, but as a regulative principle.

This perspective of a background theory – which is motivated by the algebraic approach to quantum field theory – pays tribute to yet another aspect of the natural law metaphor. Any law – even if its core is derived from *ius naturale* – contains a conventional element. With reference to Poincaré and Duhem, logical empiricists held that experimental data could never uniquely determine a theory. Laws may also become invalid by a built-in expiration or inapplicable if the circumstances they refer to cease to exist. This corresponds to the idea expressed in thesis (iv). The empiricist or positivist cannot refer to an eternal divine world of ideas that guarantees the immutability of natural laws. Instead, at least in the cultural context, both types of laws exhibit a certain evolution. With regard to natural laws, however, their cultural evolution and the possible objective evolution contemplated in thesis (iv) imply anything but post-modern arbitrariness because they refer to an empirical basis. Instead, they represent an attitude of modesty which is open to basic conceptual modifications if they are urged upon us empirically. Moreover, this attitude appears to be a better antidote against "anti-science" than the sedatives causing the daydream of a final theory. Present "science wars"[17] show that heavy artillery fire between well-entrenched bunkers does not move the front-line, let alone favor a cease-fire.

Although – on the philosophical level – the concept of natural law is still identified with science *tout court*, I believe that it provides a much more flexible instrument to correct some exaggerated hopes that have resulted from spectacular successes of reductionism. Reconsidering the term's history supports the modesty in explanation advocated here. Relaxing the concept of natural law, I do not claim – as some radical empiricists do – that science is, at bottom, exhausted by the study of successful models. We should instead keep the criteria of the laws' universal and unconditional validity, but always specify them for a certain domain or over a certain scale.

14. Frank J. Tipler: *The Physics of Immortality: modern cosmology, God and the resurrection of the dead* (London: Macmillan, 1995).
15. ibid., p. 21.
16. This holds true at least for Frank J. Tipler, op. cit.
17. Since the Sokal hoax, literature on this topic abounds. An interesting collection is Noretta Koertge (ed.): *A House Built on Sand. Exposing Post-modernist Myths About Science* (Oxford: Oxford University Press, 1998).

Otto E. Rössler, Arthur P. Schmidt, and Peter Weibel

The Interface Concept in the History of Physics

A stroll through the history of physics leads one to unfamiliar points in the picture where the subject matter is the interface. It opens up links between ancient Greek and Eastern metaphors and concepts of modern media theory. Archimedes, Boscovich, and Everett are highlighted. Everett's discovery of the "many worlds" — that is, many interfaces — has enabled the development of the modern quantum computer. Navigating across Everett worlds becomes a technological option. Even the door to paradise may lose some of its hermetic qualities.

The two angels looking at each other face-to-face on top of the covenant form what is perhaps the oldest example of an 'interface.' Almost equally old is the curved interface between Yin and Yang — that inverted S-shaped line inside a circle marking the boundary between female (Yin) and male (Yang). Anaximander of Miletus, a pupil of Thales of Miletus (who invented Western science), explains, in the few extant lines of his work, the meaning of that Eastern symbol — or so it seems. "The whole" (the full circle) is unrecognizable, but something recognizable (the interface) is "secreted" inside it. *Apokrinein* was the Greek word he used for the secretion process. In modern medicine, the term 'apocrinic glands' still refers to those organs of the body — such as the female breast — which generate their secret secretions by separating part of the volume of a living cell. In those older days, *apokrinein* primarily referred to another, more specific secretion (in the act of making love). The arc of the Yin-Yang symbol is thereby closed. Clear recognition and love were one and the same thing in antiquity (compare also the biblical "Adam recognized Eve"). Is consciousness in its essence orgiastic?

A synonym for the word 'interface' is 'cut.' The word play, "blood-stained cut, tender interface" comes to mind. In physics, two cuts are particularly famous: the Minkowski cut and the Heisenberg cut. The former goes back to the relativity theory of Einstein, the latter obtained its sharpest form in Hugh Everett III's relative-state theory. In both cases, the word 'relative' refers to the 'relative state' between an observer and the rest of the universe, or the interface. Had the word 'interface' already been available in 1905, Einstein might have preferred it to the less intuitive word, 'relativity.'

Einstein's theory of relativity is a theory dealing with 'macro interface.' A macro interface is formed whenever an observer as a whole is in motion relative to the rest of the universe, whereby the mysterious constant c (the velocity of light) comes into play. Everett's relative-state theory deals with 'micro interface.'

A micro interface is formed whenever something is in motion in an observer relative to the rest of the universe, specifically the many small particles of which he or she is made up; whereby the mysterious constant h (Planck's quantum of action) comes into play. But, you may be asking at this point, can a microscopic difference in motion possibly make a difference? An example shows that this is the case. If everything in the world suddenly moved in a direction opposite to the way it had before (in what is called a "time reversal"), it would be the same as if everything inside me were moving in the direction opposite to the way it moved before.

The first physicist who definitely recognized the importance of the 'difference principle' was Archimedes of Syracuse. Everybody has heard of the Archimedean point. In the original text, he said (in Doric Greek), *dos moi po sto kai kinaso tan gan* — "give me a place to stand and I shall move the Earth." This external position does not exist. From inside a system, the center of mass cannot be changed by any means. This holds true all the way down to the microscopic realm, as the modern example of 'heat noise' shows. My center of mass would not move a bit if I consist of nothing but quivering particles. But as soon as a single external particle is added to the dance, having collided with me just once, our joint center of mass will be the one that is fixed. To my own external particle in question — and to any other external particle. Hence, every external particle vacillates objectively for me, even if, in reality, it were motionless.

It took exactly two thousand years before another Italian physicist, Ruggiero Guiseppe Boscovich, put the difference principle back into the center of physics in 1755. Boscovich had been inspired by Leibniz's insight that to the ant, a grass leaf looms as large as a tree. The first flight simulators exploited this effect: a fiber-optics camera (like the ones used to investigate the lining of a stomach in pain) was mechanically moved over a mini-airport the size of a table. The 'endoscopic' image obtained was then projected in enlarged form on the windows of an artificial cockpit. The 'virtual reality' in a computer is nothing but a further development of this. Is true reality also perhaps a virtual reality — that is, an interface reality? This is the meaning of the claim made by Boscovich in his best-selling textbook, *Theory of Modern Physics* of 1758 (literally, *Theory of Natural Philosophy*, in Latin). It apparently inspired Kant's famous "Copernican turnabout." Boscovich actually stuck his neck out even farther than Copernicus did, as Copernicus had chosen to look at the Earth — and the sun — from a distant vantage point. Boscovich bypassed the boundaries of the universe when he imagined that the whole universe might be breathing (expanding and contracting), with all its forces joining in unison. Then one would not notice anything ("the impressions would be the same") for the "difference" would be invariant. This is the interface concept in pure form. Reality was turned into an interface reality.

When, in 1958, Niels Bohr reminded the world of the bicentennial of the publication of Boscovich's book, Everett's relative-state formulation of quantum mechanics had just appeared, in 1957. Everett revived Boscovich, just as Boscovich had revived Archimedes. Everett's theory has also gained wide appeal outside the world of physics, under the name "many worlds theory." Whenever I observe a quantum phenomenon (like the click of a Geiger counter), then, according to Everett, the universe splits up into two worlds. On the one "branch," the click has taken place, on the other, it has not. I belong only to the one branch containing my consciousness. My 'clone' in the other world has his or her own consciousness.

At first glance, this looks like a subjectivist theory. Only consciousness seems to create the world, a stipulation that, in the twentieth century, goes back to John von Neumann (who had used essentially the same quantum equations twenty-five years before). In antiquity, it can be traced to Aristotle ("without consciousness no time"). However, such a subjectivist interpretation would do injustice to Everett, for he is concerned only with science, not with philosophy. At no point does he talk of consciousness, only of the latter's material correlate — that is, the observing, partial system of the universe relative to which the rest of the universe manifests itself in a measurement. In the technical jargon used by Everett, relative to the partial wave function of the observer, the partial wave function of the rest of the composite system assumes a well-defined "relative state." The resulting objective difference — the interface — is then inherited by the consciousness of the observer — provided he or she has any. The latter question, however, is left open. For consciousness (so we may add here, along with Erwin Schrödinger) cannot be demonstrated in the world because something that contains the whole world cannot possibly be found inside of it.

The total universe — the circle — was assumed by Everett to be of a quantum mechanical rather than classical nature. This was his concession to the physics of his time. When dealing with a coup of this magnitude, however, it is perhaps not surprising that this was an unnecessary restriction. Everett's "total wave function" can be replaced by the classic "total Hamiltonian function," in a Newtonian sense. A chaotic universe of billiards, implemented in a computer using the first Newtonian principles, is a case in point. The reality of internal interface still possesses quantum mechanical properties. This at least follows, as far as the currently available tools used in analyzing the interface allow (the current upper limit of resolution is between two and three particles). At this point, the physics community is holding its breath. The new holism was given the name "endophysics" by David Finkelstein in 1983. Endophysics means "physics from within." Physics thus becomes a special case for media theory.[1-4]

Medium means 'in-between.' The fish, according to Chuang-Tzu, does not see the medium of water in which it swims. Human beings are incapable of seeing two media — the empty mirror of consciousness (the big medium) and within it, the quantitative relations, the interface, which to us means the world (the little medium). If we again skirt the big question of consciousness and focus only on the smaller one of the two movie screens, we come up with a new question: can the objective world be manipulated by manipulating the interface?

The quantum computer created by David Deutsch, David Albert, and Peter Shor is the first example of this new technological thinking. Everett inspired the inventors: different branches can be superposed. In this way, one can have many different Everett worlds work together simultaneously — which explains the astounding enhancement of computational speed.

The question posed above concerning the manipulability of the interface goes, however, even farther. David Albert's question, "can one take a picture of another Everett world?" made headlines, as did, "can one disembark from one Everett world and commute to another?" If the cut of the Now is nothing else but an Everett cut (as David Deutsch recognized), a Now control becomes conceivable. As with any time machine, immortality would be a side effect. Even more important than those two questions, however, is perhaps a third: is paradise among the approachable Everett worlds, too?

Astronautics — cosmonautics — holonautics: a new comparative superlative? Is the "world change machine" a natural continuation of the interface idea of the last two and a half millenniums of physics history? Where is the bug? Its name is "counterfactuality." Counterfactuality, according to Henry Stapp, means that even if it worked, it would be of no use (it would be against the facts, that is, not deducible from them). One can, for example, only be in one Now at a time. A migration between Nows would be like a transmigration of the soul: even if it worked, it would be unverifiable. For no whole world can contain a trace of another whole world because otherwise it would not be a whole world. Everett worlds are like the Now. That Schrödinger's cat is following the quantum ordeal, alive and frisky in another Everett world, is not detectable in the sad Everett world (and vice versa). The same hermetic quality could still hold true, if not only the individual results of a quantum measurement would vary from world to world, but also the corresponding mean values. That also the mean values (and hence the constants h and c) vary from Everett world to Everett world is suggested by the above-mentioned classic extension of Everett's theory. In the unrecognizable exo world (the circle), there would exist neither quantum events nor a finite speed of light. In each endo world, on the other hand, counterfactuality would make sure that every single cut remains sealed. An accomplished world change would thus be too successful, in a sense. If everything has been changed, no trace of a previous whole world remains. The Now is a case in point.

Could it be that, in spite of counterfactuality, a fixed Archimedean point is implicit in interface theory? The door is just a little bit ajar. The existence of more than one Everett world is empirically decidable. There is an experiment, the relativistic Bell experiment, which permits the probe. It was discussed in 1988 with John Bell, the discoverer of the famous quantum nonlocality. That the experiment has not been performed yet is in part due to the fact that no one seems to have any doubts about its outcome. But proving it would be to little avail, one might object, since each of the two Everett worlds remains hermetic. The captain in the one spaceship (in which the one measurement takes place) and the captain in the other spaceship (in which the other measurement takes place) each remain trapped in his or her own world. By letting each know that a second world inaccessible to him or her, exists, 'virtually nothing' would be gained.

Once the existence of something has been demonstrated, however, often something tangible follows suit. A thin thread can be used to pull a thicker one. A successful transfer can be verified in principle, as long as not only individual measurement results, but their mean values as well, are world-specific (as has been conjectured above). In this case, the manipulable physical parameters of the universe, which co-determine a cut world's mean values in a counterfactual fashion, can be twiddled before the transfer in such a way that, in the post-transfer world, the counterfactual mean value contains a decodable message.

The basic idea goes back to Carl Sagan, who in the 1970s co-designed the voyager space craft (with the golden record that carried Einstein's voice and the song of the humpback whales into outer space), and who, as a TV star in the early 1980s, engaged a whole generation in a deeper understanding of our cosmos. Toward the end of his life, he wrote a science-fiction novel that became a bestseller and a movie, Contact. The novel features the number *pi* (the ratio between circumference and diameter of a circle in the plane); like any real number, it contains every meaningful text somewhere in its infinite digit string. In the novel, it is assumed very early on that in the computer-accessible range of digits, a decodable message exists in pi, which fits into the narrative. While, for mathematical reasons, this hope is rated as "almost infinitely improbable," the idea to use constants of nature as information carriers is timeless. A transfer to those poor (only twelve digits known so far) physical constants h and c, which cannot yet be reduced to pure mathematics, is perhaps less daring and easier to falsify.

To conclude, a single melody has been plucked from the polyphonal history of physics. It is both encompassing and simple, a circle with a snake inside. The symbol of holism. Is interface physics perhaps a part of esoteric (new age) physics? The Greek word eso means 'from within.' In this sense the name is applicable. Moreover, readers familiar with esoteric and holistic literature may have re-encountered some of their ideas. Don Juan, the late Carlos Castaneda's mystic teacher (see reference 5 for a photograph of the real Don Juan) promised feats like Kurt Gödel's, the first inventor of a scientifically based (if up until now unrealistic) time machine. The same, however, holds true in the other direction. If there existed a scientific technology that enabled a return to paradise, a Holy Grail would have been found at the same time. Science, then, would have achieved as much as has been dreamed of by the esoteric community. Since the manipulation of the interface has not yet reached the stage of concrete feasibility, except for the quantum computer, it appears to be a good idea to recall the history of the interface concept — in the hope that a reader will be encouraged to take the next step.

Epilogue

Art and media have always been close. That science enters as a third element is unexpected. Modern mass media, with their capability to transport the viewer/user into another, virtual world, have changed our attitudes toward the word 'reality.' Reality is no longer the 'sole reality,' but a medium. The user feels entitled to free choice. The 'little medium' of physics unexpectedly complies with what a couch potato has learned to expect. Zapping and creating global self-help communities are no longer alone. A new technological option comes in, as a third leg so to speak. The quantum computer currently on the horizon is only a first example. The physical theory that spawned it is infinitely more powerful. The merger of physics with media theory represents a new reality of its own. Welcome home.

For J.O.R.

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Our thanks go to Michael Stöltzner, Roland Fischer, Roy Ascott and René Stettler for stimulation.

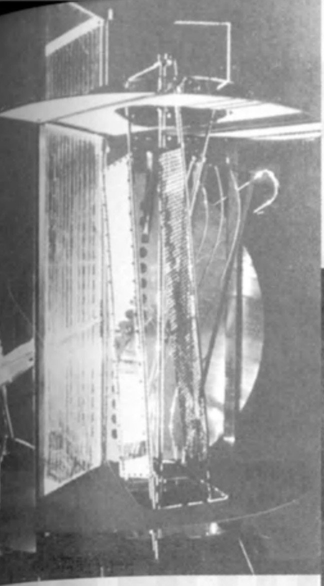
measurement observation

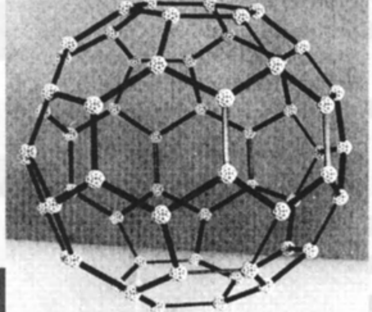
Even though the basic stance of nineteenth-century physics, still founded in naive realism, interpreted all discovered laws of nature as the final way to describe reality in and of itself, it was Einstein's theory of relativity, and, most especially, quantum theory, which incorporated the observer into reality as registered by measurement. It was hoped that Laplace's demon, a creature supposedly able to calculate all initial conditions for the universe, would lead all of natural science back to mechanical processes, yet it proved to be an illusion. The new physics was no longer mechanical, but rather mathematical: the objects of its theory could no longer be represented according to the accustomed view of Newtonian mechanics. Both Austrians and Hungarians were significantly involved in the development of quantum theory, including Wolfgang Pauli, Victor F. Weisskopf, and naturally, Erwin Schrödinger, whom Alexander Zartl views from a less familiar side.

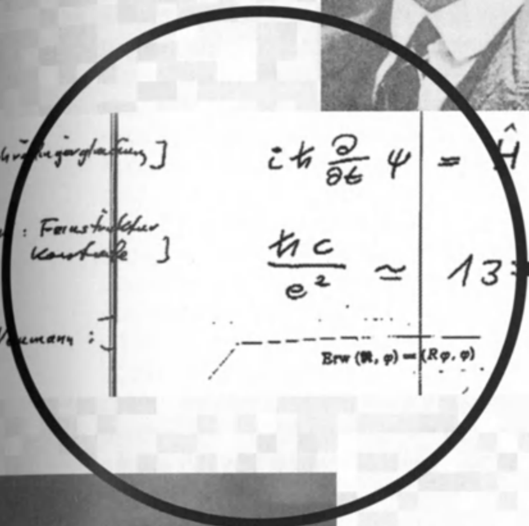
Johann von Neumann can be thanked for the modern mathematical formalism of quantum theory. As Miklós Rédei shows, Neumann had already worked out the perspectives of a comprehensive and mathematically rigorous quantum statistical physics in the 1930s. The "Vienna School" of mathematical physics, founded by Walter Thirring, also stands within this tradition. In an amazingly short work, Thirring sketched out the successes and limitations involved in the attempt to translate ergodic theory, which goes back to Boltzmann, into the quantum world. Wolfgang Pauli, the mathematical 'conscience of physics,' embodied two contrary Viennese traditions, as sketched out by Harald Atmanspacher: Mach's empiricism, and psychoanalysis as influenced by C.G. Jung.

But as Karl Svozil shows, Laplace's demon and all of its relatives by no means fell victim to quantum revolution. The virulent problem of standpoint in the demon is such a basic one that it seems worthy of a new name (Otto E. Rössler's endophysics), with which Peter Weibel forges a link to art. Modern artists often bring their deeds, as well as those of the viewer, into their work. In modern media art, the viewer becomes a part of the image while viewing it and therefore alters it. With their virtual model worlds, in which the viewer moves, interactive computer art works sharpen the problem of the viewer that was already laid out in the perspective-oriented painting of the Renaissance. Limitations as well as distortions appear for the observer, but he also gains new, authoritative powers, not unlike the role of the observer in quantum physics. Eugene P. Wigner analyzed the problem of measuring. Techniques of observation and measuring in art also physically lead to changes and interventions in the image systems under observation (Gottfried Bechtold, Gábor Császári, Attila Csörgő, Ruth Schnell).

However fundamental the role of the observer is determined to be in quantum theory, the person who experiments is more than a mere artisan. Anton Zeilinger presented the "paradoxa" of quantum mechanics in simple intellectual experiments, and with the help of computer simulation in an actual experiment. János Sugár tried this with artistic means. The computer simulations of imbalanced processes, introduced by Harald Posch, allow for the anticipation of essential traits of the fundamental concepts of reversibility and irreversibility, phenomena with which also art is involved. (Dóra Maurer, Herwig Turk).



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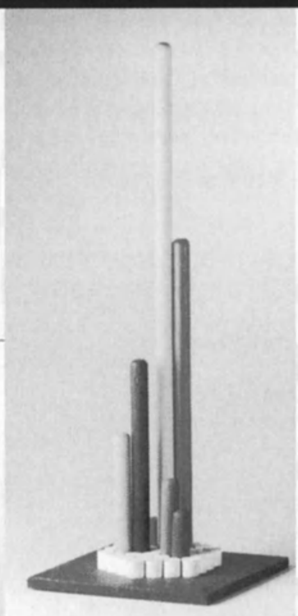

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measurement observation

Miklós Rédei

John von Neumann – Mathematical Physicist

John von Neumann (known in Hungary by the name Neumann János) was without doubt one of the greatest scientists of the twentieth century. The extraordinary breadth of his scientific activity was paired with an incredibly profound and sharp analysis of every problem to which he turned his attention. Although he was first and foremost a scientist, his activity was not limited to the sciences. He was active in politics and science management, a member of a number of committees and advisory boards, and he influenced the decisions of the U.S. government during World War II and the subsequent years. After providing a short biography of von Neumann, this essay will attempt to point out and comment on some characteristic features of his achievements in mathematical physics and in quantum mechanics in particular.

John von Neumann was born in 1903 to a well-to-do Hungarian family. His father, a successful banker, became wealthy during the calm, economically prosperous years of the Austro-Hungarian monarchy, which ensued after self-rule was introduced in 1876. Accordingly, he received a first rate education. He began studying German as a child (one of the servants in von Neumann's house only spoke German; Max von Neumann, John's father, hoped that his would foster the linguistic skills of his children). He also spoke fluent French and English. When the time came, von Neumann went to the renowned Protestant high school in Budapest. His talent in mathematics soon manifested itself there, and, while still a high school student, he started studying mathematics under the guidance of faculty members of the Technical University in Budapest. By the time he graduated from high school, professional mathematicians had already accepted him as a colleague. After studying mathematics in Budapest and chemical engineering in Zurich and Berlin, he finished his studies in Budapest with a Ph.D. in mathematics (axiomatic set theory) and at the Swiss Technical University in Zurich with a diploma in chemical engineering. After a short stay in Berlin and Hamburg as associate professor, he was invited to Princeton, New Jersey, to lecture in 1930, and he ultimately became one of the first permanent professors at the Institute for Advanced Study, established in 1933. (Since von Neumann took up residency in the U.S.A. relatively early — before the political situation in Europe became unbearable — he never considered himself a refugee scientist.) Von Neumann retained his academic position at Princeton until his death in 1957, but he spent much time traveling and lecturing at different universities and research institutes. He was not yet 54 when he died of cancer in 1957.

Johann von Neumann, born 1903 in Budapest. Universal scholar. Lectured at various European universities. 1933 emigration to the USA. Lecturer at the Institute for Advanced Study Princeton. 1926 he wrote the first axiomatic theory of quantum mechanics. 1944 he and Oskar Morgenstern developed the games theory through the application of the axiomatic method in their book *Theory of Games and Economic Behavior.* In this theory his ideas have remained pioneering up to today by uniting algebra and geometry for the first time, in artificial intelligence and in his theory of self-reproducing automates. He is regarded as the father of the computer. Because of his political convictions – his aversion against Nazism – he decided to take part in the production of the atom bomb. He died in 1957.

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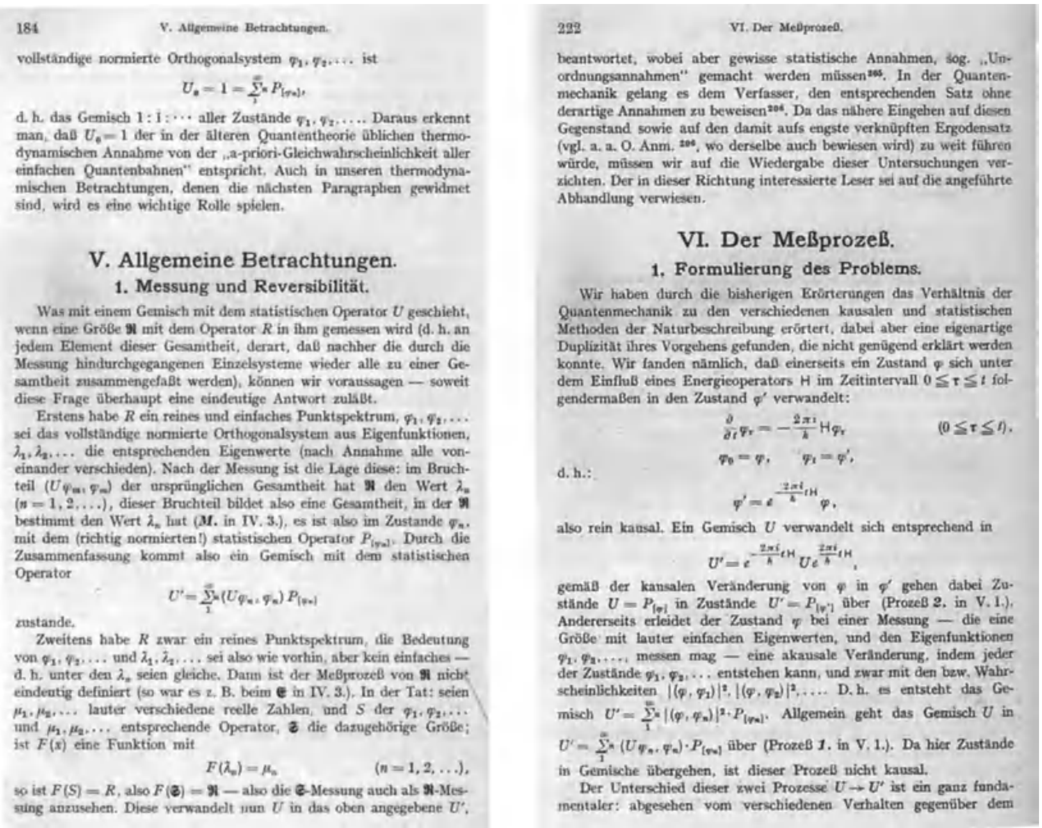
In 1956 John von Neumann was awarded the peace medal by president Eisenhower for his valuable advisory function.

Von Neumann was first and foremost a mathematician; however, he also called himself a mathematical physicist. In fact, it is often difficult to say where the borderline between mathematics and physics lies in his works. He himself never attempted to classify his research as strictly mathematical or physical, and even today it would be useless to try to come up with such a classification. In von Neumann's view, mathematics, physics, and philosophy are closely related. He emphasized that physics had always been the main source of problems that triggered development in mathematics. He also thought that physics should always play this role, to spare mathematics from degenerating into pure speculation. The way von Neumann utilized mathematics in constructing and analyzing physical theories turned mathematics into a tool for the conceptual understanding of physical theories — mathematics was thus much more than just a computational tool in von Neumann's hands. He saw opportunities to use mathematics and mathematical physics to treat philosophical problems. One of his examples demonstrated that there is a mathematical equivalence between the differential equations and the variation principles used in classical mechanics' description of motion. Von Neumann interpreted these two descriptions as the causal and teleological descriptions, and regarded their equivalence as proof that the philosophical problem of whether the correct description of the world is a causal or a teleological one is, in fact, a pseudo problem. Views such as these made von Neumann a typical representative of the classical tradition of mathematical physics influenced by modern positivism.

Von Neumann's activities in mathematical physics began in 1926-1927 in Göttingen, after his work in axiomatic set theory. In Göttingen he worked as an assistant to David Hilbert, the father of axiomatics. In those days, Göttingen was the center of mathematical physics, and there, von Neumann became thoroughly familiar with the latest developments in the exciting new physical theory of the day, quantum mechanics. Hilbert gave lectures on the foundations of quantum mechanics during the winter term of the academic year 1926/27. Von Neumann was in Hilbert's seminar, and Hilbert, von Neumann, and Nordheim, another participant, published a joint paper that summarized the content of the lectures. This paper tries to work out quantum mechanics "axiomatically," but it makes extensive use of the problematic Dirac function, which has contradictory properties. It should be noted that the three authors were fully aware that the Dirac function is a meaningless fiction. Why did they nevertheless use it? Because they were forced to do so by the assumption that all linear operators in a Hilbert space are integral operators, and linear operators played a crucial role in the Hilbert-Nordheim-von Neumann axiomatics. Without the operators and their calculations, the whole axiomatic would fall apart. It was clear to von Neumann that a deeper understanding of the linear operators in a Hilbert space was needed in order to formulate quantum mechanics axiomatically, without contradictions.



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vollständige normierte Orthogonalsystem $\varphi_1, \varphi_2, \ldots$ ist

$$U_0 = 1 = \sum_{n=1}^{\infty} P_{[\varphi_n]},$$

d. h. das Gemisch $1:1:\cdots$ aller Zustände $\varphi_1, \varphi_2, \ldots$. Daraus erkennt man, daß $U_0 = 1$ der in der älteren Quantentheorie üblichen thermodynamischen Annahme von der „a-priori-Gleichwahrscheinlichkeit aller einfachen Quantenbahnen" entspricht. Auch in unseren thermodynamischen Betrachtungen, denen die nächsten Paragraphen gewidmet sind, wird es eine wichtige Rolle spielen.

V. Allgemeine Betrachtungen.

1. Messung und Reversibilität.

Was mit einem Gemisch mit dem statistischen Operator U geschieht, wenn eine Größe $\mathfrak{R}$ mit dem Operator R in ihm gemessen wird (d. h. an jedem Element dieser Gesamtheit, derart, daß nachher die durch die Messung hindurchgegangenen Einzelsysteme wieder alle zu einer Gesamtheit zusammengefaßt werden), können wir voraussagen — soweit diese Frage überhaupt eine eindeutige Antwort zuläßt.

Erstens habe R ein reines und einfaches Punktspektrum, $\varphi_1, \varphi_2, \ldots$ sei das vollständige normierte Orthogonalsystem aus Eigenfunktionen, $\lambda_1, \lambda_2, \ldots$ die entsprechenden Eigenwerte (nach Annahme alle voneinander verschieden). Nach der Messung ist die Lage diese: im Bruchteil $(U\varphi_n, \varphi_n)$ der ursprünglichen Gesamtheit hat $\mathfrak{R}$ den Wert λ_n $(n = 1, 2, \ldots)$, dieser Bruchteil bildet also eine Gesamtheit, in der $\mathfrak{R}$ bestimmt den Wert λ_n hat (**M.** in IV. 3.), es ist also im Zustande φ_n, mit dem (richtig normierten!) statistischen Operator $P_{[\varphi_n]}$. Durch die Zusammenfassung kommt also ein Gemisch mit dem statistischen Operator

$$U' = \sum_{n=1}^{\infty} (U\varphi_n, \varphi_n)\, P_{[\varphi_n]}$$

zustande.

Zweitens habe R zwar ein reines Punktspektrum, die Bedeutung von $\varphi_1, \varphi_2, \ldots$ und $\lambda_1, \lambda_2, \ldots$ sei also wie vorhin, aber kein einfaches — d. h. unter den λ_n seien gleiche. Dann ist der Meßprozeß von $\mathfrak{R}$ nicht eindeutig definiert (so war es z. B. beim $\mathfrak{E}$ in IV. 3.). In der Tat: seien $\mu_1, \mu_2, \ldots$ lauter verschiedene reelle Zahlen, und S der $\varphi_1, \varphi_2, \ldots$ und $\mu_1, \mu_2, \ldots$ entsprechende Operator, $\mathfrak{S}$ die dazugehörige Größe; ist $F(x)$ eine Funktion mit

$$F(\lambda_n) = \mu_n \qquad (n = 1, 2, \ldots),$$

so ist $F(S) = R$, also $F(\mathfrak{S}) = \mathfrak{R}$ — also die $\mathfrak{S}$-Messung auch als $\mathfrak{R}$-Messung anzusehen. Diese verwandelt nun U in das oben angegebene U',

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beantwortet, wobei aber gewisse statistische Annahmen, sog. „Unordnungsannahmen" gemacht werden müssen[205]. In der Quantenmechanik gelang es dem Verfasser, den entsprechenden Satz ohne derartige Annahmen zu beweisen[206]. Da das nähere Eingehen auf diesen Gegenstand sowie auf den damit aufs engste verknüpften Ergodensatz (vgl. a. a. O. Anm. [206], wo derselbe auch bewiesen wird) zu weit führen würde, müssen wir auf die Wiedergabe dieser Untersuchungen verzichten. Der in dieser Richtung interessierte Leser sei auf die angeführte Abhandlung verwiesen.

VI. Der Meßprozeß.

1. Formulierung des Problems.

Wir haben durch die bisherigen Erörterungen das Verhältnis der Quantenmechanik zu den verschiedenen kausalen und statistischen Methoden der Naturbeschreibung erörtert, dabei aber eine eigenartige Duplizität ihres Vorgehens gefunden, die nicht genügend erklärt werden konnte. Wir fanden nämlich, daß einerseits ein Zustand φ sich unter dem Einfluß eines Energieoperators H im Zeitintervall $0 \leqq \tau \leqq t$ folgendermaßen in den Zustand φ' verwandelt:

$$\frac{\partial}{\partial t}\varphi_\tau = -\frac{2\pi i}{h}\mathsf{H}\varphi_\tau \qquad (0 \leqq \tau \leqq t),$$

$$\varphi_0 = \varphi, \qquad \varphi_t = \varphi',$$

d. h.:

$$\varphi' = e^{-\frac{2\pi i}{h}t\mathsf{H}}\varphi,$$

also rein kausal. Ein Gemisch U verwandelt sich entsprechend in

$$U' = e^{-\frac{2\pi i}{h}t\mathsf{H}}\, U\, e^{\frac{2\pi i}{h}t\mathsf{H}},$$

gemäß der kausalen Veränderung von φ in φ' gehen dabei Zustände $U = P_{[\varphi]}$ in Zustände $U' = P_{[\varphi']}$ über (Prozeß **2.** in V. 1.). Andererseits erleidet der Zustand φ bei einer Messung — die eine Größe mit lauter einfachen Eigenwerten, und den Eigenfunktionen $\varphi_1, \varphi_2, \ldots$, messen mag — eine akausale Veränderung, indem jeder der Zustände $\varphi_1, \varphi_2, \ldots$ entstehen kann, und zwar mit den bzw. Wahrscheinlichkeiten $|(\varphi, \varphi_1)|^2, |(\varphi, \varphi_2)|^2, \ldots$. D. h. es entsteht das Gemisch $U' = \sum_{n=1}^{\infty} |(\varphi, \varphi_n)|^2 \cdot P_{[\varphi_n]}$. Allgemein geht das Gemisch U in $U' = \sum_{n=1}^{\infty} (U\varphi_n, \varphi_n) \cdot P_{[\varphi_n]}$ über (Prozeß **1.** in V. 1.). Da hier Zustände in Gemische übergehen, ist dieser Prozeß nicht kausal.

Der Unterschied dieser zwei Prozesse $U \to U'$ ist ein ganz fundamentaler: abgesehen vom verschiedenen Verhalten gegenüber dem

Two pages of von Neumanns *Mathematische Grundlagen der Quantenmechanik (Mathematical Foundations of Quantum Mechanics)*, 1932, concerning the process of measuring.

Von Neumann applied himself to this task in Göttingen, working out the mathematical foundations of quantum mechanics in three papers. These three papers form the basis of his book, *Mathematische Grundlagen der Quantenmechanik*, first published in German by Springer in 1932, and in English as *Mathematical Foundations of Quantum Mechanics*, by Princeton in 1955. This book summarizes what is called the "Hilbert space formalism of quantum mechanics," which, without any essential modification, is still considered the formalism of quantum mechanics. The core of von Neumann's axiomatic structure is the solution of the "eigenvalue" problem of self-adjoint linear operators that are not necessarily bounded. To solve this problem, von Neumann first extracted the notion of abstract Hilbert space from particular function space representations by axiomatically fixing the key properties of the function spaces. The eigenvalue problem was then reformulated in terms of the geometry of the abstract Hilbert space. The reformulation made it possible, even required, to provide a mathematically precise definition of the basic concepts of quantum mechanics — such as the concept of "state" and the "observable physical quantity" of a quantum system. It also became possible to investigate the structure of quantum mechanics. The resulting systematic reformulation of quantum mechanics made it clear that quantum mechanics is a new kind of probability calculus, and von Neumann was also able to define notions of probability theory, such as expectation value and dispersion, in terms of Hilbert space theory. The aim of his second paper on quantum mechanics was to derive the quantum mechanical probability calculus from a few well-defined assumptions, on the basis of the relative frequency interpretation of probability. One of the assumptions was that the standard trace functional could be interpreted as an a priori probability. Since the trace functional on an infinite dimensional Hilbert space is not finite (i.e., it cannot be normalized), the probabilities given by the trace cannot in fact be interpreted as relative frequencies. This contradiction was one thing that motivated von Neumann to search for a non-commutative probability calculus that could serve as a mathematical framework for quantum mechanics differing from Hilbert space formalism. Von Neumann found these mathematical structures in the "rings of operators," theory, known today as "von Neumann algebras."

The von Neumann algebras theory is perhaps von Neumann's most original contribution to modern mathematics and mathematical physics. He began studying these structures as early as the 1920s; however, the great surprise came in 1936, with the discovery of von Neumann algebras, which had unexpected structural properties. Von Neumann's idea was to define certain subclasses of the set of all bounded operators in a Hilbert space. From the point of view of physics this meant that one drops the assumption that all self-adjoint operators in a Hilbert space represent physical quantities, in order to explore what is a possibly much smaller class of observables. Yet the subclass in question must be 'large enough' in some sense. Von Neumann's approach was to investigate classes of bounded operators, which, along with every operator, also contains its adjoint, and which, along with every sequence of operators that converges on each element of the Hilbert space, also contains the limit operators for the sequence. Such a class of operators is called von Neumann algebra, and a von Neumann algebra is called a factor, if there is no non-trivial element in the algebra that commutes with every other element in the algebra. The set of all bounded operators in a Hilbert space is clearly a factor of von Neumann algebra, and it is far from obvious that there are other examples not in this form. It seems that von Neumann conjectured at the beginning of his research that all factors are isomorphic with the set of all bounded operators. It is this expectation that turned out to be completely false in 1936. It turned out that there are five different classes of factors: types I_n, I_∞, II_1, II_∞, III.

The different types are distinguished by the possible values forming the range of a dimension function defined on the projections of the algebra. Type I_n is nothing more than the von Neumann algebra of all bounded operators in a Hilbert space of finite (n) dimension, and the dimension functions as an ordinary dimension. A projector corresponds to a linear subspace, whose dimension can be one of the discrete values 0,1,2...n. The dimension can also function as the restriction of the trace functional to the projectors. The type I_∞ describes the case of all bounded operators in a Hilbert space of infinite dimension. As is the case with the type In the dimension function here can also be seen as the restriction of the trace functional that cannot be normalized and results in the usual linear dimension of a projector (linear subspace). The possible values of these dimensions are 1,2, 3...∞. The existence of the three other types is unexpected. In these cases, the possible values of the dimension function are: all real numbers in the interval [0,1] (type II_1, case); all non-negative real numbers (type II_∞); and the zero and ∞ (type III). The fact that the dimension can not only be a whole number, but it can also take on values in a continuum is strange; however, it is not the first and only surprising fact in the mathematics of the infinite. It is remarkable that in 1936, when J. Murray and von Neumann discovered this classification of von Neumann algebras, there had been no known example of type III up until then. It was only four years later that von Neumann was able to construct the first example. The question of 'how many' different factors in a given class exist and what the invariants are that distinguish the different examples, is a problem which hundreds of mathematicians have worked on and won 'field medals' for. One might think that the 'esoteric' von Neumann algebras are just mathematical curiosities, without any relevance whatsoever for physics, but this is not so. For instance, the von Neumann algebra of observables in local Lorentz covariant quantum field theory is of type III. The quantized version of the classic, chaotic dynamic system known as "Arnold cat" leads to a type II_1 von Neumann algebra, and it is possible to name further physical examples.

Von Neumann constructed examples of the type II_1, and he thought that the theory for factors of this type might be more suitable for quantum mechanics than standard formalism (i.e., the type case). The reason von Neumann had this view is that the normalized dimension function for these algebras can be interpreted as the quantum mechanical a priori probability — in contrast to the Hilbert space quantum mechanics, where such an a priori probability does not exist. Von Neumann considered the existence of an a priori probability, which can be interpreted as relative frequency, so important that the idea determined his concept of quantum logic. In a famous paper published in 1936 in collaboration with G. Birkhoff, the authors proposed the basic idea of quantum logic. The main idea was to interpret the projections, which (themselves being elementary self-adjoint operators) completely determine the algebra of operators, as propositions, and to view the lattice structure of the set of all projections as a propositional calculus in the sense of formal logic. The lattice obtained in this way from the type I_∞ (= standard Hilbert space formalism of quantum mechanics) is an orthomodular but non-modular lattice. Only type I_n and type II_1 lead to a modular lattice, the modularity being a consequence of the fact that there exists a finite dimension function on these lattices. In their paper, von Neumann and Birkhoff postulated quantum logic as a modular lattice, i.e., they interpreted the von Neumann algebras of type I_n and type II_1, especially the latter, as the mathematical framework most suitable for quantum mechanics.

Another direction in which von Neumann further developed quantum mechanics was the theory of Jordan algebras. Philosophically, he found it very unsatisfactory that the ordinary product (composition) AB of two self-adjoint operators A and B does not have a physical meaning in general: the product AB does not represent an observable because AB is not self-adjoint — unless A and B commute. Why should meaningless operations be allowed in formalism, he asked. It is much more natural to interpret the symmetrical product (or Jordan product as it became called), $A \cdot B = 1/2(AB+BA)$, which always yields self-adjoint operators as long as A and B are self-adjoint, as the operation that determines the structure of the observables. This idea led von Neumann to an investigation of Jordan algebras, in which the properties of the symmetrical product are axiomatically prescribed. Since the self-adjoint part of a von Neumann algebra forms a Jordan algebra, the theory of von Neumann algebras is the link that connects different formalisms of quantum mechanics.

Another important contribution of von Neumann to mathematical physics was his proof of the ergodic theorem. Ludwig Boltzmann, the famous Austrian physicist, formulated the problem of ergodicity in the late nineteenth century. The problem was formulated in the context of the foundations of classical statistical mechanics: if one considers a physical system consisting of many particles, whose movement is governed by the equation of motion of classical mechanics, then one can compute two sorts of expectation values of macroscopic observable physical quantities of the system: the one obtained as the time average, and another one calculated as the expectation value with respect to a certain probability measure. Boltzmann thought that the success of classical statistical mechanics (in which the average is always computed with this second method) is founded in and explained by the fact that the two averages are equal. But it was not at all known whether these two expectation values can indeed be equal. Von Neumann was the first to have transformed this problem into a sharply defined mathematical problem, and he succeeded in proving that the two expectation values can indeed, in a certain sense, be equal. His results mark the beginning of a new branch of mathematics known as ergodic theory, which is to this day a rapidly developing field of mathematics. Von Neumann considered his ergodic theorem (together with his results on the spectral theory of self-adjoining operators) his most important contribution to the sciences.

Von Neumann's scientific activity in connection with physics — in particular quantum mechanics — is often misunderstood. Physicists view his work on quantum mechanics as an example of striving for mathematical exactness, which is considered unnecessary in physics. However, von Neumann's investigations were not motivated by the desire to create pure, mathematically unobjectionable theories. He states this very clearly in his book on the foundations of quantum mechanics, where he explicitly emphasizes that the elimination of the problematic Dirac function (along with other mathematical nonsense) from formalism was just one goal of his investigations. A more important aim for him was to work out quantum mechanics in a form that does not contain mathematical representatives of hypothetical elements that are in principle empirically inaccessible and hence unnecessary. Further evidence for the claim that von Neumann's main concern was not mathematical precision is the fact that the Hilbert space formalism of quantum mechanics worked out in his book was precise enough to meet any mathematician's standard of precision, however keen. Yet, as we have indicated, von

Neumann searched for (and found) ways to go beyond this formalism, and he was ready to abandon that beautiful and exact theory, replacing it with a new one considered more suitable. In his research in connection with quantum mechanics, he was thus motivated by the desire to achieve two goals: to give quantum mechanics a conceptually clear formulation in order to better understand it, and to eliminate from the theory, as far as possible, superfluous elements for which there is no empirical justification.

This philosophical and methodological standpoint was close to the logical positivism of the time. This is not a mere coincidence. Von Neumann had good personal relations to the Vienna Circle, though he was not an official member. He occasionally attended the colloquia run by K. Menger, a mathematician in Vienna, who was also frequently attended the Vienna Circle seminars. In the 1920s, von Neumann worked on Hilbert's program in mathematics, and he was one of the selected few who had heard and immediately understood the significance of Gödel's result for this program. Gödel, also a member of the Vienna Circle, was in contact with von Neumann until the latter's death; von Neumann considered Gödel the greatest logician since Aristotle. Von Neumann also had extensive discussions with another prominent member of the Vienna Circle, Rudolf Carnap, while Carnap was staying in Princeton in the 1930s. Von Neumann was also familiar with the relative frequency interpretation of probability advocated by Richard von Mises. Although von Mises lived in Berlin, he was close to the Vienna Circle. It is no wonder, then, that von Neumann shared many of the philosophical views held by members of the Vienna Circle, though he himself rarely discussed philosophical issues explicitly in his publications. But his striving for conceptual, linguistic, and logical clarity, his belief in the power of the mind and human intellect, and his desire to abandon eliminable metaphysics mark von Neumann as a typical product of an influential intellectual trend in Central Europe during the first half of the twentieth century.

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3

Alexander Zartl

Taking the Side Roads: Erwin Schrödinger in the 1940s

Erwin Schrödinger, born 1887 in Vienna. In 1906 he began to study physics at the University of Vienna; 1912 private lecturer. After World War I he left his native country for economic reasons. From 1922 to 1927 he worked at the University of Zurich where he developed wave mechanics and became one of the founders of modern quantum theory. In 1927 he moved to Berlin as the successor of Max Planck. In 1933 he was awarded with the Nobel prize, but had to flee to England from the Nazis. In 1936 he was appointed Professor at Graz. Two years later he again fled from the Nazis to Ireland where he remained at the Dublin Institute for Advanced Studies until 1956. Schrödinger spent the last years of his active career in Vienna where he died in 1961.

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Although Erwin Schrödinger had little respect for religion in general and religious communities in particular, and as a scientist was close to positivism, he nevertheless longed for spirituality and occupied himself during most of his lifetime with metaphysical questions. He once wrote in a letter that natural science can describe only a part of reality: "a purely rational conception of the world, devoid of all mysticism, is an absurdity."

The Veda, the writings of traditional Hindu philosophy, particularly interested him. Its idea of the world as a unity pervaded by a universal consciousness that includes all beings, became a determining element of Schrödinger's worldview. Taking this background into account, it becomes understandable that, over a period of many years, he returned again and again to a problem which, even according to the present state of physics, has not been solved in a satisfying way: the search for a uniform field theory, i.e., for a single theory that can simultaneously explain the phenomena of gravitation and electromagnetism.

Schrödinger started his considerations with the theory of general relativity that Albert Einstein had devised almost thirty years previously. Einstein himself had regarded the lack of a description of electromagnetic phenomena as an imperfection in his theory that he had tried to overcome, but he was not successful, and, after some years, he disappointedly gave up his efforts. In 1943 Schrödinger presented a method that aimed to modify the equations of relativity in such a way that both the laws of gravitation and electromagnetism should be derivable from them. His idea was to take back some of the mathematical conditions encoded in Einstein's equations and replace them by others that ought to correspond better to the physical structure of four-dimensional space/time. However, it soon turned out that, from a mathematical point of view, there were several ways to manage this, and at first sight none of them could be regarded as exceptionally convincing. The possibility Schrödinger selected in his first attempt led to a generalized form of conventional electromagnetic theory, according to which the photon must have a rest mass other than zero. Schrödinger tried to find experimental confirmation for his predictions, but the available data from geophysical measurements and solar observations proved to be insufficient. For the time being, the decision had to be delayed, and Schrödinger turned to a problem that had always fascinated him, and not only as a follower of holistic wisdom: unraveling the mystery of life.

As a professor at the Dublin Institute for Advanced Studies, Schrödinger was, among other things, obliged to hold occasional lectures before an audience of laymen. For 1943, he had planned a series of talks under the slogan *What is Life?* In this series, he wanted to discuss the influence of x-rays on the mutation rate of the fruit fly, Drosophila. (No other animal — including the white mouse — has had to make greater sacrifices in the service of genetic research than the fruit fly.) Schrödinger became interested in the topic through an article titled *Über die Natur der Genmutation und der Genstruktur* (On the Nature of Gene Mutation and the Structure of Genes), published in 1935 by German physicist and biochemist Max Delbrück and his colleagues, Karl Zimmer and N. V. Timofeeff. A series of experiments conducted by American geneticist Hermann J. Muller in the 1920s had proven that exposing the gametes of an organism to x-rays leads to a drastic increase in the frequency of mutations.

The external appearance of the processes that occurred during a cell division and the structure of the cell nucleus containing the chromosomes were already well known at this time. Also, it was known from breeding experiments and microscopic investigations that different genes control the features of an organism, and that these genes could be identified as certain clearly defined areas on the chromosome fibers. However, the question of the composition of the carrier of all genetic information — the gene itself and its internal structure — was still unsettled. In his article, Delbrück set up the thesis that mutations might possibly be caused by the relocation of individual atoms within the genes.

Schrödinger dealt primarily with the question of how it is at all possible that a gene, which is passed on from generation to generation, can endure for so long without its genetic information changing during the process (unless it is affected by a mutation). Considering everything that was known thus far about genes, it was estimated that the number of atoms contained within an individual gene is, at most, on the order of a magnitude of one million, but probably much smaller. Schrödinger charged himself with the task of considering the gene from the physicist's point of view and treated it, in accordance with the rules of his science, as a macroscopic system. If particles in a macroscopic system can move freely, as is the case in liquids or gases, for example, then the laws of statistical physics govern their behavior. These laws state, among other things, that the more particles it contains, the more regularly the system will behave and the more easily predictable it will be. Now, one million particles are far too few to ensure this regularity in the behavior of a system — a much larger number would be required. The obvious long-term stability of the genes can therefore be explained only by the fact that they do not follow the laws of statistics. Hence, a gene cannot be thought of as a small drop of liquid or some other substance that is in some way assembled from a large quantity of independent particles; instead, it has to be regarded as a single small body — in the long run, only molecules were conceivable. Thus Schrödinger came to the conclusion that a gene is nothing but an individual, very large molecule. This realization was actually not earth-shattering. Although it cannot be said that Schrödinger's idea had at that time already attained the status of a truism, he was, nevertheless, not the first scientist to express it. However, it was to Schrödinger's merit that he derived from the principles of physics alone the proof that the stability of genes can have no other cause. Moreover, he conclusively stated that without quantum theory it is impossible to arrive at a complete understanding of the phenomenon of hereditary transmission, because it is only in the context of quantum theory that the characteristic behavior of atoms in forming molecules and chemical compounds can be adequately explained. The apparently coincidental analogy between quantum leaps and spontaneous modifications of the genetic information, with which Schrödinger first started, now emerged as a deeply rooted causal connection: the sudden transformation of a molecule caused by a relocation of its atoms is indeed nothing but a quantum leap.

Schrödinger had shown that the methods of physics can play a substantial role in the study of the complex problems of genetics; he had thereby closed the gap between physics and biology which, up until then, science had been trying to bridge in vain. However, the actual stroke of genius can be found in a seemingly marginal sentence in the book, *What is Life?*, which was a later product of the lectures. The sentence in question reads as follows:

> *It is these chromosomes ... that contain in some kind of code script the entire pattern of the individual's future development and its functioning in the mature state. Every complete set of chromosomes contains the full code... The chromosome structures are at the same time instrumental in bringing about the development they foreshadow. They are statutes and executive power ... in one.*

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Johann Götschl, *Erwin Schrödinger's World View. The Dynamics of Knowledge and Reality* (Dordrecht/ Boston/ London: Kluwer Academic Publishers, 1992).

Thus Schrödinger, a layman, had introduced a fundamental concept of modern biology, that of the idea of the genetic code. The book's publication caused a wave of enthusiasm, and a whole number of scientists who originally had worked in completely different fields of research avidly took up Schrödinger's new ideas. Among those for whom *What is Life?* was a crucial influence was the young biology student, Francis Watson, who, through the book, discovered genetics as his proper sphere of activity. In his memoirs, he admitted, "after I read Schrödinger's book, I was obsessed with the idea of decoding the secret of the genes." Watson's colleague, Francis Crick, wrote in a letter to Schrödinger, "Watson and I once had a talk about how we had come to work in the field of molecular biology, and we discovered that both of us had been influenced by your little book, *What is Life?*" In addition, Maurice Wilkins, who, by virtue of his x-ray diffraction photographs, became the third in the company of genetic explorers, was induced by *What is Life?* to depart solid-state physics and occupy himself with fundamental research in biology. In 1953, this trio's collaboration led to the discovery of the double helix structure of desoxyribonucleic acid, and the three researchers were distinguished with the Nobel Prize in 1962.

Erwin Schrödinger, 1914

Yet before the sales of *What is Life?* got underway, Schrödinger was already up to his ears in work on the uniform field theory, and he had high hopes of bringing his research to a successful end. At the beginning of 1947, he believed he had arrived at a crucial breakthrough; he had found a Lagrangian function of captivating simplicity and clarity, and it was his firm conviction that it would be possible to deduce the field equations of gravitation and electromagnetism from it:

$$£ = \sqrt{-\det R_{ik}}$$

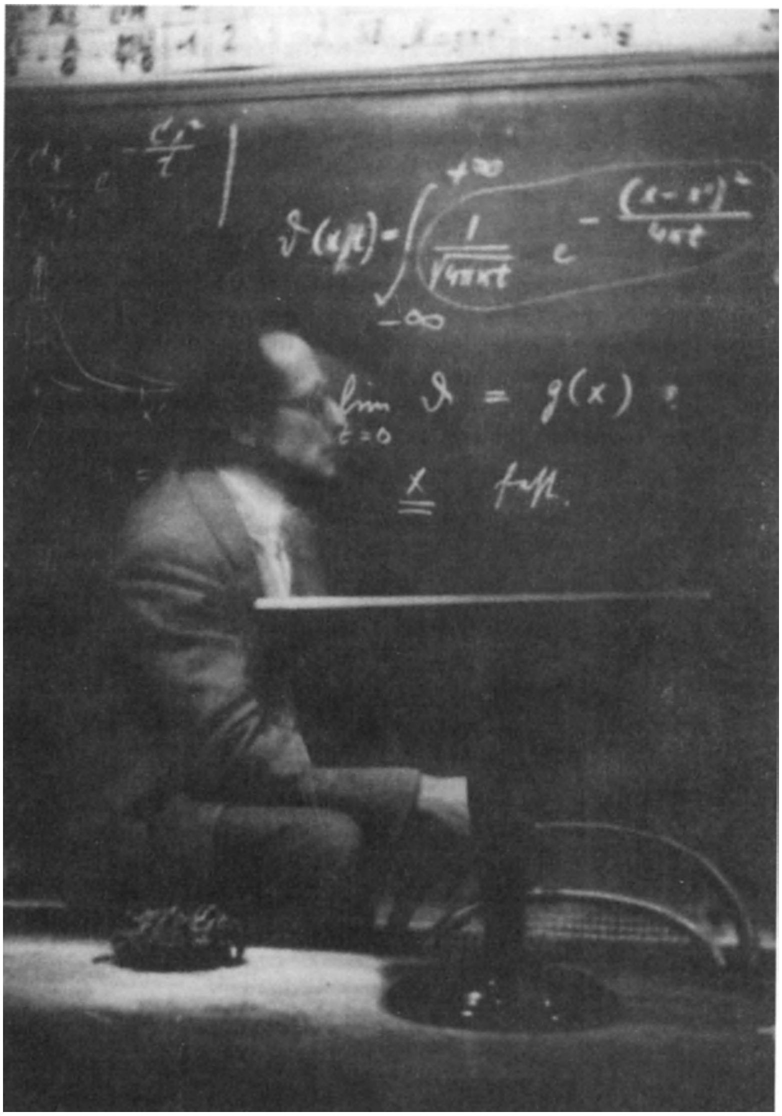
(Here, R_{ik} denotes the Einstein tensor.) Schrödinger was so sure of himself that he wanted to present the new formula to the public, and by the end of January, the Irish press had declared it a great sensation. Foreign press agencies took up the message and handed Schrödinger's paper to internationally recognized physicists for confirmation. But then the devastating blow came: Einstein proved that Schrödinger's theory was, up to an insignificant addition, equivalent to his own results from the year 1923 and therefore led to a dead end. Schrödinger was deeply affected. He collected all newspaper cuttings and letters concerning this unfortunate affair and kept them in a briefcase suggestively labeled The Einstein Mess. Even after this failure, he did not desist from occupying himself with the uniform field theory; there still remained some hope that refining the measuring techniques might help to bring his earlier experiment with the photon mass back to life. But gradually, this possibility waned, too, and Schrödinger had

Erwin Schrödinger at his inaugural lecture in Vienna, 1956

Alexander Zartl, born 1965 in Vienna. In 1983 he took up his studies of mathematics and physics at the University of Vienna which he concluded in 1992 with a thesis dealing with a topic in statistical physics. After a short interlude as a lecturer at the Institute for Theoretical Physics he started to work as a librarian at the Central Library for Physics in Vienna where he has been since 1993. In 1995 he arranged the memorial exhibition on occasion of the 100th anniversary of Josef Loschmidt's death. A number of his articles on Austrian physicists have been published in various publications.

to bury all hopes that he might significantly advance the development of physics for a second time during his life.

The only remaining result of his many years of work was a short book, entitled *Space-time Structure*, which was published in 1950. In it, he summarized the knowledge that had been so painfully acquired. However, the book has become a classic of theoretical physics. It addresses itself mainly to an audience of specialists who want to penetrate more deeply into the problems of relativity theory. On the other hand, *What is Life?* is probably the only twentieth-century book that not only succeeded in preparing the way for a crucial breakthrough in natural science, but can also be read by the layman for pleasure and education. Up to now, more than 100,000 copies have been sold, making it one of the few long-sellers in the history of popular science.



Erwin Schrödinger during a lecture in Graz, 1937

29. Juli 1949

Lieber Polanyi!

Haben Sie vielen Dank für die Nummer mit Ihrem Aufsatz über das Wesen der wissenschaftlichen Überzeugung, die Sie mir zusandten. Ich hab ihn mit großem Interesse gelesen. Ich glaube ich verstehe Ihr Bestreben, sich ~~zu jeder Art von Glauben~~ zunächst auf einen vollkommen neutralen, unvoreingenommenen Standpunkt zu stellen gegenüber jeder Art von Glauben. Neulich versuchte ich in einem Aufsatz (der aber nicht über die Vorarbeiten gediehen ist) noch weiter zu gehen und die Frage zu beantworten: Why the Truth? Es bedarf nämlich selbst dies der Rechtfertigung, daß wir es für richtig halten, <u>die</u> Meinung öffentlich zu vertreten und ihr womöglich allgemeine Zustimmung zu verschaffen, die wir für die zutreffende halten. Es ist gar nicht so leicht, jemandem zu antworten, der erklärt, man müsse die Ansichten verbreiten, die das glückliche Zusammenleben der Menschen am meisten fördern, ob sie nun wahr sind oder nicht. Es gibt beispielsweise nicht Wenige, die sich selbst als "Freidenker" bezeichnen, aber doch wenigstens in betracht ihrer Kinder finden, es sei besser sie zunächst religiös zu erziehen oder erziehen zu lassen, und zu sehen was daraus wird.

Aber das war eine Abschweifung. Ich frage mich, ob Sie in dem Sie kennzeichnenden Streben nach unbestechlicher Gerechtigkeit nicht gefährlich weit gegangen sind z.B. in den Schlüssen, zu denen Sie auf S.25 oben gelangen. Sie stellen die Waage so völlig gleich ein zwischen verschiedenen "Orthodoxien", dass man zweifelt, wie es gelingen kann, das von uns bevorzugte Ende überzeugend herunterzuziehen. Auf den folgenden Seiten, die dies tun sollen, stellen Sie sehr stark auf die sozialen und moralischen Wirkungen ab. Ich finde kaum ein Argument, das nicht ebenso gut von <u>jeder</u> Orthodoxie für sich in Anspruch genommen werden kann. Ferner finde ich eine Anzahl von "Soll". So S.26, Z. 15 v.u. "is···to be"; dann im 2.Absatz S.27 "Nor <u>should</u> members of a free society· ··" und "They <u>should</u> insist··"

Jedes "Soll" setzt, ebenso wie die 10 Solls auf dem Sinai, ein befehlendes Subjekt voraus; jedem Soll läßt sich aus freier Willkür ein anderes Soll entgegensetzen. Und wenn man sich darauf beruft, daß es sich um eine Gesamtheit von Meinungen handelt, die von einer großen freien Gesellschaft anerkannt und für wahr gehalten werden, so kann die Gegenseite darauf hinweisen, daß dieses Meinungs-Ensemble ungeheuren historischen Änderungen unterworfen ist, daß eine bedeutende Umwälzung eben jetzt im Zuge ist, und daß ein sehr großer Teil der Menschen sich ihr schon angeschlossen hat und sich mit Fanatismus dazu bekennt.

Das Grunddogma, daß wir in der Wissenschaft nach "Wahrheit" streben, läßt sich, glaube ich, nur stützen auf den angeborenen Neugier-Trieb, herauszufinden, wie unsere nähere und fernere räumliche und zeitliche Umgebung wirklich beschaffen ist oder war. Ihm nachzugehen war von jeher, und ist heute mehr denn je, Gemeinschaftsarbeit nötig. Das schließt die Aufwendung verhältnismäßig beträchtlicher staatlicher Geldmittel und damit die Gefahr einer sachlichen Einmischung der Staatsautoritäten ein, deren Aufgaben und Zwecke ganz andere sind als die Wahrheitfindung. Diese Einmischung ist störend und hinderlich. Uns bleibt nichts anderes übrig als immer aufs neue darauf hinzuweisen, daß sie es ist; daß sie dem Zweck, für welchen das Geld angeblich zur Verfügung gestellt wird entgegenarbeitet; daß mithin ein solches Verfahren - Subventionierung der Wissenschaft mit gleichzeitigem Dreinreden und Ziele-vorschreiben - entweder eine Verschwendung ist oder eine Heuchelei, je nachdem ob es den Staatsautoritäten ernst damit ist, die Wahrheitsuche zu fördern oder nicht. - Mit dieser Auffassung darf man nun ruhig paritätisch gerecht sein, d.h. man darf die staatliche Einmischung als grundschädlich (für ~~die~~ die Befriedigung des Neugiertriebes) bezeichnen intra et extra muros. -

Noch zwei Bemerkungen zu Details. Die Idee, daß rotierende Massen als solche ein ihrem Drehimpuls proportionales magnetisches Moment besitzen ist nicht von Blackett. Im Handbuch des Erdmagnetismus von Chapman und Bartels, Bd.II, werden W.F.G. Swan (1927) und Schlomka (1933) citiert für Theorien, welche darauf hinauslaufen. Zufällig hatte ich kurz vor dem Erscheinen der Blackettschen Arbeit auf diese Möglichkeit hingewiesen (Proc. Roy. I.A. (A) 51, p.170, 27. Januar 1947), in der vorläufig nicht bestätigten Hoffnung, daß die dort behandelte Version der allgemeinen Feldtheorie zu diesem Ergebnis führen würde. Ich sagte u.a. There can, I think, be little doubt that the magnetic field is a direct consequence of the mass rotation. It is well known that the field is just about what a rotating electric ~~charge~~ density, $-\sqrt{k}$ times the actual mass density, would produce. Another way of expressing the same thing is, that the magnetic moment of a rotating mass seems to bear to its moment of momentum the ratio $\frac{\sqrt{k}}{-2c}$, which by the way is roughly by the 21st power of 10 smaller than in the case of the electron.

Auf S. 18 unten (schwarzer Smoking in der Sonne, weißer Schnee in der Dämmerung) bin ich nicht einverstanden damit, dass Sie von einem "act of interpretation" sprechen. Hering gibt das Beispiel eines gedruckten Textes, dessen schwarze Lettern in der Sonne mehr Licht reflektieren als die weißen Seiten am Abend. Aber der Adaptationszustand und die Vergleichsobjecte sind andere. Es ist nicht Sache des Urteils, sondern der unmittelbaren Empfindung, dass das eine schwarz, das andere weiß ist. Ein sehr instruktiver Versuch vo Hering ist dieser. Man stelle sich vor einen Tisch gegen das Fenste und betrachte eine auf dem Tisch liegende helle Farbfläche, etwa ein sattes Gelb, durch ein etwa in die Mitte zwischen Auge und Tisch gehaltenes weißes Blatt starken Papiers, vielmehr durch ein Loch (etwa ein Quadrat von zwei bis drei cm Seite), das man in das Papie geschnitten hat. Sodann wende man das Papier, das man in Händen häl rasch einmal so, daß es helles Licht vom Fenster bekommt, dann so dass es beschattet ist. Das Umspringen der Farbempfindung innerhalb des Loches ist erstaunlich.

Viele herzliche Grüße von Ihrem ergebensten

Dr. Leo Szilard
Institute of Radiobiology and Biophysics
Chicago 37, Illinois

12. Februar 1951

Lieber Herr Szilard!

Erst jetzt nach meiner Rückkehr von meinem Österreich-Urlaub habe ich Ihre fundamentale Arbeit gelesen, die Sie so freundlich waren mir schon im November im Durchschlag zuzuschicken. Es war ein großer Genuß, besonders in unserer Zeit der Hast, Unklarheit und Nachlässigkeit in bezug auf die Darstellung, etwas nach Inhalt und Darstellungsform so Vollkommenes und Wohldurchdachtes in die Hände zu bekommen, das ganz und gar an die Untersuchungen unserer großen Klassiker gemahnt, an die Zeiten, da es in der Wissenschaft noch mehr auf scharfen Verstand und geniale Intuition als auf große Geldmittel ~~ankommt~~ ankam. So viel ich davon verstehe, haben Sie hier mit einer verhältnismäßig einfachen, aber äußerst sinnreich bis ins Kleinste durchüberlegten Apparatur und durch sorgfältige Planung der ersten damit angestellten Versuchsreihen nicht nur schon jetzt ganz fascinierende Ergebnisse zutage gebracht, sondern ein ungeheures Gebiet erschlossen, das noch Jahre lang reiche Früchte zu tragen verspricht. Gerade diese Mutationsversuche, mit denen Sie begonnen haben, scheinen mir in zwei ganz verschiedenen Richtungen der Anfang einer großen Entwickelung zu sein, nämlich erstens als "Modell" der Evolution überhaupt, zweitens in der praktischen Medizin. Es ist wohlbekannt, daß bei vielen Krankheiten sich der klinische Befund, der Verlauf und die Gefährlichkeit in verhältnismäßig kurzen Zeiträumen von der Größenordnung Jahrzehnte stark verändert hat, in manchen Fällen periodisch schwankt, was man jetzt vielleicht auf die Ursachen wird untersuchen und, wenn man diese kennt, wird beherrschen können. Auch klingt mir etwas im Ohr von "Züchtung nichtvirulenter Kulturen" für Zwecke der Immunologie. - Aber Sie wissen das alles wohl besser als ich.

Ob sich Ihre Methode wohl auf Virusse ausdehnen läßt?

In der Apparatbeschreibung ist mir aufgefallen, daß Sie auf p. 4, Zeile 6 sagen: the pressure, which forces the nutrient liquid through the sintered disk is at all times equal to the water column in the pressure regulator. Ist jener Druck nicht die <u>Differenz</u> jener Wassersäule und der Nährlösungssäule zwischen dem sintered disk und dem anderen Ende der Kapillare, aus welchem die Nährlösung in das Züchtröhrchen (growth tube) tropft. - Die Bemerkung ist belanglos; auch kann man ja unter "the pressure that forces", wenn man will, einfach die Druckdifferenz an den beiden Enden (sintered disk und Tropfende) der Kapillare verstehen - und so ist es wohl gemeint.

Zu einer Bemerkung Ihres Briefes möchte ich sagen: zugrunde gehen dürfte das Leben auf unserem Planeten auch im schlimmsten Falle wohl nicht, sondern es dürfte sich, ähnlich wie in Ihrer growth tube ein Gleichgewicht einstellen, spätestens sobald unsere mörderische Art so stark dezimiert ist, daß sie für die immerhin recht beträchtlichen Anstrengungen, welche die Herstellung der gefährlichsten Mordwaffen erfordert, nicht mehr die Kraft hat. Diese optimistische Ansicht setzt allerdings voraus, daß die bis dahin etwa eingetretene Verseuchung mit sublethalen Mutationen noch nicht zu ~~zu~~ ausgedehnt ist, um sich durch Selektion von-selbst zu eliminieren.

Ich würde mich sehr freuen, wenn wir Sie bei Ihrem geplanten Europabesuch hier in Dublin sehen könnten. Wenn es noch während des akademischen Betriebs ist - etwa vor 1. Juli - würden Sie uns eine public lecture halten wollen? Soll ich versuchen, so was zu arrangieren? Sie brauchen natürlich darauf nicht gleich zu antworten, sondern sobald Sie wissen, ob es Ihnen passen würde.

Viele herzliche Grüße und Wünsche von Ihrem ergebensten

3

Erwin Schrödinger's letters to Mihály Polányi and Leo Szilard
Zentralbibliothek für Physik / Central Library for Physics, Vienna

July 29, 1949

Dear Polanyi,

Many thanks for the issue you sent me containing your essay on the essence of scientific conviction, which I read with great interest. I believe I understand your effort to first come to a fully neutral, unbiased position regarding all forms of belief. In a recent essay (which is still in the first draft), I tried to go one step further and answer the question: Why the Truth? This in and of itself requires the justification that we believe it correct to represent this opinion in public, and, where possible, to garner general support for the position we believe to be correct. It is rather difficult to reply to someone who states that we must spread the views most advantageous to the convivial co-existence of human beings, whether these views are true or not. There are, for example, more than just a few of those self-proclaimed "free thinkers" who feel, at least where their children are concerned, that it is better to offer or be offered a religious upbringing and to see what will come of it.
But that was a digression. I ask myself, whether you, in your distinctive efforts toward unbiased justice, have not gone too dangerously far, for example, in the conclusions that you reach on page twenty-five. You have set the scale so precisely between the different "orthodoxies" that one doubts whether you can convincingly effectuate from us the desired result. In the pages that follow (and they should do just that), you switch strongly to the social and moral effects. I find scarcely an argument that could not just as well be claimed by every orthodoxy. Furthermore, I find a number of "shoulds": p. 26, line 15 from "is...to be;" then in the second paragraph on p. 27, "Nor should members of a free society..." and "They should insist...." The "should" aspect requires, as do the Ten Commandments of Sinai, a subject who gives orders; every should allows another to counter it arbitrarily. And if one claims that it refers to a totality of opinions recognized and held to be true by a large, free society, then the other side can suggest that this ensemble of opinions is subject to monstrous historical changes, that a significant upheaval is now in operation, and that a great number of people have already joined and fanatically accepted it.
The fundamental dogma, that we strive for "truth" in science, is, I believe, based simply on an innate curious desire to determine how our near and distant spatial and chronological environment is, or was, created. The pursuit of this desire has always required collective work, today more than ever. This includes relatively large state financial expenditures and with that, the danger of material interference from state authorities, whose tasks and goals have nothing to do with discovering the truth. This interference is a disruption and hindrance; we are left with no other choice than to constantly point out that this is so; that this authority works against the goal for which it supposedly provides money; that therefore this kind of procedure — the subsidization of science accompanied by simultaneous interference and stipulation of goals — is either a waste or hypocrisy, depending on whether or not the state authorities truly intend to support the search for truth. With this view, one can easily be equally right — that is, one may describe state intervention as fundamentally destructive (to satisfy the curiosity) intra et extra muros.
Two additional comments on details. The idea that rotating masses as such possess a magnetic aspect proportional to their rotary impulse is not Blackett's. In the Handbook of Earth Magnetism, vol. II, by Chapman and Bartels, W.F.G. Swan (1927) and Schlomka (1933) are cited for theories that lead to that view. Coincidentally, I had referred to this possibility just before the publication of Blackett's work (Proc. Roy. I.A. (A) 51, p. 170, January 27, 1947) in the still unconfirmed hope that the version of the general field theory it treats would lead to this conclusion. I said, among other things, "There can, I think, be little doubt that the magnetic field is a direct consequence of mass rotation. It is well known that the field is just about what a rotating electric density (÷K times the actual mass density) would produce. Another way of expressing the same thing is that the magnetic moment of a rotating mass seems to bear to its moment of momentum the ratio (÷K/2C, which by the way is roughly by the 21st power of 10 smaller than in the case of the electron."
On p. 18, (black tuxedo in the sun, white snow at twilight), I do not agree with you, when you speak of an "act of interpretation." Hering uses the example of a printed text, whose black letters reflect more light in the sun than do the white pages in the evening. But the conditions for adaptation and the objects of comparison are different. It is not a matter of judgment, but rather of the immediate impression that one is black and the other white. A very instructive attempt by Hering is this: one stands in front of a table set against a window and observes a brightly colored area on the table, perhaps a rich yellow, through a thick, white paper held approximately in the middle between the eye and table, or, even better, through a hole (perhaps a square,

between two and three centimeters wide) that has been cut into the paper. Then, while holding the paper, one quickly rotates it so as to capture the bright light from the window, and then again, so that it is shadowed. The change in color perception inside this hole is astounding.

Many kind regards. Yours faithfully,

E. Schrödinger

Dr. Leo Szilard,
Institute of Radiobiology and Biophysics
Chicago 37, Illinois
12 February 1951

Dear Mr. Szilard,

After returning from my Austrian holiday just recently, I read your fundamental work, of which you were so kind to have already sent me a copy in November. It was a great pleasure, especially in our time of haste, uncertainty, and neglect, to have been handed something of such conceptual and expressive excellence, which recalls so entirely our great classicists of the days when science depended much more on sharp understanding and ingenious intuition than on large financial means. As far as I can see, you have here — by a relatively simple, yet extremely clever and detailed investigation, and by carefully planning the first series of experiments of this kind — brought to light results that are completely fascinating today. Moreover, you have opened up a huge territory, which promises to be fruitful for many years to come. The mutation experiments with which you began seemed to me the start of a great development in two entirely different directions: first, as an ultimate "model" of evolution and second, in practical medicine. It is well-known that the clinical test results, the course, and the danger of many diseases have changed dramatically over a relatively short period of time — just a few decades — and in some cases altered periodically, and now perhaps their origins will be investigated, and, when these are known, these illnesses will be controllable. I've also heard something about the "cultivation of nonvirulent cultures" for uses in immunology, but you certainly know more about it than I.

Can your methods also be applied to viruses?

In the investigation's description, it occurred to me that you said on page four, line six, "the pressure, which forces the nutrient liquid through the sintered disk is not at all times equal to the water column in the pressure regulator." Is this pressure not the difference in the water column and the nutrient liquid column between the sintered disk and the other end of the capillary, from which the nutrient solution drips into the growth tube? This comment is inconsequential; one can, if desired, also interpret "the pressure that forces" as simply the pressure difference of the capillaries at both ends (sintered disk and drip end) — which is probably what was meant.

In response to a comment in your letter, I want to say: life on our planet will probably not be destroyed, even in the worst case, but rather it will most likely attain a balance like the one in your growth tube — at least as soon as our murderous species is decimated enough so that it no longer has the strength for what are, after all, the very considerable efforts that have to be put into producing the most dangerous weapons. This optimistic view first requires, however, that the contamination through sublethal mutations, which might have by then occurred, is not yet too widespread to be eliminated by process of selection.

I would be very happy if, on your planned trip to Europe, you were to visit us here in Dublin. If it is during the academic year, before the first of July, would you like to hold a public lecture for us? Shall I try to arrange this? Of course, you needn't answer right away, but as soon as you know if it would suit you.

Many kind regards and best wishes. Yours faithfully,

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Harald Atmanspacher

Wolfgang Pauli – Not Just a Physicist

Wolfgang Pauli, born 1900 in Vienna. Studied physics at the University of Munich from 1918-21 (with A. Sommerfeld. In 1923 he went to the University of Heidelberg, where he formulated the Pauli-Principle (exclusion principle). In 1928 professor at Zurich. In 1931 he got to know C. G. Jung, got interested in the field of academic history, epistemology and Jungian depth psychology. 1940-46 he worked at the Institute for Advanced Study in Princeton. In 1945 Nobel-Prize for the Pauli-Principle. In 1946 he returned to Zurich, where he died in 1958.

Wolfgang Pauli

Wolfgang Pauli was born on 25 April 1900 in Vienna. He was the only son of Wolfgang Josef Pascheles, who assumed the name Pauli in 1898, and his Protestant wife, Bertha Camilla, née Schütz. Pascheles came to Vienna in 1889, was baptized a Catholic, and married on 2 May 1899. Previously, he had studied medicine with his friend, Ludwig Mach, in his hometown of Prague. Mach was the son of another Prague native, physics professor Ernst Mach, who became Wolfgang's godfather on 31 May 1900. As Pauli later wrote in a letter to Carl Gustav Jung on 3 March 1953 (Meier 1992), "Mach was probably a stronger personality than the Catholic priest, and the result seems to be that I was baptized anti-metaphysically, instead of as a Catholic."

Mach had been appointed to a newly established chair of "philosophy of inductive sciences" at the University of Vienna in 1896. (His successors were Ludwig Boltzmann and later Moritz Schlick). There he devoted himself to his profound interest in borderline questions of physics, particularly psychological and philosophical issues of epistemology. Mach's "empiriocriticism," which reduces objective science to elements of sensation and their functional links, thus radically rejecting any kind of elementary metaphysical cause, was an early form of the logical empiricism and positivism of the Vienna Circle, which had originally been founded in 1928 as the Ernst Mach Association, and was chaired by Schlick. Even though Pauli's stance toward Mach's anti-metaphysics later changed, his intellectual development in many aspects should be viewed against the backdrop of Mach's influence, which endured over long periods of time.

Pauli went to study physics in Munich under Arnold Sommerfeld in 1918, and at the age of 21, he completed work on a two-hundred-page *Übersichtsartikel über die spezielle und allgemeine Relativitätstheorie* (Survey of Specific and General Theory of Relativity). Albert Einstein was full of praise for this work, and as a result, the attention of scientific world was drawn to the "child prodigy," Pauli. After obtaining his doctorate in 1921 at the university in Munich, Pauli worked with Max Born (Göttingen) and Niels Bohr (Copenhagen), and after qualifying as a university lecturer in Hamburg in 1924, he worked on developing quantum theory. In 1925 he proposed the Pauli exclusion principle, for which he was later awarded the Nobel Prize. However, of primary importance in those years was his work on the Copenhagen Interpretation of Quantum Mechanics, done in collaboration with Niels Bohr and Werner Heisenberg. Even though the field was still relatively new, this interpretation contained the focal points for the revolution of natural science, which today are becoming increasingly clear on a broad front. I will mention only a few key issues such as the changing concept of reality that accompanies quantum theory and the metamorphosis of traditional atomism into quantum theory holism. In 1928 Pauli was appointed to a newly created chair of theoretical physics at the Federal Institute of Technology in Zurich.

As the "conscience of physics," Pauli was well-known and much feared as a merciless critic of works and developments he considered unimportant, irrelevant, or unfounded; and on the strength of his extensive knowledge and the precision of his arguments, his criticism was widely accepted. Characteristic comments were "completely wrong" or, worse still, "not even wrong." And yet he did not see himself as infallible in any way. "I have often declared something right to be wrong..." — albeit adding: "...but I have never declared something wrong to be right" (von Meyenn, 1984).

The rational bias expressed by this (and other) citations, along with other events, brought him to an existential crisis that reached its critical point in the 1930s. His mother died at the end of 1927, he left the Catholic church in 1929, and in Vienna, on 26 November 1930, he divorced Käthe Deppner, whom he had married barely one year previously in Berlin. Pauli's lifestyle became very unstable; he started drinking and smoking, and finally, at the recommendation of his father, went to see Zurich-based doctor and psychoanalyst Carl Gustav Jung, who delegated Pauli for analysis to a young colleague, Erna Rosenbaum. During this time, Pauli wrote down some 1500 (!) dreams, a selection of which Jung later used for his work on dream symbols of the individuation process. On 4 April 1934, Pauli married Franca Bertram of Munich, with whom he remained united until his death in 1958.

Looking back, Pauli wrote in a letter to Kronig dated 3 August 1934 (von Meyenn, 1985) regarding this period, which was of such importance for his later life:

> *I was extremely afraid of all things emotional and thus repressed them. This finally caused an overload of all emotional demands in my unconscious, and the latter revolted against a one-sided adjustment of the conscious, which expressed itself as disgruntlement, loss of values, and other neurotic manifestations. After having arrived at a very low point in the winter of 1931-32, things slowly started to improve. I also became acquainted with psychological matters with which I had not been previously familiar and which I would subsume under the term autoactivity of the soul. There is no doubt in my mind that there are things that are spontaneous products*

of growth, which we can call symbols — an objective psychological aspect that can not and should not be explained with the aid of material causes.

And in a letter to Jung dated 24 May 1939 (Meier, 1992):

The specific danger of my life was that I tended to go from ‚one extreme to another' in the second half of my life (enantiodromia). — During the first half of my life I was, for other people, a cynical, cold devil and an intellectual 'educator.' — The opposite of this would be, on the one hand, a tendency toward criminality, toward being a ruffian (which could have degenerated into being a murderer), and, on the other, existing as an unworldly, wholly non-intellectual hermit with ecstatic states and visions. The reason for my neurosis, then, was to keep me from this danger of becoming the complete opposite.

The acquaintance between Pauli and Jung, which was to lead to almost thirty years of very close contact, was a great benefit and stimulus to both men — albeit in fundamentally different respects, which cannot be detailed here (see, for example, Atmanspacher et al., 1995; Atmanspacher and Primas, 1996).

"Just as physics seeks completeness, your analytical psychology seeks a home," Pauli wrote on 27 May 1953 to Jung (Meier, 1992). Pauli saw an incompleteness in the problem of observing quantum mechanics, which is, in contrast to Einstein's view, "not an incompleteness of quantum mechanics within physics, but rather an incompleteness of physics within life as a whole," as stated in the manuscript, *Moderne Beispiele zur Hintergrundphysik* (Modern Examples of Background Physics), which was not intended for publication (Meier, 1992). Pauli hoped that Jung's depth psychology and modern quantum theory would provide insights into a common origin of both, an underlying unity. Key issues include the concepts of the "collective unconscious" with its archetypal contents and "synchronicity," which Jung first detailed in an article published along with Pauli's studies on the history of ideas about Kepler (Jung and Pauli, 1952).

V 19. RELATIVITÄTSTHEORIE.*)

Von

W. PAULI jr.

IN MÜNCHEN.

Inhaltsübersicht.

I. Grundlage der speziellen Relativitätstheorie.

1. Historisches (*Lorentz, Poincaré, Einstein*).
2. Das Relativitätspostulat.
3. Das Postulat von der Konstanz der Lichtgeschwindigkeit. Die Theorie von Ritz und verwandte Theorien.
4. Relativität der Gleichzeitigkeit. Ableitung der Lorentz-Transformation aus den beiden Postulaten.
5. Lorentz-Kontraktion und Zeitdilatation.
6. *Einsteins* Additionstheorem der Geschwindigkeiten und seine Anwendung auf Aberration und Mitführungskoeffizient. Dopplereffekt.

II. Mathematische Hilfsmittel.

7. Die vierdimensionale Raum-Zeitwelt (*Minkowski*).
8. Übergang zu allgemeineren Transformationsgruppen.
9. Tensorrechnung bei affinen Koordinatentransformationen.
10. Die geometrische Bedeutung der kontra- und kovarianten Komponenten eines Vektors.
11. Flächen- und Raumtensoren. Vierdimensionales Volumen.
12. Duale Ergänzung zu Flächen- und Raumtensoren.
13. Übergang zur allgemeinen Geometrie *Riemanns*.
14. Begriff der Parallelverschiebung eines Vektors.
15. Geodätische Linien.
16. Raumkrümmung.
17. *Riemanns* Normalkoordinaten und ihre Anwendungen.
18. Die Spezialfälle der euklidischen Geometrie und der konstanten Krümmung.
19. Die Integralsätze von *Gauß* und *Stokes* im vierdimensionalen Riemannschen Raum.
20. Herleitung von invarianten Differentialoperationen mit Benutzung der geodätischen Komponenten.
21. Affintensoren und freie Vektoren.
22. Realitätsverhältnisse.
23. Infinitesimale Koordinatentransformation und Variationssätze.

*) Ich möchte auch an dieser Stelle Herrn Geheimrat *Klein* für das große Interesse, das er diesem Referat entgegengebracht hat, seine tatkräftige Hilfe bei der Durchsicht der Korrektur und seine vielen wertvollen Ratschläge meinen wärmsten Dank aussprechen. Auch Herrn *Bessel-Hagen* bin ich für sorgfältige Durchsicht eines Teiles der Korrekturbogen zu Dank verpflichtet.

Encyklop. d. math. Wissensch. V 2. 36

The legendary synoptic article on the Theory of Relativity by the 21-year-old Pauli, in: *Encyklopädie der Mathematischen Wissenschaften mit Einschluß ihrer Anwendungen*, 1921.

The idea that there exists a collective sphere beyond the personal unconscious, whose contents are beyond personal character and experience, is one of the key aspects that Jung developed after breaking with the Viennese psychologist Sigmund Freud, with whom he had worked closely for many years. From Augustine, Jung borrowed the concept of the "archetype" to describe these collective contents. They include instincts and other autonomous, motivating forces, as well as typical forms of conception and perception, for example duality, trinity, or (as was very important in the Pauli-Jung dialogue) quaternity. With the archetypes of the collective unconscious, Jung took a step beyond pure psychology, entering territory that Freud had sought carefully to avoid — the realm of transcendence, or, as he called it in a letter to Pauli dated 4 May 1953 (Meier, 1992), "archetypal theology or metaphysics." The interesting thing here is the positive commitment with which the "anti-metaphysically baptized" Pauli responded.

It is equally interesting to note that this stance, which would have been virtually inconceivable for the young Pauli, was also precisely "empirically" motivated — although, of course, not in the way of the conventional natural sciences would regard the notion of empiricism, as it demands experimental reproducibility and thus consistently excludes the "actuality of the unique." In his life and dreams, Pauli himself experienced the "autoactivity of the soul" and the "objective psychological aspect" as the effects of archetypal forces. "Empirical metaphysics" in this sense would thus have constituted at best an unacceptable paradox for Mach and the Vienna Circle. For Pauli and Jung, the subject of "synchronicity," the logical correspondence of causal and unconnected occurrences, referred to an area in which correspondences, which we regard as strange or even obscure relationships between the psyche and matter, are structured as archetypal dispositions. In a letter to Fierz dated 7 January 1948, Pauli writes:

Here we must postulate a cosmic order of nature opposed to our arbitrariness, to which both outer material objects and inner images are subjected... That which orders and regulates must be situated beyond the distinction between physical and psychological. I am all in favor of calling these ordering and regulating forces archetypes, but it would be illegitimate to define them as psychological contents. Rather, the aforementioned inner images...are the psychological manifestations of the archetypes that would also have to produce, generate, and cause all natural laws in the behavior of the corporeal world. The natural laws of the corporeal world would then be the physical manifestations of the archetypes... Then every natural law would possess an equivalent, and vice-versa, although this is not always immediately apparent today.

In another, only recently published and partly very private manuscript, the *Klavierstunde* (Piano Lesson) (Atmanspacher et al., 1995), Pauli speculates on the relationships of the concept of synchronicity with subjects such as causality, statistics, coincidence, and finality — above all, with regard to Darwin's theory of evolution. Under the impression of the questions and problems that this theory leaves unanswered, he outlines a model according to which

the outer physical circumstances, for one, and, for another, inherited genetic changes adjusted to these circumstances (mutations) are not causally related, but have occurred at the same time as the outer conditions to form a meaningful, expedient indivisible whole — correcting the 'blind,' chance fluctuations of mutations.

In addition to causal laws and statistical laws, Pauli continues, "what we are seeing today is the third type of natural law that we have sought and that consists of a correction of the fluctuations of chance by means of meaningful or expedient coincidences of causally unrelated occurrences."

There can be no question: here again we see a wide field of exciting questions and research projects unfold, whose connection with contemporary issues such as chaos and complexity is immediately obvious. Pauli died two and a half years before Jung, on 15 December 1958, in Zurich. He was not only one of the greatest physicists of our time, but also one of the most versatile and certainly one of the most extraordinary. Victor Weisskopf, one of his first assistants, said at the funeral oration on 20 December, "Pauli's meaning for us and for physicists all around the world is so vast, we cannot even begin to imagine it. He has left a world in which the problem of balancing the Scylla, a blue mist of mysticism, and the Charybdis of sterile rationalism is constantly growing" (von Meyenn, 1984).

From a new viewpoint, the Pauli-Jung dialogue examines a number of fundamental, partly ancient questions exceeding the realm of psychology and physics — albeit without providing definitive answers. In view of their significance for future science, we cannot overestimate the potential stimulus and inspiration emanating from the interplay of these two giants of the twentieth century.

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Harald Atmanspacher, born in 1955. Studied physics in Göttingen, Zurich and Munich, got his Ph.D. in 1985. 1988 he worked at the Max Planck Institute for Extraterrestrial Physics in Garching, Munich. Habilitation at the University of Potsdam, 1995. Since 1998 Haed of the Department for Theory and Data Analysis at the Institute for psychology in Freiburg. Lecturing at the Universities of Munich and Heidelberg. Fields of research: nonlinear dynamics and complex systems, special academic-historical and epistemological questions.

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Walter Thirring

Quantum Ergodic Theory

Nova acta Leopoldina NF 60, Nr. 265, 71-73 (1989)

Quantenergodentheorie {Kurzfassung}

von Walter THIRRING (Wien)

Mitglied der Akademie

Walter Thirring

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To explain the properties of normal matter, quantum mechanics, not classical mechanics, proves relevant. Hence, it appears interesting to see to what extent the concepts of classical ergodic theory can be carried over to quantum systems. Each lives on the idea that the energy shell in phase space is densely surrounded by a single orbit. In order to transfer these ideas to quantum theory, it is useful to distinguish between observables and states. The observables form an algebra, and states, which contain information about the system, are positive linear functionals of the algebra. As a special case of commutative algebra, classical mechanics fits in well with this scheme. In addition, quantum systems that reflect a thermodynamic behavior are supposed to be asymptomatically ABELian. This means that any observable at one time commutes with each observable at a much later time. This does not hold for atomic systems, and it also distinguishes particular infinite systems. Accordingly, for the systems that exhibit classic behavior for macroscopic time intervals, ergodic theory can be correspondingly generalized. First of all, a state is defined as ergodic if it is invariant as time evolves and cannot be represented as a combination of other time-invariant states. Such states are characterized by the following properties:

1. If the state can be decomposed into other states, it is the temporal mean of each of its components.

2. The temporal mean of each observable equalizes the expectation value with this state.

3. The state is the only time-invariant state in this representation of the observable and

4. the temporal correlation functions factorize, if the mean is taken over all times.

In many cases, there are mixing properties instead of ergodic properties, in which the above statements are fulfilled not only in the temporal mean, but also in the limit $t \rightarrow \pm \infty$.

As a corresponding generalization of the Boltzmann-Maxwell distribution, one nowadays considers states that fulfil the so-called KMS state. This states that the analytic continuation in time around the imaginary inverse temperature of a correlation function yields the one in which the sequence of operators in the product is changed. It turns out that extremal KMS states that cannot be dissected into other KMS states are able to mix and therefore have the desired ergodic properties.

So in accordance with the classic idea, a quantum system will be called ergodic if the extremal KMS states are all precisely ergodic states. It turns out that this is connected to the classic requirement that other constants be absent, in as far as it is equivalent to the absence of other modular automorphisms that interchange with the evolution of time.

Unfortunately, the property of ergodicity cannot be proven through quantum mechanics for realistic systems. This leads to the question of whether there are other reasons for the empirical distinction of KMS states. As a matter of fact, they are characterized by certain properties of stability and passivity, which make their prevalence in nature seem plausible.

Nova acta Leopoldina, NF 60: 265 (1989): 71-73.

Stephen Jay Gould, John Maynard Smith, Lewis Wolpert, Stuart Kauffman, Roger Penrose, Gerald Edelman, Walter Thirring, and Leslie Orgel (from left to right); symposium on the occasion of the 50th anniversary of Erwin Schrödinger's book *What Is Life*, Trinity College, Dublin, 1993

Walter Thirring, born 1927 in Vienna. Studied physics and mathematics at the University of Vienna. Worked at the Institute for Advanced Studies, Dublin, in Glasgow and in Göttingen, at the University of Bern at the Institute for Advanced Study, Princeton. Professor at the Universities of Bern, Cambridge, Washington and Vienna. Professor for theoretic physics at the University of Vienna, 1959. Head of department at CERN in Geneve. His fields of research are mathematical physics, elementary particle physics, quantum theory, solid-state physics and multi-state physics. Several publications in these fields. He lives in Vienna.

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3

Anton Zeilinger

Bell's Theorem, Information, and Quantum Physics

Anton Zeilinger, born 1945 in Ried/Innkreis. Professor of experimental physics at the University of Innsbruck. Guest professor at several universities in Europe and the USA, author of more than 150 publications. Currently at the Institute of Experimental Physics, University of Vienna. Main focus on fundamental questions in physics, especially in the field of the quantum theory, quantum communication, and quantum cryptography. In 1997 he and a group of colleagues managed to teleport light particles over several kilometers.

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1. Information and Interference

In the famous double-slit experiment [4], which, according to Feynman [5], contains in it the heart of quantum mechanics, a number of deep epistemological questions about quantum mechanics are raised. As is well known, an interference pattern only arises when both slits in the intermediate diaphragm are open (Fig. 1). It can be argued that each individual particle has information that both slits are open because all particles avoid the minima in the interference pattern. Yet we still might ask ourselves through which of the two slits does a specific particle pass. Yet, all of the numerous gedanken attempts to demonstrate that one can find out which of the two slits the particle uses, and still obtain the interference pattern, were in vain. Whenever it is possible to determine the path precisely, by whatever means, the interference pattern vanishes. On the other hand, if there is no possibility, not even in principle, to find out which path was taken by a particle registered at the observation screen, the interference pattern arises with perfect visibility. Already here we can note that it is information which plays a crucial role in whether or not interference is observed. Path information and the information contained in the interference pattern exclude the other. It is important to realize that it does not matter whether or not an observer actually takes note of the path the particle took. It is the mere possibility of determining the path which makes it impossible to observe the interference pattern.

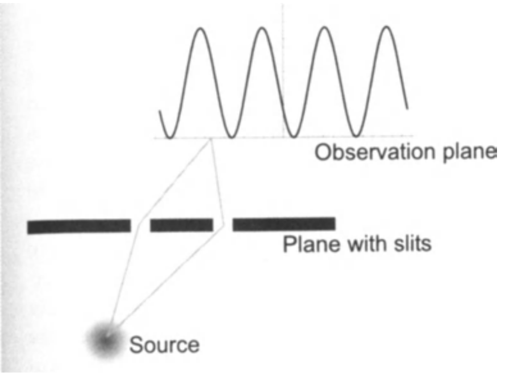

Fig. 1. The double-slit interference experiment [4]. The interference fringes in the observation plane are collected one particle at a time, each of them passing individually through the plane with the slits.

The double-slit experiment therefore is a basic example of complementarity in quantum mechanics. Complementarity in general is, as introduced by Niels Bohr, the notion that there exist pairs, or combinations of more than two observables, such that if one is determined perfectly, the others are by necessity completely undetermined. For Niels Bohr [6], this was a consequence of the fact that in order to demonstrate mutually complementary observables, one has to use apparata that exclude each other. This might suggest the impossibility of experimental demonstration, or the simultaneous determination of complementary observables, because of the clumsiness of macroscopic apparata which are unsuitable for determining the fine details of quantum objects. Yet, as signified most clearly by the Kochen-Specker theorem [7], as also found by John Bell [8], it is impossible to assign to a quantum system observable properties per se, i.e. independent of considering the apparatus with which the properties will be measured. Thus, we do not in an experiment reveal a pre-existing feature of a quantum system. Therefore, measurement is constitutive in what can be physical reality in the sense that the experimentalist by deciding which apparatus to use chooses which physical observable can become reality. In the case of the double-slit experiment, by deciding to measure the path the particle takes, the experimentalist decides that "path taken" can become an element of reality. On the other hand by deciding to choose an experimental set-up intrinsically unsuitable to determine the path taken, the observer decides that the interference pattern can become reality. This indicates that the observer, by choosing the experiment, can actually choose between different kinds of information that will manifest themselves in the experiment, although the total amount of information is apparently limited.

This has often led to confusion and to the wrong impression that the observer in a quantum measurement has so much influence that she [in some of his papers, John always referred to physicists in the feminine] can define reality. Yet, an important point is suggested by the fact that the observer cannot define which particular value will turn out for the observable chosen out of the class of complementary observables. Specifically, the observer has no influence on which of the two paths the particle will be found in if the path is measured. And likewise she has no influence on where exactly in the interference pattern the particle will be found.

This indicates that the observer has a qualitative, but not a quantitative influence on reality. She can define which quality will show up in the experiment, but not the quantity, the exact value, the latter being completely random, except in the rare case when the quantum system is in an eigenstate of the observed quantity.

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This small discussion already indicates that information might be at the root of the interpretation of quantum mechanics. In the double-slit experiment, the observer can decide to obtain information either about the path taken or the information contained in the interference pattern. It also turns out that using a new measure of information the total information in a quantum system is a constant [9], Complementarity then simply is a consequence of the fact that the total information which is represented by a quantum system is finite [10].

2. Information and Entanglement

Bell's theorem [8] states that any local realistic view of the world is incompatible with quantum mechanics. More precisely, John Bell demonstrates that for entangled states, it is not possible to explain all correlations between two particles using a local realistic model. A crucial assumption of such a model is [11] that a measurement result for each of two entangled particles is independent of whatever measurement is performed on the other particle. While this is often interpreted as demonstrating non-locality in quantum mechanics, there are also alternative viewpoints possible, most notably the assumption that the philosophical notion of counterfactuality does not hold or that the existence of a reality independent of observation makes no sense in physics. By now, the conflict between local realism and quantum mechanics has led to numerous experiments, all of which support quantum mechanics [12-14]. It is therefore safe to assume that the world cannot be understood using the rather intuitively reasonable ideas leading to Bell's inequality.

While entanglement apparently seems to be still posing problems as to understanding its nature, the information-theoretical interpretation of quantum mechanics again leads to a very natural point of view, as we will see now for a specific example [15-17].

Considering just two two-state systems, i.e. two qubits, it is natural to assume that the information carried by the system is one bit of information per qubit. In a classical way of encoding, this would lead to the following factorizable states:

$$\begin{aligned}|\Psi_1\rangle &= |0\rangle_1\,|0\rangle_2\\ |\Psi_2\rangle &= |0\rangle_1\,|1\rangle_2\\ |\Psi_3\rangle &= |1\rangle_1\,|0\rangle_2\\ |\Psi_4\rangle &= |1\rangle_1\,|1\rangle_2\end{aligned} \tag{1.1}$$

Here the first (second) ket refers to the first (second) system. In that way of encoding, each system is the representative of one well-defined bit of information. In the system of the states represented by (1.1), we indeed have encoded two bits of information, since each of the two particles is represented by a choice of two orthogonal states which easily can be identified. This is just like in classical coding, where we would have two physical bits, each one carrying either the value "0" or the value "1" with four possible combinations corresponding to the four states (1.1). On the other hand, quantum physics is a holistic theory in the sense that a quantum state intrinsically is not limited by space-time allocation. Therefore, two quantum systems can carry two bits of information in such a way that neither of them carries any well-defined information on its own. An example of such maximally entangled states is given by the so-called "Bell-basis"[18].

$$\begin{aligned}|\Psi^+\rangle &= \frac{1}{\sqrt{2}}(|0\rangle_1|1\rangle_2 + |1\rangle_1|0\rangle_2)\\ |\Psi^-\rangle &= \frac{1}{\sqrt{2}}(|0\rangle_1|1\rangle_2 - |1\rangle_1|0\rangle_2)\\ |\Phi^+\rangle &= \frac{1}{\sqrt{2}}(|0\rangle_1|0\rangle_2 + |1\rangle_1|1\rangle_2)\\ |\Phi^-\rangle &= \frac{1}{\sqrt{2}}(|0\rangle_1|0\rangle_2 - |1\rangle_1|1\rangle_2)\end{aligned} \tag{1.2}$$

In which way do these four states carry two bits of information in a nonlocal way? Obviously, one bit of information is encoded in the states $|\Psi^+\rangle$, $|\Psi^-\rangle$ versus $|\Phi^+\rangle$, $|\Phi^-\rangle$. It is the truth-value of the proposition "the two qubits are equal". Apparently, this statement is false for the first two states and correct for the second two states. But where is the other bit of information? This is easily seen if one goes to a conjugate basis by using the transformation

$$\begin{aligned}|0\rangle &\to \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)\\ |1\rangle &\to \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)\end{aligned} \tag{1.3}$$

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Then, one will find that in the new basis, the proposition "the two qubits are equal" will now be false for the states $|\Psi^-\rangle$ and $|\Phi^-\rangle$ and correct for the states $|\Psi^+\rangle$ and $|\Phi^+\rangle$.Together, the two statements allow a unique determination of the four non-local states, each one representing a unique combination of the truth values "0", "1" of the two propositions.

The lesson here therefore is that information can be carried by quantum systems in a very non-local way. independent of their spatio-temporal arrangements. One might notice that similar reasoning is possible for higher entangled states, as in GHZ states of the general form [11]

$$|\Psi\rangle = \frac{1}{\sqrt{2}}(|000\rangle + |111\rangle) \tag{1.4}$$

and W-states [19] of the general form

$$|\Psi\rangle = \frac{1}{\sqrt{2}}(|011\rangle + |101\rangle + |110\rangle) \tag{1.5}$$

Here, for example, $|011\rangle=|0\rangle_1|1\rangle_2|1\rangle_3$. In such three-qubit states evidently three propositions define all eight states of the complete basis.

We note that a general criterion exists for quantum non-locality in a two-qubit system, this is that a state violates a Bell inequality if, and only if, more than one bit of information is encoded jointly by the members of the system into the correlations.

These considerations might indicate to the reader that in quantum physics information is a more basic notion than in any classical view of the world.

3. Bell's Theorem, Quantum Communication and Quantum Information

Most interestingly, essentially in the last decade a fully unexpected and novel development set in. This is based on the realization that using individual quantum systems one can obtain completely novel ways of encoding, transmitting and processing information. These new ways of communication and of computation include as a fundamental concept quantum entanglement. It is safe to say that this very recent development would not have been possible without John Bell's seminal work. Therefore, it might be appropriate to review now a few of the basic procedures.

3.1 Quantum Dense Coding

It was first suggested by Bennett and Wiesner [20] that if two players have access to entangled states, Alice can actually encode more than one bit of information into one particle. This can easily be seen by referring to the Bell-basis of (1.2). There one sees that starting, for example, with state, $|\Psi^+\rangle$, one can easily obtain any of the other Bell-states by just manipulating one of the qubits, say qubit 2. If qubit 2 is flipped, then one obtains the state $|\Phi^+\rangle$, if the phase of qubit 2 is changed by π, then one obtains $|\Psi^-\rangle$, and if both procedures are applied one obtains $|\Phi^-\rangle$. Thus, Alice can send to Bob more than one bit of information by manipulating just one photon, if Bob has full access to the complete state, i.e. also the other photon, and if he can perform the Bell-state measurement determining which of the four Bell-states characterizes the complete two-qubit system. While at present complete Bell-state analyzers for independent qubits do not exist, the principle of quantum dense coding has been successfully demonstrated in an experiment [21]. In that experiment, see Fig. 2, it was possible to determine two Bell-states definitely, and the other two Bell-states gave the same third result.

Thus, it is possible to transmit ld3 = 1.584... bits of information for each qubit manipulated, which is clearly larger than the classical limit of 1. Yet, clearly the real limit of 2 bits per pair is not surpassed. Quantum dense coding may be viewed as a direct application of the fact that information is carried in an entangled state in a holistic or non-local way, and that the experimentalist, by manipulating only part of the state, can change the complete two-qubit state such that it becomes another Bell-state, i.e. qualitatively different. We remark that while Alice only has access to one qubit, Bob needs to have access to both qubits in order to extract the information encoded by Alice.

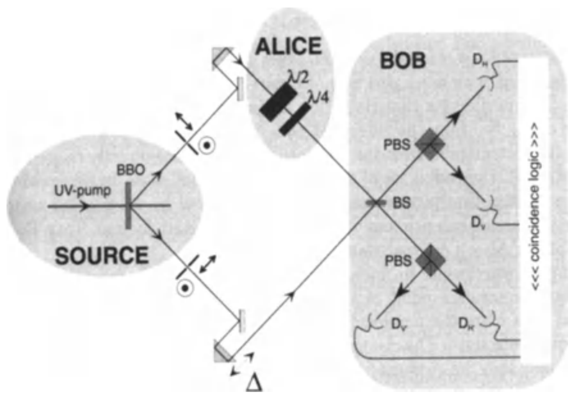

Fig. 2. Quantum dense coding setup. Entangled photon pairs are produced by spontaneous parametric down-conversion in a BBO crystal. One photon is sent directly to Bob, and the other is sent to Alice, who encodes the three-valued information on this photon by adjusting the λ and wave plates, and then passes them on to Bob. Bob combines the two photons in his Bell-state analyzer, which allows him to identify three of the four Bell-states [21].

3.2 Quantum Teleportation

An extension of these procedures is quantum teleportation, where Alice and Bob initially share an entangled pair of qubits [22,23]. See Fig. 3.

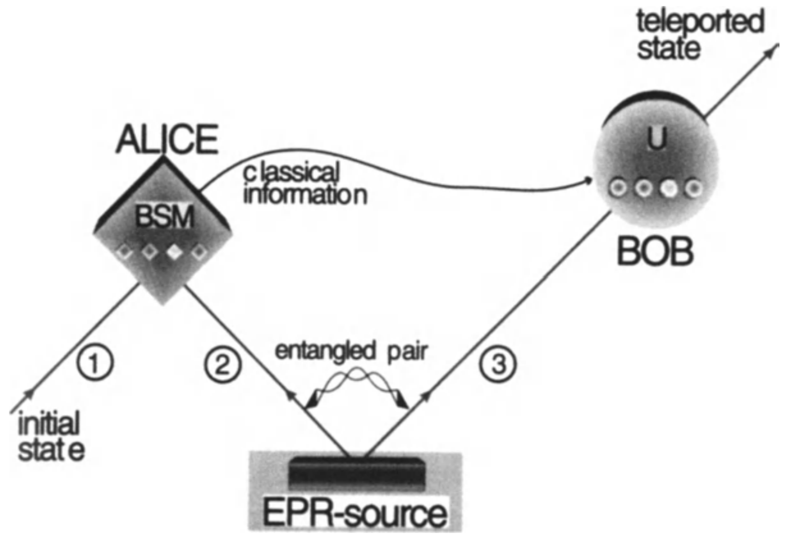

Fig. 3. Principle of quantum teleportation: Alice has a quantum system, particle 1, in an initial state which she wants to teleport to Bob. Alice and Bob also share an ancillary entangled pair of particles 2 and 3 emitted by an Einstein-Podolsky-Rosen (EPR) source. Alice then performs a joint Bell-state measurement (BSM) on the initial particle and one of the ancillaries, projecting them also onto an entangled state. After she has sent the result of her measurement as classical information to Bob, he can perform a unitary transformation (U) on the other ancillary particle, resulting in it being in the state of the original particle. In the case of quantum teleportation of a qubit, Alice makes a projection measurement onto four orthogonal entangled states (the Bell states) that form a complete basis. Sending the outcome of her measurement, i.e. two bits of classical information, to Bob will enable him to reconstruct the initial qubit.

Alice then performs a joint Bell-state measurement on her qubit together with one of the two from the entangled pair. This measurement immediately projects the second qubit from the pair into a specific state directly related to Alice's original. Depending on the result of Alice's Bell-state measurement, Bob then applies a unitary transformation determined by Alice's Bell-state measurement result independent of which state Alice initially had. Thus Bob finally obtains Alice's original state.

It may be worthwhile to analyze this experiment briefly from an information-interpretational point of view [15]. What happens is that initially, Alice and Bob share the non-local information contained in the original entangled quantum state. That is, they know how qubits 2 and 3 relate to each other, should they be measured. By obtaining the Bell-state measurement result, Alice acquires further information on how the original qubit to be teleported and her member of the entangled pair relate to each other. Thus, by a simple logical chain, it is now known how the qubit to be teleported and Bob's entangled member of the pair are related. Thus, one obtains by these measurements a sequence of relational statements, and it is therefore uniquely determined through which unitary operation Bob's qubit is related to the original. This simple information-interpretational point of view supersedes all possible paradoxes, as all that changes by Alice's measurement is the quantum state of the total system, that is, the information which the observers have. No action at a distance or other mysterious processes happen.

It is actually interesting to notice that the information contained in Alice's original state is immediately teleported over to Bob's station as soon as Alice's Bell-state measurement is performed. Bob certainly has four different states at hand, depending on the specific result of Alice's measurement. Yet, each of these states is related to the original through a rotation independent of the properties of the original. Thus, in a sense, the information is already there [24], yet Bob cannot really read it out without knowing Alice's result. Interestingly, this has operational consequences. For example, one can start a quantum computer at a time before the classical information has arrived [25] and thus save computational time.

3.3 Teleportation of Entanglement

A most interesting application of these ideas is the teleportation of entanglement [22, 26, 27], also called entanglement swapping. In that experiment, one teleports a photon which does not enjoy its own quantum state but is still entangled with another one. Thus, one cannot even say here that a quantum state is teleported. In a recent experiment [28], it was possible to perform the teleportation of an entangled photon in such a high quality that the original photon and the teleported one were entangled well enough to observe a violation of Bell's inequality between two independently created photons. This, more than any experiment before, underlines that Bell's theorem is not about properties particles carry, but about the information concerning possible measurement results. See Fig. 4.

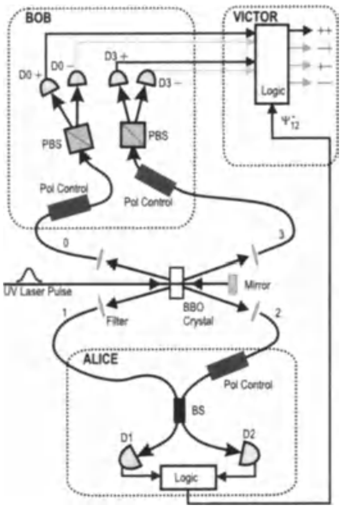

Fig. 4. Setup of the experiment teleporting an entangled photon. Two entangled photon pairs are produced by down-conversion in a BBO crystal, pumped by femtosecond UV-laser pulses traveling through the crystal in opposite directions. All photons are collected in single-mode optical fibers for further analysis and detection. For performing the Bell-state analysis, photons 1 and 2 interfere at a fiber beam splitter, where one arm contains a polarization controller for compensating the polarization rotation introduced by the optical fibers. Photons 0 and 3 were sent to Bob's two-channel polarizing beam splitters for analysis, and the required orientation of the analyzers was set with polarization controllers in each arm. All photons were detected with silicon avalanche photodiodes, with a detection efficiency of about 40%. Alice's logic circuit detected coincidences between detectors D1 and D2. It is essential that she passes the result as a classical signal to Victor, who determines whether Bob's detection events violate Bell's inequality [28].

The teleportation of entanglement also can easily be understood on the basis of an information interpretation of quantum mechanics. This is just one step further than standard teleportation. Alice and Bob initially share two relational statements, each one characterizing each of the two entangled pairs. By performing a Bell-state measurement on one photon from each pair, they obtain further relational statements and thus can conclude the chain of logical links from photon 0 to photon 3. About these two photons, they obtain the same joint statement as about the possible states of the Bell basis of (1.2). Again, these are statements about possible experimental results only, should an experiment actually be performed.

3.4 Quantum Cryptography

The technically most advanced application of fundamental quantum concepts in communication is quantum cryptography. The protocols closest related to Bell's ideas are again based on the use of entangled states, as first suggested by Ekert [30]. Without going into details, one uses an entangled state to create the same identical key by independent measurements by two observers, Alice and Bob. The big advantage of Ekert-type quantum cryptography is that the cryptographic key does not need to be transported from A to B, but is really created by measurements in the same basis as a sequence of entangled pairs. Thus, one of the essential security problems of classical cryptography, namely the necessary transportation of a classical key, immediately vanishes. Another advantage of quantum cryptography with entangled states is that any eavesdropper can readily be identified by just observing whether the data measured by Alice and Bob still violate a Bell inequality. If such is the case, then no essential information could have leaked out to an eavesdropper, and Alice and Bob can readily use the key obtained. See Figs. 5 and 6.

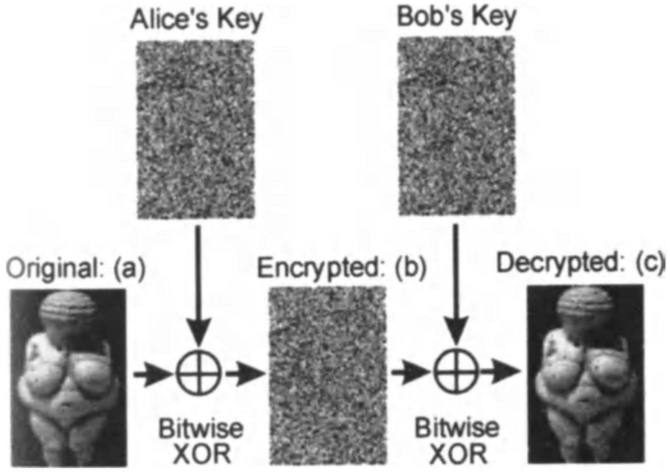

Fig. 5. In an experimental realization using polarization entangled pain of photons, a key was created and it was used to actually transmit visual information, in this case a picture of the famous Venus von Willendorf sculpture [29].

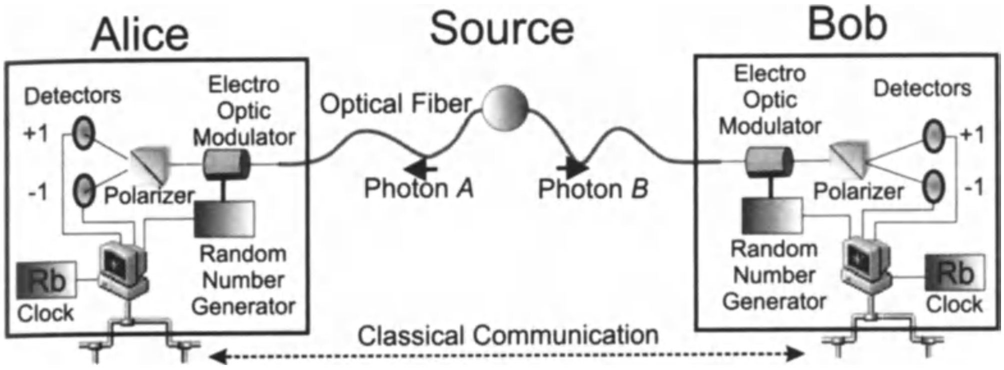

Fig. 6. Polarization-entangled quantum cryptography [29]. The most salient feature of this experiment is, besides the creation of the entangled pair, that each photon is sent to experimental stations which finally are separated by more than 300m. In each station, one has an independent Rubidium clock, which simply registers the photon arrival times and two-channel polarizers, where one channel is identified as "0" and the other is identified as "1". If the two polarizers are parallel, the correlations are perfect, and Alice and Bob obtain the same random sequence after eliminating those events where only one photon was registered. In order to identify a possible eavesdropper, both Alice and Bob randomly switch between two bases independent of each other. They then identify those situations where they happen to have the same basis, and they know that in these situations they obtain the key. The situations where they happen to have different bases can be used to check for a possible eavesdropper.

There is a very fundamental information-theoretic interpretation of the security of entangled-state quantum teleportation. The basic observation is that a two-qubit system can carry only two bits of information. For a maximally entangled state, three bits are denned non-locally, i.e. the two bits are all used up to define the entanglement. Now, if the eavesdropper extracts any information, this can only be at the expense of the two non-local bits, thus reducing the entanglement.

4 John Bell's Desiderata and the Interpretation of Quantum Mechanics

In his famous paper "Against measurement" [31], John Bell suggests: "Here are some words which, however legitimate and necessary in application, have no place in a formulation with any pretension to physical precision: system, apparatus, environment, microscopic, macroscopic, reversible, irreversible, observable, information, measurement."

By now, the reader might have gathered that the present author does not agree with John Bell's statement. In contrast it is suggested that information is the most basic notion of quantum mechanics, and it is information about possible measurement results that is represented in the quantum states. Measurement results are nothing more than states of the classical apparatus used by the experimentalist. The quantum system then is nothing other than the consistently constructed referent of the information represented in the quantum state. In a measurement, one of the possible measurement results becomes reality with a relative frequency as indicated by the quantum state. For a quantum system, the environment therefore is just an external bath information can leak into, and the situation is reversible if this information can be recovered somehow from the environment, and irreversible if that is not the case.

The point where I agree with John Bell is that microscopic and macroscopic should not command any fundamental place in any physical theory. Experimental progress will certainly make it possible to push the regime where quantum phenomena have been demonstrated very far into what we would consider macroscopic. Thus, while the dichotomy microscopic-macroscopic should not have any place in a physical theory, the dichotomy quantum-classical is a most fundamental one.

While it is clear that I respectfully disagree with the general philosophical position of John Bell concerning the foundations of quantum mechanics, one cannot but show deep respect for his high intellectual integrity. His way of thinking led him to advocate the quest for more complete theories than quantum mechanics, which, as he hoped, would finally explain why individual events happen. Even if the interpretation of quantum mechanics based on information — which runs completely against his expectation — will turn out to be the correct one, then John Bell will turn out to have raised the correct challenges.

R. A. Bertlmann, A. Zeilinger, *Quantum (Un)speakables. From Bell to Quantum Information* (Vienna-New York: Springer, 2002) pp. 241-254.

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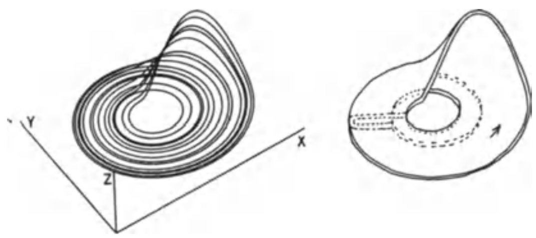
3

Peter Weibel

Endophysics and Art

Peter Weibel, born 1944 in Odessa. Studied literature, medicine, logic, philosophy, and film in Paris and Vienna. 1981-84 guest professor of creative art and visual education at the Academy of Applied Arts, Vienna. In 1981 professor at the College of Art and Design, Halifax, Canada. 1979/80 guest professor, 1981 lecturer and 1982-85 professor of photography at the Comprehensive University Kassel. 1984-89 Associate Professor of Video and Digital Arts at the Center for Media Study, State University of New York, Buffalo. 1989-94 director of the Institute of New Media at the Staedel School in Frankfurt/ Main. Since 1984 professor of visual media creation at the Academy of Applied Arts in Vienna. 1986-95 artistic adviser, then director of the ars electronica, Linz. Since 1993 curator of the Neue Galerie, Graz. 1993-99 Austria-commissioner of the Biennale, Venice. Since 1999 director of ZKM, Center for Art and Media Technology in Karlsruhe. Lives in Karlsruhe and Vienna.

Endophysics is a science that explores what a system looks like when the observer becomes part of it. Is there another perspective than that of the internal observer? Are we only inhabitants of the inner side of the interface? What does classical objectivity then mean? Endophysics shows to what extent objective reality is necessarily dependent on the observer. Ever since perspective was introduced into painting during the Renaissance and then later, group theory in the nineteenth century, the phenomena of the world have been known to be contingent on the regular localization of the observer (co–distortion). Only outside of a complex universe is it possible to give a full description of it (see Gödel's theorem of undecidability). For endophysics, this position is only possible as a model, existing outside of a complex universe — not within reality itself. In this sense, endophysics offers an approach to a general model and a simulation theory (as well as to 'virtual realities' of the computer age). Endophysics developed from chaos theory, to which Otto Rössler has contributed since 1975 (see the famous Rössler Attractor, 1976).



תהו ובהו ΧΑΟΣ 混 沌

O.E. Rössler, *Chaotic Behavior in Simple Reaction Systems,* in: *Zeitschrift für Naturforschung,* 31a, 1976, pp. 259-64.

Another aspect of endophysics is its reinterpretation of issues related to quantum physics. Rössler provides a link between Everett's, Bell's, and Deutsch's interpretations of quantum physics and Nelson's stochastic mechanics. Endophysics differs from exophysics, as the physical laws that are valid when one belongs to what one is observing are generally different from what is true in an imagined or real external point of view. Gödel's undecidability is only valid within the system. The model world of physics has to take in an explicit observer in order to make its existing reality accessible to him. Endophysics provides 'double access' to the world. Apart from the direct access to the real world (by way of sensorial interface), a second observation position is opened up from the position of an imaginary observer. Is so-called objective reality only the endo side of an exo world? Time and again, the history of cultural production has provided evidence that people sense that the world might be just the endo side of an exo world. This is revealed in many visions, gnostic formulations, riddles, and paradoxes. In order to illustrate the phenomenon of the interface as the only reality, we have recourse to the model of the 'bubble boy' who lives in a sterile bubble and only communicates with the world via the interface. The only scientific way of figuring out whether our world has a second, exo-objective side is to construct model worlds (or artificial worlds) on another level below our world, as endophysics attempts to do.

The endo approach has great promise for the complex, technological world of the electronic age. The implications of both the industrial (machine-based) and the post-industrial (information-based) cultural mechanics such as new media, simulation, synthetization, semiosis, artificial reality, withdrawal symptoms of existence, etc. — are integrated into a new discourse. This approach provides a new theoretical framework for describing and understanding the scientific, technical, and social conditions of the postmodern world. The issues that endophysics addresses — from observer relativity, representation, and non-locality to the notion that the world is a mere interface — are central issues in an electronic, telematic civilization. Observer reality, the contingency of the manifestations of the world revealed to us by endophysics, and the differences between observer-internal and observer-external phenomena provide valuable forms of discourse for self-referential aesthetics (the intrinsic world of image signals), virtuality (of the immaterial character of picture sequences), and interactivity (of the observer relativity of the image) as they are defined by electronic art. The endo approach to electronics implies not only that the opportunity to experience the relativity of the observer is dependent on an interface, but also that the world can be described as an interface from the perspective of an explicit internal observer. For isn't electronic art a world of the internal observer par excellence by virtue of its participatory, interactive, observer-centered, virtual nature? The leap from an external, dominated viewpoint to an internal, participatory viewpoint also determines the nature of electronic art. Electronic art thus drives art onward in its development, from being object-oriented to context- and observer-oriented.

Constructing model worlds on a level lower than the real world, which contain an explicit internal observer — as in a closed-circuit installation, where the observer sees him/herself in the observation devices; or in feedback situations, where a machine watches itself; or as in virtual reality, where the image contains the hand of the external observer simulated as part of the internal observer — is in keeping with the principle of endophysics. The description of the world as an interface problem and the acknowledgement that the nature of objects is not objective, but observer-objective are both corollaries of the endophysical theorem. Regarding the world as observer-relative, as an interface, is the task of endophysically interpreted electronics. The world changes with our measuring instruments (observation), our interface. The boundaries of the world are the boundaries of our interface. We do not interact with the world, but only with the interface to the world.

Electronic technology has led to the realization that we are only part of the system or an inhabitant inside the system we observe or with which we interact. For the first time, we also have access to a kind of technology and theory in which the world is imposed on us as an interface only visible from within. We are now also able to observe the system and its interface from the outside and conceive of the interface as being extended in nanometric and endophysical terms. In this sense, we are able to break out of the prison of space and time (the Cartesian coordinates) initially described in detail by Descartes. The grid of here and now becomes more malleable.

By using a computer to generate model worlds that incorporate an explicit internal observer (who can be described in microscopic detail), the otherwise inaccessible interface between explicit observer and the rest of the surrounding world can be explicitly explored. Via such model world methods or meta-experiments, the opportunity arises to get behind the interface ("take a look behind the curtain") and partially disentangle the observer-specific distortions in our own world. With the availability of computers and the opportunities to generate simulations, it is no longer pure demonism[1] to believe that the external operator of a kinetic realm can gain access via the model to a second level of reality hitherto out of bounds. As early as 1957, Alder and Wainwright demonstrated that it is feasible to simulate molecular dynamics on a computer.[2]

The inventor of endophysics, Otto E. Rössler, has demonstrated that these meta-experiments are more than mere "mathematical tomfooleries".[3] It is, for example, possible to construct a chaotic Hamilton universe in one dimension so that it will an internal observer inside it — an excitable system — is completely comprehensible and transparent. The world that the observer inhabits will appear quite different to such an observer than anyone would expect from the outside. Quantum manifestations would be non-existent in such a universe. They could only be valid in the interface created inside the universe, between the observer and his perceived world. Kant's conclusion that the world is different, objectively, from the world as it is perceived, was an early interface hypothesis. In another revolutionary work, written in 1755, mathematical physicist Roger Joseph Boscovich defined the interface hypothesis more accurately. "A common movement shared between us and the world cannot be recognized by us...It might even possibly be the case that the whole world lying outstretched right before our eyes could contract or extend in a matter of days; yet if this actually occurred, there would be no change in the mind's impression and thus no perception of such a change."[4] In other words, Boscovich maintained, the shape of the world can change (like rubber), without our being able to perceive it, because, as an integral part of that world, we ourselves are like rubber and undergo the same alterations.

A crucial point now is that technological media — electronic media in particular — represent this type of model world, and it increasingly stretches (like flexible rubber skin) all over our world. Jean Baudrillard has compared the state of the postmodern world to a state where the land (reality) is metaphorically covered with a map (hyper-reality, simulation). From this, he derived the "agony of the real," the inability to differentiate between simulation and reality. Endophysics provides an improved theoretical formula for articulating the artificial character, the model characteristic of the media world. At the same time, the world of computers is part of the first phase of endophysics, which is still an emerging science. In 1983, E. Fredkin described the first model for an explicit, computer-simulated model universe, a reversible cellular automat.[5] In endophysics, virtual worlds are only one special case in point. In the electronic age, the interface between observer and object has become susceptible to manipulation. The media represent no more than man's attempt, from a position within the universe, to simulate a possible escape from that very universe. Media worlds are no more than artificial model worlds generated to demonstrate that if we are merely internal observers in the real world, we can be both internal and external observers in media worlds. In both closed-circuit and interactive video installations, cyberspace, virtual reality, and other observer-related, participatory, interactive media art forms, we already have the prototypes for a technologically implemented view of the universe where we are always a part of the systems we observe and with which we interact.

Camera Austria 49 (1994): 33-44.

1. See Maxwell's demon in J. C. Maxwell, *Theory of Heat* (1871), in the chapter "Limitation of the Second Law of Thermodynamics." See also H. S. Leff, A. F. Rex, eds., *Maxwell's Demon. Entropy, Information, Computing* (Bristol: A. Hilger, 1990).
2. B. J. Alder, T. E. Wainwright, "Studies in Molecular Dynamics," J. Chem. Phys. 27 (1957).
3. Peter Weibel, Otto E. Rössler, eds., *Endophysik. Die Welt des inneren Beobachters* (Berlin: Merve, 1992).
4. R. J. Boscovich, *Theoria Philosophiae Naturalis* (Vienna, 1758). Reprinted as A Theory of Natural Philosophy (Cambridge, MA: MIT Press, 1996).
5. E. Fredkin, *Digital Information Mechanics*, Reprint, 1983. E. Fredkin, "Digital Mechanics," Physica D 45 (1990): 254-270.

3

Otto E. Rössler and Peter Weibel

The Two Levels of Reality – "Exo" and "Endo"

Otto E. Rössler, born in 1940. 1966 medical doctor at the University of Tübingen. 1967 post doc at the Max-Planck-Institute of Behavior Physiology, Seewiesen. 1969 guest lecturer at the center of Theoretical Biology, University of New York, Buffalo. Since 1970 professor at the Institute for Physical and Theoretical Chemistry at the University of Tübingen. 1973 Habilitation. Since 1977 several guest lecturings, main fields of research are in deductive biology, chemical, chaotic attractors, hyper-chaos and endophysics; discovered the so-called Rössler-Attractor.

References:
Peter Weibel (ed.), Otto E. Rössler, *Endophysik – die Welt des inneren Beobachters*, (Bern: Merve Verlag, 1992).
Otto E. Rössler, *Das Flammenschwert. Wie hermetisch ist die Schnittstelle des Mikrokonstruktivismus* (Berlin, 1996).
Otto E. Rössler, *Springende Identitäten von Teilchen*, in: W. Hahn, P. Weibel (eds.), *Evolutionäre Symmetrietheorie* (Stuttgart, 1996).

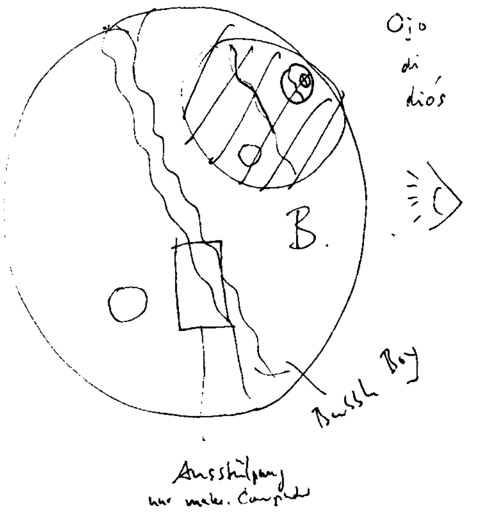


Illustration from: Otto E. Rössler, Endophysik – *Physik von innen*, in: K. Gerbel und P. Weibel (eds.), *Die Welt von innen – Endo & Nano*, ars electronica '92, PVS Verleger, Vienna 1992, p. 49.

In the electronic age, the "interface" between observer and object becomes amenable to artificial manipulation. Perspective is, as is well known, not completely objective but only "observer objective". Distorting the world, it appears, is unavoidable if one is an observer. Relativity is the second example, and "mirages" are the third.

To set up a virtual reality with mirage-like properties is a modern challenge – an "interactive trompe-l'oeil," if you like. In Frankfurt, a touch screen and a touch-sensitive floor panel have been installed, with the aim of making the intimate entanglement between observer and environment perceptible as both a frightening and liberating experience. What is liberated is the mind.

The mind can be "made similar" to anything, according to Anaxagoras. The *Kon-Ton* (jpn.; chin. *Hun Tun* = mixture) of Chuang Tzu, the *Whole* (One) of Anaximander and the *ΧΑΟΣ* (chaos, mixture) of Anaxagoras are all early names for the intangible. The chaos in each case is accompanied by a twin notion: *Shu-Hu* (lightning) with Chuang Tzu, *Apokrinein* (a separating internal secretion) with Anaximander, and *ΝΟΥΣ* (mindblade) with Anaxagoras. The dual notion in each case refers to the cut, the interface, the place where the cosmic egg pops open, respectively. It is a daring business to spring the bark of an internally burning log. But only if we catch the lightning by looking right into it (another ancient Chinese myth) can we glimpse the predivided (exo) world. The latter is called *Kon-Ton* (chaos) in Japanese.

The first Western scientist to recognize the interface problem was the eighteenth-century mathematician-cum-theologian Roger Joseph Boscovich, from Dalmatia. He asserted that the world really is deformable (we would say: "like rubber"), but that we are unable to notice this. Due to our being made of "rubber" too, we are subject to code formation. Hence the interface falsely presents a solid world to us.

Both quantum mechanics and relativity reflect this "cut type" (or endo) position. A mere observer objectivity of the world ceases to be hermetic once it has been recognized. For it then becomes possible to investigate its properties with the aim of finding a loophole. A prison whose existence has been recognized can be sprung. Science and wisdom are no longer at odds.

Otto E. Rössler

For J.O.R..

Otto E. Rössler, *Endophysics. The World as an Interface*, World Scientific, Singapore-New Jersey-London-Hong Kong 1998, pp. 59-60.

O.E.R. thanks Yoshiki Kuramato and the late Kazuhisa Tomita for stimulation.

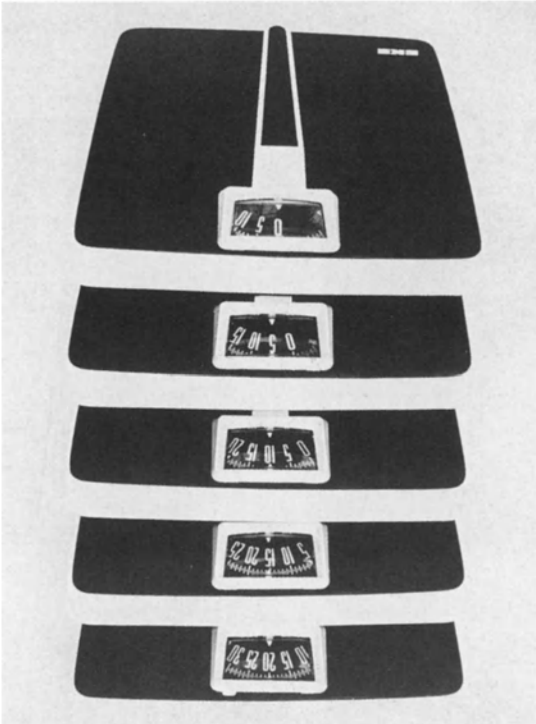
Gottfried Bechthold

Gottfried Bechtold
born 1947 in Bregenz. Lives in Hörbranz, Vorarlberg.

1971 Forum Stadtpark, Graz
Galerie nächst St. Stephan, Vienna
1978 Bregenzer Kunstverein
1993/94 Neue Galerie, Graz; Magazin 4 – Vorarlberger Kunstverein, Bregenz; Galerie Museum, Bozen
1996 Bregenzer Kunstverein; Kunsthalle, Vienna
1998 *To Hear Is to See*, Goetheinstitut, Venezuela
1999 *Gottfried Bechtold – Hans Schabus. Fotoprofile*, Camera Austria, Graz
2003 Galerie Lisi Hämmerle, Bregenz

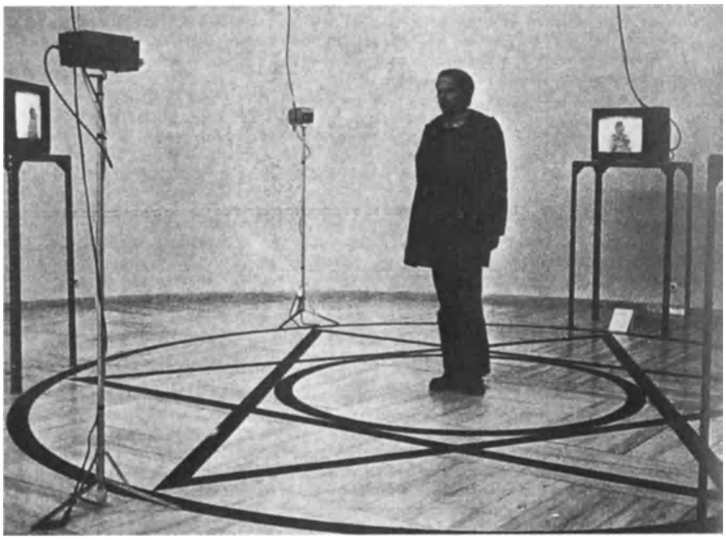
Group shows
1971 Trigon 71, Neue Galerie, Graz
1972 documenta IV, Kassel
1973 Trigon 73, Neue Galerie, Graz
1977 Trigon 77, Neue Galerie, Graz
1979 Trigon 79, Neue Galerie, Graz
1986 ars electronica, Linz
1992 *Identität : Differenz*, Neue Galerie, Graz
2000 *Get Together*, Kunsthalle, Vienna
Re-Play, Generali Foundation, Vienna
2002 *The Mallory Project*, Künstlerhaus, Bregenz
2003 Palais Liechtenstein, Feldkirch

References:
Gottfried Bechtold. Graz/Bregenz/Bozen (Graz: Neue Galerie, 1994).
Gottfried Bechtold (Bregenz: Bregenzer Kunstverein, 1996).



Gottfried Bechtold
Scales, 1973

Peter Weibel



Peter Weibel
Observation of the Observation: Uncertainty, Künstlerhaus Graz, 1973

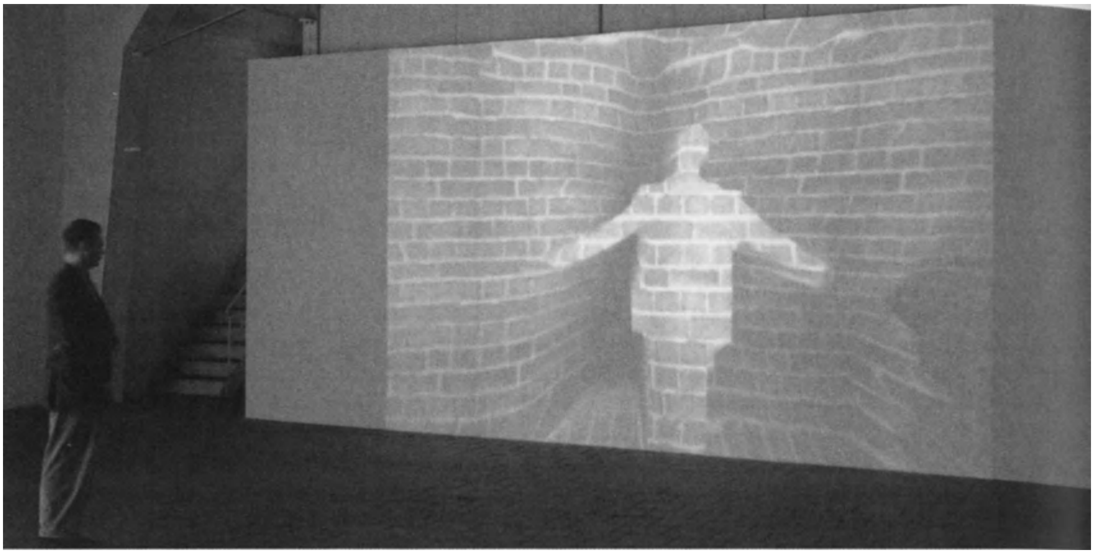
Peter Weibel
born 1944 in Odessa. Studied philosophy, literature, medicine, logic, and film in Vienna and Paris.

1975 Galerie nächst St. Stephan, Vienna
1978 Stichting de Appel, Amsterdam
1986 Museo d'Arte Contemporaneo, Madrid
1988 Museum for Applied Arts, Vienna
1991 Galerie Grita Insam, Vienna
1992 Neue Galerie, Graz
1993 Venice Biennial
Mücsarnok, Budapest
1996 Museum of Tolerance, Los Angeles
1999 Landesgalerie, Klagenfurt
2004 *the open work 1964-1979*, Neue Galerie, Graz

Group shows
1973 Trigon 73, Neue Galerie, Graz
1974 Projekt 74, Kunsthalle, Köln
1975 *Video*, Serpentine Gallery, London
1977 documenta VI, Kassel
1984 *New Narration*, American Film Institute, Los Angeles
ars electronica, Linz
1985 *Zeit – die 4. Dimension*, Museum of Modern Art, Vienna
1986 *Künstlerphilosophen*, Kunsthaus, Zürich
1987 ars electronica, Linz
1989 *Das Spiel des Unsagbaren*, Secession, Vienna; Palais des Beaux-Arts, Brussels
1990 *Le desénchantement du Monde*, Villa Arson, Nizza
1992 *Der entfesselte Blick*, Kunstmuseum, Bern
1993 *Die Sprache der Kunst*, Kunsthalle, Vienna; Kunstverein, Frankfurt
1995 *Self Construction*, Museum of the 20th Century, Vienna
1996 *The Butterfly Effect*, Mücsarnok, Budapest
1998 *Out of Actions*, The Museum of Contemporary Art, Los Angeles
1999 Kunsthalle, Krems

Peter Weibel

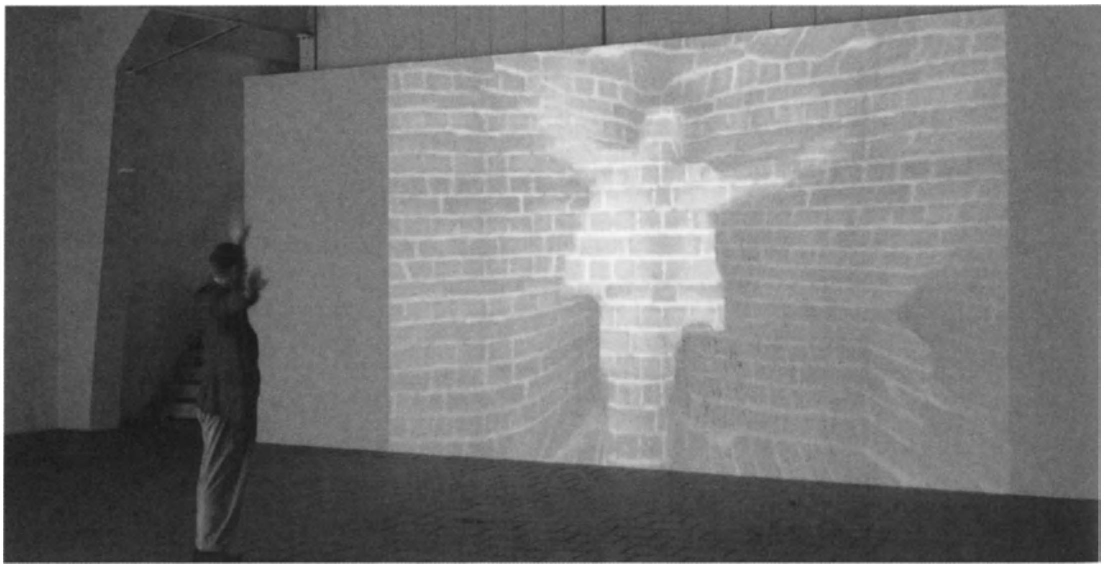
The Wall, the Curtain (Border, the), or, in Technical Terms: Lascaux, 1994



Peter Weibel, *The Wall, the Curtain (Border, the), or in Technical Terms: Lascaux,* 1994

The image of a brick wall is stored in a computer and is projected onto a wall with the aid of a data beamer. A video camera records viewers as soon as they enter the room. The analog signals of their movements are sent to the computer, where they are converted into digital strings influencing the digital signal sequences of the image of the wall. Time-delayed and frame-skeletized, the effects of both signal sequences are displayed on the screen. The viewers become part of the picture. They are real, internal viewers and simulated, external viewers pressing against the wall from behind.

Romana Schuler, ed., *Peter Weibel. Bildwelten. 1982-1996* (Vienna: Triton, 1996) pp. 244-250, p. 255.



Ruth Schnell

Door, 1988

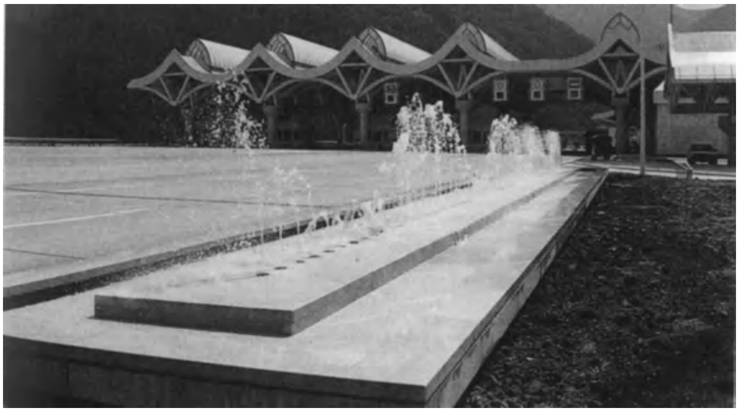
Door is an interactive computer and video installation consisting of the following elements: a real door (closed), a portal/porch, a walkway, a video projection with computer animation, a live camera, a video player and tape; sound, and sensors. It is a mise- en-scène of a simultaneous presentation, a mise-en-scène of the relativity of the present and the past, the real and the projected. Behind the computer-animated door, there is a 'live transmission' of what is happening outside, from where the viewer is coming. At the same time, the window shows a past situation in the same large-screen projection: fast-motion, edited video recordings (night, same camera angle). Apparently, the viewer is master of the central perspective. He triggers the opening of the projected door via sensors. The walkway tilts him straight into the projected event. How can a continuous sequence of movements in the real plane and the shifting of movement into another plane of time take place from the same viewpoint and from the same space? Illusionary architecture, a traditional element of art since the Renaissance, Baroque, and Mannerism, is advanced through specific media. As machines that reproduce images, the media intensify the realism, the trompe l'oeil caused by the moving image, and the integration of the viewer.

Ruth Schnell, *Door,* 1988, Academy of Applied Arts, Vienna

Water Fence, 1990-91

Interactive water installation at the Karawanken tunnel customs clearance facilities, Austrian-Slovenian border crossing; marble plate, 17 meters long, 80 sensor-controlled water fountains. The speed of the sinus-like wave movement depends on the volume of traffic and the speed of the passing cars. It requires at least one vehicle crossing the Austrian border mark to create the water fountains. The moving water fence runs at right angles to the border and crosses it.

Ruth Schnell, *On the Occasion of La Biennale di Venezia* 1995 (Vienna, 1995).



Ruth Schnell, *Water Fence,* 1990/91

Ruth Schnell, born 1956 in Feldkirch. Studied at the University of Creative Arts, Linz, the Academy of Fine Arts, Vienna and at the Academy of Applied Arts, Vienna. In 1983 she founded the group Duplikat, together with Gudrun Bielz. Since 1987 several lecturings. 1994/95 guest professor of New Media at the Academy of Creative Arts, Bratislava. Lives in Vienna.

1984 *1984,* Museum of the 20th Century, Vienna
1989 *Im Netz der Systeme,* ars electronica 89, Linz
1991 *Les Images en Follies,* Martigny, Switzerland
Nagoya Biennial
1992 *Babel,* Symposium and Workshop, Kunsthochschule für Medien, Cologne
1993 *Kunst – die halbe Miete,* Bludenz
Beyond the Screen, allerArt Galerie, Bludenz
1994 *Lokalzeit – Wiener Material im Spiegel des Unbehagens,* Kunstraum Strohal, Vienna; Moderna Galerija, Ljubljana; Fondazione Querini, Venice
1995 Venice Biennial
1998 *Ruth Schnell,* Galerie Grita Insam, Vienna
1999 *Oh Hitchcock,* Kunsthalle Tirol, Hall in Tirol
La casa, il corpo, il cuore – Konstruktionen der Identitäten, Museum moderner Kunst, Stiftung Ludwig, 20er Haus, Vienna; Národni galerie v Praze, Praha
2002 *Ruth Schnell. Territorism,* Kunsthaus Bregenz, KUB, Bregenz
2003 *Kraftwerk peripher,* Kraftwerk Imsterberg, Imst / Österreich
2003 *Ruth Schnell – L'Ordre du Regard,* Galerie Lisi Hämmerle, Bregenz

References:
Vera and Gabor Body (eds.), *AXIS* (Cologne: 1986).
Peter Weibel, Edith Decker (eds.), *Vom Verschwinden der Ferne* (Cologne: 1991).
Ruth Schnell, *On the Occasion of La Biennale di Venezia 1995* (Vienna: 1995).

3

Victor F. Weisskopf

The Exactitude of Quantum Physics

Born in Vienna in 1908, Victor Weisskopf studied for two years with Hans Thirring, the father of Walter Thirring. In 1928, following Thirring's recommendation, he went to Göttingen, where he finished his dissertation under the guidance of Max Born and James Franck in 1931. He assisted Werner Heisenberg in Leipzig, Erwin Schrödinger in Berlin, and Lev D. Landau in Charkov (Ukraine). In 1932, as a Rockefeller scholar, Weisskopf worked with Niels Bohr in Copenhagen and with Paul Dirac in Cambridge. In 1933 he became Wolfgang Pauli's assistant at the ETH Zurich. From fall 1936 until spring 1937, he was in Russia. Time and again he visited Niels Bohr and his Institute for Theoretical Physics[1] before he left Europe in 1937 and became a professor at the University of Rochester.[2] From 1943 on, he worked on the Manhattan Project. After 1945 he taught at MIT, Boston. From 1960-65 he took a leave to serve as the director of the European Center for Nuclear Research (CERN) in Geneva. His friend, Hans Bethe, the Nobel laureate for physics wrote, "Victor Weisskopf has written many important publications on the theory of electromagnetic fields and on electrodynamics, nuclear physics, and the physics of high energy particles. Three of his writings have determined the development of physics." His book, *Theoretical Nuclear Physics*, written with John M. Blatt, became a standard reference work. Other books by Weisskopf, such as *Physics in the Twentieth Century*, *Selected Essays*, and *Knowledge and Wonder: The Natural World as Man Knows It* (1966) were re-published more than once due to their clarity and breadth of subject matter (from cosmology to chemistry). In his booklet on *La révolution des quanta* (1989), he placed the stability and individuality of quantum states — instead of their indeterminacy — at the center of quantum physics ("The most important idea in quantum physics is the identity principle").

Peter Weibel

1. Where he wrote "On the Self-Energy and the Electromagnetic Field of the Electron," published in Physical Rev., 56 (1939): 72-85.
2. Where, in 1936, he wrote "On the Electrodynamics of the Vacuum Based on the Quantum Theory of Electrons," published in Kongelige Dankse Videnskabernes Selskab, Mathematisk-fysiske Meddelesler XIV:6. Both essays were reprinted in *Selected Papers on Quantum Electrodynamics*, Julian Schwinger, ed. (New York: Dover, 1958).

Eugene P. Wigner

The Philosopher and the Problem of Measurement

The Hungarian Jenő (Eugene) Wigner, who emigrated to the United States, went to the same Protestant high school in Budapest as Edward Teller and John von Neumann. Wigner was professor for physics at the University of Princeton and a Nobel laureate, and has contributed enormously to the conceptual foundation of quantum mechanics.[1] One of his first works was *Über das Paulische Äquivalenzverbot* (On Pauli's Equivalence Ban),[2] which he wrote with Pascual Jordan. Wigner used the problems raised by quantum mechanics to apply scientific research to classic philosophical problems. With the help of new physical results and theoretical models, he found new answers for the mind-body dualism[3] and for the question of whether we are machines.[4] Apart from his technical articles,[5] *The Unreasonable Effectiveness of Mathematics in Natural Sciences*[6] was a particularly groundbreaking work. His technical publications, such as *Group Theory and its Application to the Quantum Mechanics of Atomic Spectra*,[7] became standard reference works. In their combination of physics and philosophy, which also questions the limits of science, his collection of essays, *Symmetries and Reflections*,[8] shows Wigner's most brilliant side.[9]

Peter Weibel

1. E. P. Wigner, "The Problem of Measurement," American Journal of Physics 31 (1963): 6-15; E.P. Wigner, "Interpretation of Quantum Mechanics," lecture, Princeton University, 1976. Published in *Quantum Theory and Measurement*, J.A. Wheeler, W.H. Zurek, eds. (Princeton UP, 1983); E.P. Wigner, "Die Messung quantenmechanischer Operatoren," Zeitschrift für Physik 133 (1952): 101-08.
2. Zeitschrift für Physik 47 (1928): 631-51.
3. E.P. Wigner, "Remarks on the Mind-Body Question," *The Scientist Speculates*, I.J. Good, ed. (London, 1961; New York, 1962).
4. E.P. Wigner, "Are We Machines?," Proc. Amer. Phil. Soc. 113 (1969): 95-101.
5. see for example E.P. Wigner, "On the Time-Energy Uncertainty Relation," *Aspects of Quantum Theory*, A. Salam, E.P. Wigner, eds. (Cambridge UP, 1972).
6. Commun. Pure Appl. Math. XIII (1960): 1-14.
7. New York: Academic Press, 1959.
8. Indiana UP, 1967.
9. E.P. Wigner, "The Limits of Science," Proc. Amer. Philos. Soc. 94 (1950): 422.

Karl Svozil

3

Is the World a Machine?

Suppose the world is a machine. This is a long-held suspicion, at least as old as the Pythagoreans, which was revitalized by early modern natural sciences. Presently this intuition is formalized by both the computer sciences and constructive as well as discrete mathematics.

Of course, anybody claiming nowadays that the world is a machine is a heretic. This claim contradicts the canon of physics outright, at least at the moment. We are told that certain quantum mechanical events occur randomly and uncontrollably; and chaos theory claims that there is randomness even in classical continuum mechanics and electricity.

Otherwise regarded, the statement that the world is a machine is trivial; a self-fulfilling prophesy, if you like. Because anything that can be comprehended can automatically be called machine-like, causal, or constructive. Alternately, if there were no comprehension of the world, there would be no talk of its machine-like character. But then there would most probably be no talk at all.

Having said this as a preamble, let me explain more explicitly one particular consequence of the assumption that the world is a machine. There has been hardly any feature of quantum mechanics that has given rise to as many fruitless speculations as complementarity. Intuitively, complementarity states that it is impossible to (irreversibly) observe certain observables at the same time with arbitrary accuracy. The more precisely one of these observables is measured, the measurement of other, complementary observables is that much less precise. Typical examples of complementary observables are position/momentum (velocity), angular momentum in the x/y/z direction, and particle number/phase.[10, 18]

The intuition (if intuition makes any sense in the quantum domain) behind this feature is that the act of (irreversible) observation of a physical system gives rise to a loss of information by (irreversibly) interfering with the system. Thereby, the possibility of measuring other aspects of the system is destroyed.

Well, this is not the whole story. Indeed, there is reason to believe that — at least up to a certain amount of complexity — any measurement can be 'undone' by properly reconstructing the wave function. A necessary condition for this is that all information about the original measurement is lost. Schrödinger, the creator of wave mechanics, liked to think of the wave function as a sort of catalogue of predictions.[26] This prediction catalogue contains all potential information. Yet it can only be opened at a single particular page. The prediction catalogue may be closed before this page is read. Then it could be opened once more at another complementary page. In no way is it possible to open the prediction catalogue at one page, read and (irreversibly) memorize (measure) the page, close it, and then open it at another complementary page. (Two non-complementary pages, which correspond to two co-measurable observables, can be read simultaneously.)

This may sound a little bit like voodoo. It is tempting to speculate that complementarity can never be modeled by classical metaphors. Yet, classical examples abound. A trivial one is a dark room with a ball moving in it. Suppose that we want to measure its position and its velocity. We first try to measure the ball's position by touching it. This finite contact inevitably causes a finite change of the ball's motion. Therefore, we can no longer measure the initial velocity of the ball in arbitrary position.

There are a number of more faithful classical metaphors for quantum complementarity. Take, for instance, Cohen's "firefly-in-a-box" model,[5] Wright's urn model,[36] and Aerts's vessel model.[1] In what follows, we are going to explore a model of complementarity pioneered by Moore.16 It is based on extremely simple systems, probably the simplest systems you can think of — finite automata. The finite automata we will consider here are objects that have a finite number of internal states and a finite number of input and output symbols. Their time evolution is mechanistic and can be written down on tables in matrix form. There are no built-in infinities anywhere, no infinite tape or memory, no non-recursive bounds on the runtime, et cetera.

Let us develop computational complementarity, as it is often called, as a game between you, the reader, and me, the author. The rules of the game are as follows. First, I give you all you need to know about the intrinsic workings of the automaton. For example, I tell you, "if the automaton is in state 1 and you input the symbol 2, then the automaton will make a transition into state 2 and output the symbol 0," and so on. Then I show you a black box that contains a realization of the automaton. The black box has a keyboard, with which you input the input symbols. It has an output display, on which the output symbols appear. No other interfaces are allowed. Suppose that I can choose which initial state the automaton will be in at the beginning of the game. I do not tell you this state. Your goal is to find out by experiment which state I have chosen. You can simply guess or rely on your luck by throwing a dice. But you can also perform clever input-output experiments and analyze your data in order to find out. You win if you give the correct answer. I win if you guess incorrectly. (So I have to be mean and select worst-case examples).

Suppose that you try very hard. Is cleverness sufficient? Will you always be able to definitely determine the initial state of the automaton? The answer to that question is no. The reason is that there may be situations when the input causes an irreversible transition into a state that does not allow any further queries about the

Karl Svozil, born 1956 in Vienna. Studied physics in Vienna and in Heidelberg. Works at the Institute of Theoretical physics at the Technical University in Vienna. Research at the University of California, Berkeley, the Lawrence Berkeley Laboratory, at the Lomonosov University, Moscow and at the Lebedev Physical Institute. Lives in Vienna.

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initial state. This is the meaning of the term "self-interference." Any such irreversible loss of information about the initial value of the automaton can be traced back to many-to-one operations:[13] different states are mapped onto a single state with the same output. Many-to-one operations, such as "deletion of infomation," are the only source of entropy increase in mechanistic systems.[13, 2]

In the case of the automaton discussed above, one could, of course, restore reversibility and recover the automaton's initial state using Landauer's "Hänsel and Gretel" strategy. That is, one could introduce an additional marker at every many-to-one node, which would indicate the previous state before the transition. But then, since the combined automaton/marker system is reversible, going back to the initial state erases all previous knowledge. This is analogous to re-opening the pages of Schrödinger's prediction catalogue.

This might be a good moment to introduce a sufficiently simple example. Consider, therefore, an automaton, which could be in one of three states, denoted by 1, 2, and 3. This automaton accepts three input symbols, namely 1, 2, and 3. It outputs only two symbols, namely 0 and 1. The transition function of the automaton is as follows: on input 1, it makes a transition to (or remains in) state 1; on input 2, it makes a transition to (or remains in) state 2; on input 3, it makes a transition to (or remains in) state 3. This is a typical irreversible many-to-one operation, since a particular input steers the automaton into that state, no matter which one of the three possible states it was in previously. The output function is also many-to-one and rather simple: whenever both state and input coincide — that is, whenever the guess was correct — it outputs 1; otherwise it outputs 0. So, for example, if it was in state 2 or 3 and receives input 1, it outputs 0 and makes a transition to state 1. There it awaits another input. These automaton specifications can be conveniently represented by diagrams such as the one drawn in fig. 1(a)).

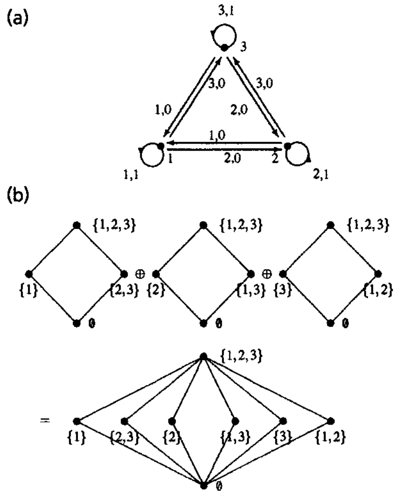

Fig. 1:
(a) Describes a complementary game using a diagram of the quantum-like (Mealy) automaton $M_5=(S, I, O, \delta, \lambda)$. The automaton has three states 1, 2, 3; three input symbols 1,2,3; and two output symbols 0,1.
Input and output symbols are separated by a comma. Arrows indicate transitions. Formulas could be

$$S = \{1, 2, 3\},$$
$$I = \{1, 2, 3\},$$
$$O = \{0, 1\}.$$

The transitional and output functions are ($\delta_{s,x}$ stands for the Kronecker delta function)

$$\delta(s, i) = i,$$
$$\lambda(s, i) = \delta_{s,i} \begin{cases} 1 & \text{if} \quad s = i \\ 0 & \text{if} \quad s \neq i \end{cases}$$

(b) Hasse diagram for the propositional structure. Lower elements imply higher ones, if they are connected by lines.

Computational complementarity manifests itself in the following way. If one does not know the automaton's initial state, one must choose among the input symbols 1, 2, or 3. This will correspond to the answer to the question of whether the automaton was initially in state 1, 2, or 3. If the output is 1, one knows that the answer is correct. If, on the other hand, the answer is output 0, then is might have been in 1 or 3 (corresponding to input 2), or in 1 or 2 8 (corresponding to input 3) In other words, whenever the automaton responds with a 0 (for failure), all one knows is that the automaton is not in the input state and must therefore be in one of the other two states. Otherwise, all the rest of the information about the automaton's initial state has been lost, since the transition function was chosen so that its final state would correspond to the input, completely independent of the initial state. The following propositions can be stated: on input 1, one obtains information that the automaton either was in state 1 (exclusive) or not in state 1, that is, in state 2 or 3. This is denoted by v(1)={{1}, {2, 3}}. On input 2, we obtain information that the automaton was either in state 2 (exclusive) or in state 1 or 3, denoted by v(2)={{2}, {1, 3}}. On input 3, we obtain information that the automaton either was in state 3 (exclusive) or in state 1 or 2, denoted by v(3)={{3}, {1, 2}}. In this way, we naturally arrive at the notion of partitioning automaton states according to the information obtained from input/output experiments. Every element of the partition stands for the proposition that the automaton is in (one of) the state(s) contained in that partition.

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From any partition we can construct the Boolean propositional calculus, which can be obtained if we identify its atoms with the elements of the partition. We then ‚paste' all Boolean propositional calculi (sometimes called subalgebras or blocks) together. This is a standard construction in quantum logics and the theory of orthomodular arranged masses.[11, 20, 19, 17] In the above example, we arrive at a form of non-Boolean lattice, whose Hasse diagram MO3 is of the "Chinese lantern" type shown in fig.1 (b).

Let us go still a little bit further and ask which of the above automaton games people can play. The answer requires the systematic investigation of all possible non-isomorphic automaton propositional structures, or, equivalently, partition logics.[30, 23, 24, 25] In fig. 2, the Hasse diagrams of all nonisomorphic four-state automaton propositional calculi are drawn.

New automata can be composed from old ones, by using parallel and serial compositions. In figs. 3 and 4, the Hasse diagrams for simple parallel compositions of two and three automata are drawn.

Recall that the method introduced here is not directly related to diagonalization and is a second, independent source of undecidability. It is already realizable at an elementary pre-diagonalization level, i.e., without the requirement of computational universality or its arithmetic equivalent. The corresponding machine model is the class of finite automata.

Since a universal computer can simulate any finite state automaton, complementarity is a feature of sufficiently complex, deterministic universes as well. To put it pointedly: if the physical universe is conceived as the product of a universal computation, then complementarity is an inevitable and necessary feature of the perception of intrinsic observers. It cannot be avoided.

Conversely, a sufficiently complex finite automaton can realize any computation. Therefore, the class of all complementary games is a unique one, encompassing all possible deterministic universes.

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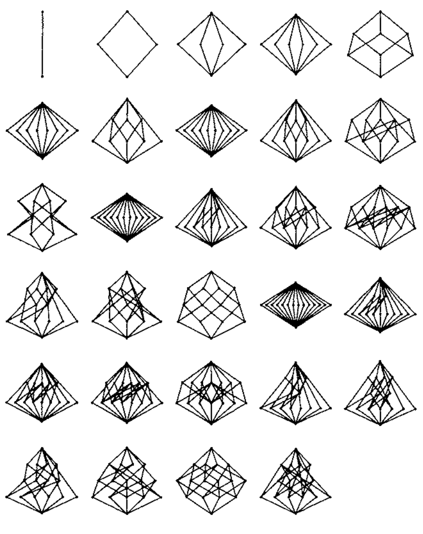


Fig. 2: Variations of the complementarity game for up to four automaton states.

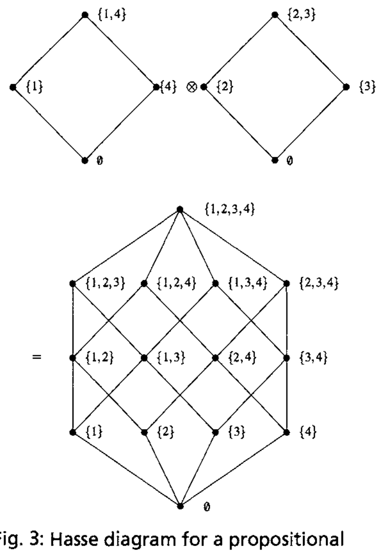


Fig. 3: Hasse diagram for a propositional calculus of two parallel automatons.

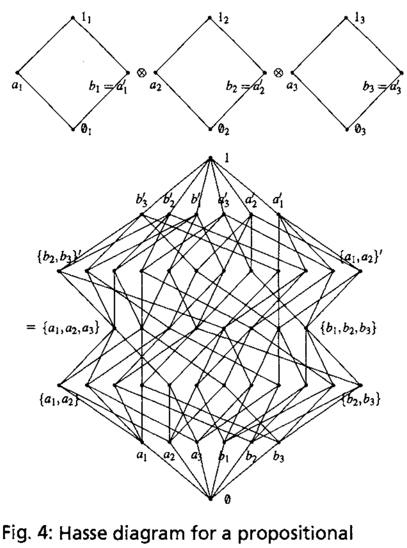


Fig. 4: Hasse diagram for a propositional calculus for three parallel automatons.

3

Gábor Császári

The Photograph of Time

Gábor Császári, born in 1959. Camera assistant for Hungarian television, 1976-79. 1978-80 interviewer of the Institute of Sociology of the Hungarian Academy of Sciences. In 1980 emigration to Berlin via Belgrade. In 1981 Metropolis Cinema, Berlin. Studied at the University of Fine Arts, Hamburg, 1981-86. 1987-88 DAAD assistantship at the Art Institute of Chicago. 1988-90 guest professor of Intermedia at the Hungarian Academy of Fine Arts, Budapest. In 1994 he emigrated a second time to Germany.

The photo finish camera has existed since 1937 and has been used since 1948 at every significant world sport competition to judge the indisputable winner, the fastest. The camera is remarkable not just because a clock is an essential part of its recording equipment — which means it 'measures' the photographed person's time — but also because its technology provides a continuous image. The camera contains a roll of film in constant motion, which is only exposed along a narrow strip. This generally corresponds to the tape or finishing line. Out of the 'whole' photograph, only a narrow strip of the image appears.

Since the aperture always allows light from the outside world to come in contact with a new section of the continuously moving film and, in the meanwhile, time goes on, new elements are always recorded. The crucial innovation is, however, that since the film is in continuous motion, everything that is still 'disappears,' becoming a continuous strip or line, while everything that moves is recorded as a still picture, as the sequence of things passes by the line of 'perception' (meaning the aperture). The picture takes on the form defined by the relationship of its own speed to that of the camera.

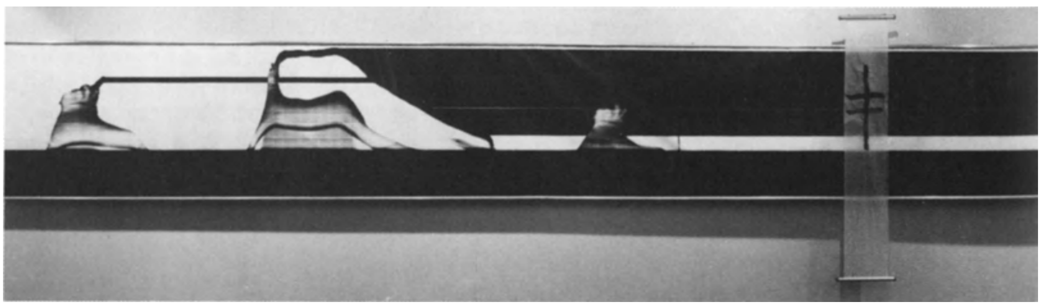
This is only the case if the photo-finish camera is standing. If moving, the situation naturally changes. To this date, I have only seen these kinds of photographs done by Gábor Császári, who has been working with this technique for years.

If we photograph passersby on the street with this type of camera, everybody on the photograph, regardless of whether they are going left or right, appears to move in the same direction, that of time.

The reason for this is the direction in which the film continuously moves is parallel with the direction of time. Depending upon the relationship between the actual speed and the general' or 'usual' passing of time recorded by the watch installed in the machine, the camera sequentially records on film all of the moments when the strip contacted the finishing line / the streak of light, where the section of the image is 'written.' Consequently, the dimension of the image in this direction is time itself. The image tells us when and what happened in each spot that it 'saw,' and which of the above-mentioned lines it was. The other axis is a kind of 'height' that expresses the relationship between the location of the thing perceived and the distance of the camera.

Accordingly, this camera is the first piece of equipment of its kind that we can use to perceive the relationship between space and time, or, to put it another way, we can transcribe this relationship into a form that we can perceive with our senses.

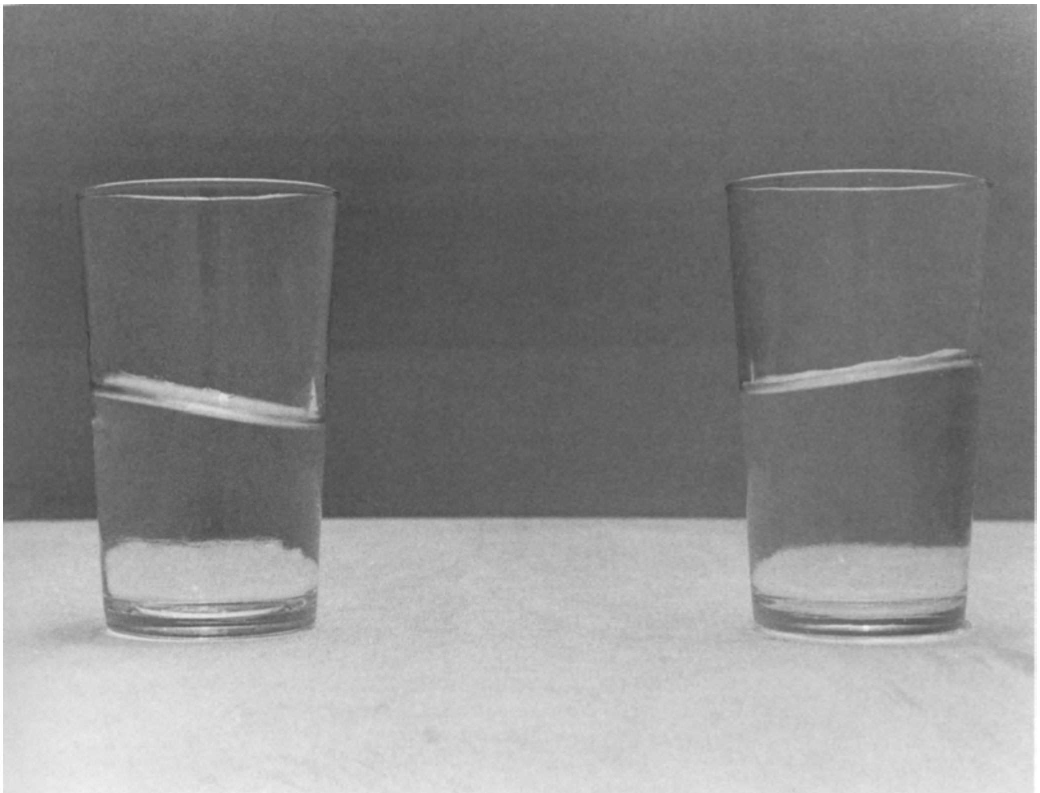
Miklós Peternák, *Új képfajtákról*, Intermédia (1993): 37-38.



Gábor Császári, *16*, 1988
Photo finish photography, tempera on paper, 97 × 693 cm

Attila Csörgő

The Maelstrom-Project



Attila Csörgő
Water Askew, 1995
Installation with two glasses
© VBK, Vienna, 2005

Attila Csörgő
born 1965 in Budapest. Studied painting in Budapest and Amsterdam.

1993 Galerie DAAR, Amsterdam
1994 Óbuda Galéria, Budapest
1995 Goethe Institute, Budapest (with Róza El-Hassan)
1996 Stúdió Galéria, Budapest

Group shows
1990 *Árnyék*, Barcsay terem, Budapest
1991 *Ostmodern*, Künstlerhaus, Munich
Oszcilláció, Bastei VI, Komarno, Slowakei; Műcsarnok, Budapest
Germination 6, Ludwig Forum für internationale Kunst, Aachen; Budapest Galéria
1992 *Künstleraustausch*, Kunsthalle, Bern
Dialogue, Budapest Galéria
1993 *Jövőszeminárium*, Liget Galéria, Budapest
Biennial, Murska Sobota
1995 *Zusammenziehende Häuser*, Kunsthaus, Hamburg
In And Out Of Touch, Budapest Galéria
2000 *Selected Works from the Collection*, Ludwig Múzeum, Budapest
2001 *What, how and for whom*, Kunsthalle Exnergasse, Vienna
2002 *Modesty*, Pavelhaus, Laafeld
2003 *Poetic Justice*, International Istanbul Biennial, Istanbul
2003 *Himmelschwer. Transformationen der Schwerkraft*, Kulturzentrum bei den Minoriten, Graz
2004 *Bewegliche Teile. Formen des Kinetischen*, Kunsthaus Graz, Graz

The Maelstrom Project arose as a cross-section of personal ideas and the imagination of a writer. One of its components, *Water Askew*, came to my mind during the course of a late-night conversation, which at first seemed to be leading nowhere. I wanted to present an extreme case of the technical complexities oppressing an artist. The idea comprised an almost ascetic group of objects: a horizontal table and a glass in which the water was apparently askew. Later, I tried to realize this idea, but in a less austere manner: I fixed glasses on a rotating table, along with a camera, which was supposed to record the hydraulics of this 'closed system,' i.e., the unevenness of the water level.

The other component is E. A. Poe's short story, *A Descent into the Maelstrom*, in which an immense maelstrom is the central motif: an ebony black, extremely smooth, gigantic curve, which swallows everything that falls into its scope — namely unfortunate fishermen.

Naturally, I had to content myself with a much narrower framework for the Maelstrom Project. Forty-five liters of swirling motor oil generate the vortex. The black liquid creates a reflecting surface, which bends into a parabola as it rotates. From the moment it is turned on, it continuously transforms until it hits its ultimate speed: the curve of the parabola grows increasingly deeper; at the same time, this brings about a change in the reflection as well, which consists of two fundamentally different phases, which are in accordance with the rules of the parabola reflection. At first, one can observe the reflection as it enlarges, until finally, the enlarged eyes of the viewer span the entire reflective surface. From that point on, we see our own reversed reflection, which shrinks as fast as if a whirlpool were pulling it down into its depths. Between the two phases, when the focus point of the parabola coincides with the point of view, the reflection disappears for a second.

Attila Csörgő
The Maelstrom Project, 1995
Motor oil, motor, cup,
60 × 60 × 80 cm
© VBK, Vienna, 2005

Newton's Bucket —Mach's Principle (A Physicist's Ruminates on Attila Csörgö's object)

In a rotating bucket, the surface of the water forms an elliptical vault against the wall. Each water molecule is subjected to centrifugal force, which drives it away from the center, where the surface is raised because the fluid cannot be compressed. Neglecting adhesion, it is insignificant whether the bucket itself is rotating. What, however, happens if the walls of the cylindrical bucket become thicker and thicker until they represent the dominant part of the gravitational force? Newton's bucket problem, thus far. Whereas for Newton, every mechanical motion took place within an eternal, absolute space, Ernst Mach severely criticized this inherent apriorism — a criticism that made him Einstein's most important predecessor in the development of the general theory of relativity. Mach believed that it is only possible to observe relative motions between mass points. Mach's Principle modified Newton's bucket problem: take a cylinder that rotates within another cylinder at the same angular velocity. If the world were otherwise void, there would be no centrifugal force exerted on the inner cylinder, because the whole environment rotates along with it. Centrifugal force emerges only with respect to a global inertial frame, such as the fixed stars. Vienna physicists Josef Lense and Hans Thirring studied this effect after World War I.[1] In the early years, Einstein considered Mach's Principle as one of the three building blocks of general relativity. Today, various formulations of Mach's Principle exist, some of which are the basis for modifications of general relativity, while others intend to provide a possible experimental verification of so-called inertial frame dragging effects. How far Mach's Principle is consistent with Einstein's general relativity theory depends upon its exact formulation. According to a recent straw poll, the majority of experts are skeptical.[2]

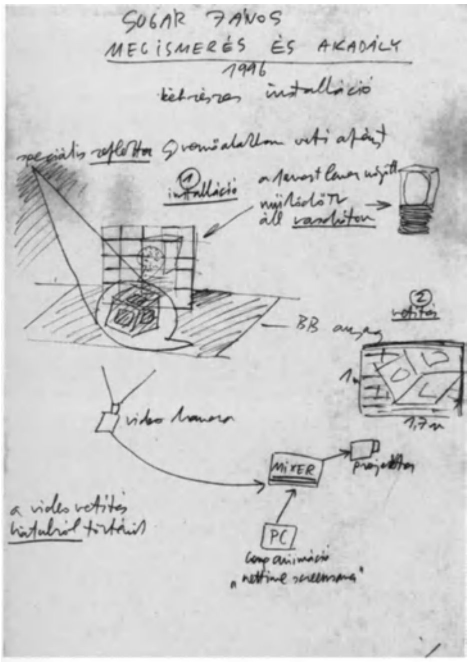
Michael Stöltzner

1. Josef Lense and Hans Thirring, "Über den Einfluß der Eigenrotation der Zentralkörper auf die Bewegung der Planeten und Monde nach der Einsteinschen Gravitationstheorie," Physikalische Zeitschrift 19 (1918): 156-163.
2. For the present state of the art, see: Julian B. Barbour and Herbert Pfister, eds., *Mach's Principle. From Newton's Bucket to Quantum Gravity* (Boston-Basel: Birkhäuser, 1995).

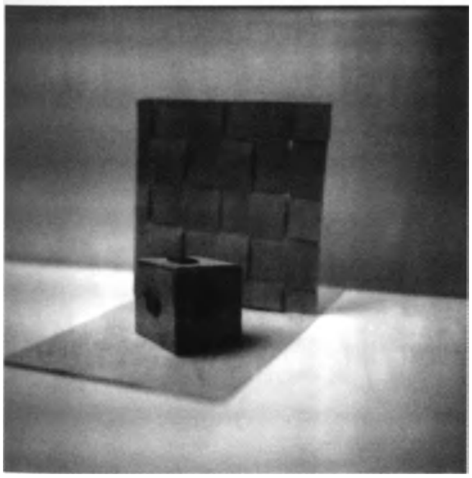
Something is either nothing or a fact. Outside of nothingness and fact, around their central common point, extends the force-field of free will: the present that is invigorated by the flow of facts from the pole of something to the pole of nothing. As far as time reaches, there are gaping white and black holes producing nothing or something.

As the possibilities of something become nothing, the world may only reflect upon itself in different ways, depending on free will, which is forced between the two horizons of occurrences. Or rather, self-reflection, as a power station driven by existence, needs the world. The mark of the relationship between nothing and something in the present is calligraphy. As fuel for the eternal, the various presents consume themselves. Culture, the most radical explorer of the unknown, passionately endeavors to be equally incompetent toward everything. It seeks to find what can never be targeted.

"Nearly Nothing — Just Barely Something," *János Sugár. Mínusz pátosz* (Budapest: Balassi Kiadó-Intermédia, 1995) pp. 50-54.



János Sugár
Sketches for *Approach and Obstacle*, 1996



János Sugár
Approach and Obstacle, 1996
Two-part installation, model

János Sugár
born 1958 in Budapest. Studied at the Academy of Applied Arts, Budapest. Lives in Budapest.

1984 Bercsényi Klub, Budapest
1986 Stúdió Galéria, Budapest
1988 Institut Français, Budapest
1989 Salone Villa Romana, Florence
1992 Knoll Galéria, Budapest
1993 Galerie Knoll, Vienna
1996 Stúdió Galéria, Budapest
1997 *Schule der Geduld*, Galerie Knoll, Vienna
2003 *Yael Bartana, Janos Sugar*, Franziskaner-kloster, Schwaz

Group shows
1989 *MásKép*, Ernst Múzeum, Budapest
1991 Trigon '91, Neue Galerie, Graz
1992 documenta IX, Kassel
1996 *A pillangó hatás*, Műcsarnok, Budapest
Manifesta 1, European Biennial of Contemporary Art, Rotterdam
1997 *White Flags*, mobile symposium in open studios, Budapest
1999 *Ungarn Unbegrenzt*. Galerie Knoll, Vienna
2003 *Moszkvatér / Gravitáció*, Ludwig Múzeum, Budapest
2004 *Softmanipulations. Videokunst aus Österreich und Ungarn/ Magyar-Osztrák Videokiállítás*, Budapest Galéria; Budapest Kiállítóterem; Osztrák Kulturális Fórum, Budapest

Films and videos
1985 *Persian walk*, colour, 16 mm, 50 min, BBS
1987 *Fotex-fist*, U-matic 9 min, BBS
1988 *Immortal culprits*, U-matic, 30 min, BBS
1992 *Camera in trouble*, color, 16 mm, 70 min, BBS

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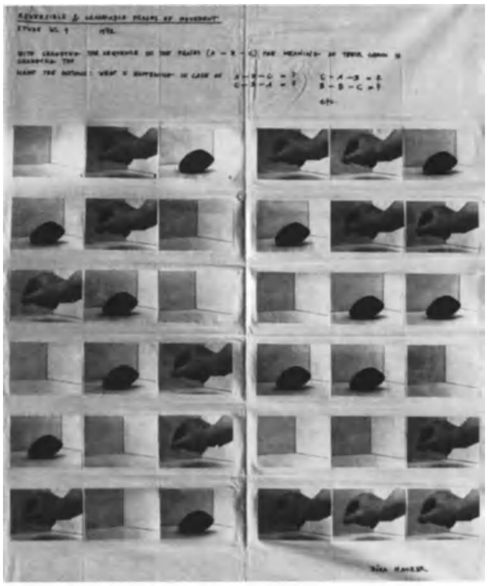
Aspects/Positions. 50 Years of Art in Central Europe 1949-1999 (Vienna, 1999).

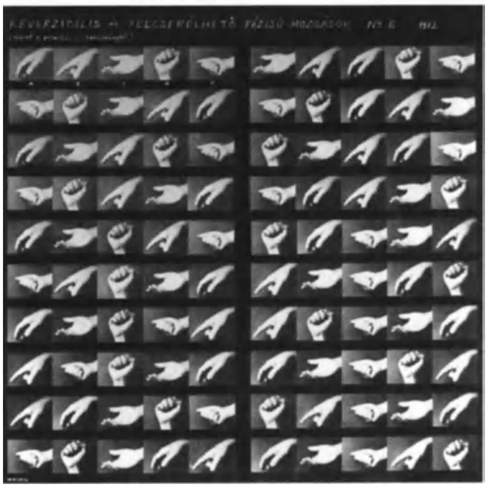
Dóra Maurer

Dóra Maurer
born 1937 in Budapest. Studied at the Academy of Fine Arts in Budapest. Lives in Budapest and Vienna.

1975 Neue Galerie, Graz
1976 Szent István Király Múzeum, Székesfehérvár
1979 Pécs Galéria, Pécs
Hedendaagse Kunst, Utrecht
1984 Ernst Múzeum, Budapest
1986 Galleri Herzfeld, Stockholm
1993 Szombathely Képtár, Szombathely
1996 Kiscelli Museum, Budapest
1998 *Arbeiten 1974-1977*, Josef Albers Museum Quadrat, Bottrop
2002 Collegium Budapest
2003 Gutmann Galéria, Budapest
2004 Galerie Peter Lindner, Vienna

Group shows
1967 São Paulo Biennial
1971 Trigon '71, Neue Galerie, Graz
1975 *Neue ungarische Konstruktivisten*, Städtisches Museum, Bonn
1979 *Photography as Art – Art as Photography*, ICA, London
1980 *Ein Künstler – ein Prinzip*, Museum moderner Kunst, Vienna
1981 *Erweiterte Photographie*, Secession, Vienna
1983 *BBS-films*, Centre Georges Pompidou, Paris
1985 *Raumkonzepte*, Fészek Galéria, Budapest
20 Years of Hungarian Experimental Film, Museum of Modern Art, New York
1986 *Experimental Films from Budapest*, Museum of Fine Arts, Boston
1988 *Das Licht der Peripherie*, Museum des 20. Jahrhunderts, Vienna
1994 *Hommage au carré für Vera Molnár*, März Galerien, Mannheim
1996 *The Butterfly Effect*, Műcsarnok, Budapest
2001 Műcsarnok, Budapest
2004 *Gegen-Positionen*, Museum Moderner Kunst - Stiftung Wörlen, Passau





Dóra Maurer, *Études Nos. 1, 4, 6*, 1972
Reversible & variable phases of movement
Photos on canvas, 100 × 100 cm

These seven series of photographs (reversible and variable phases of movement) demonstrate the shifting of terms and references.

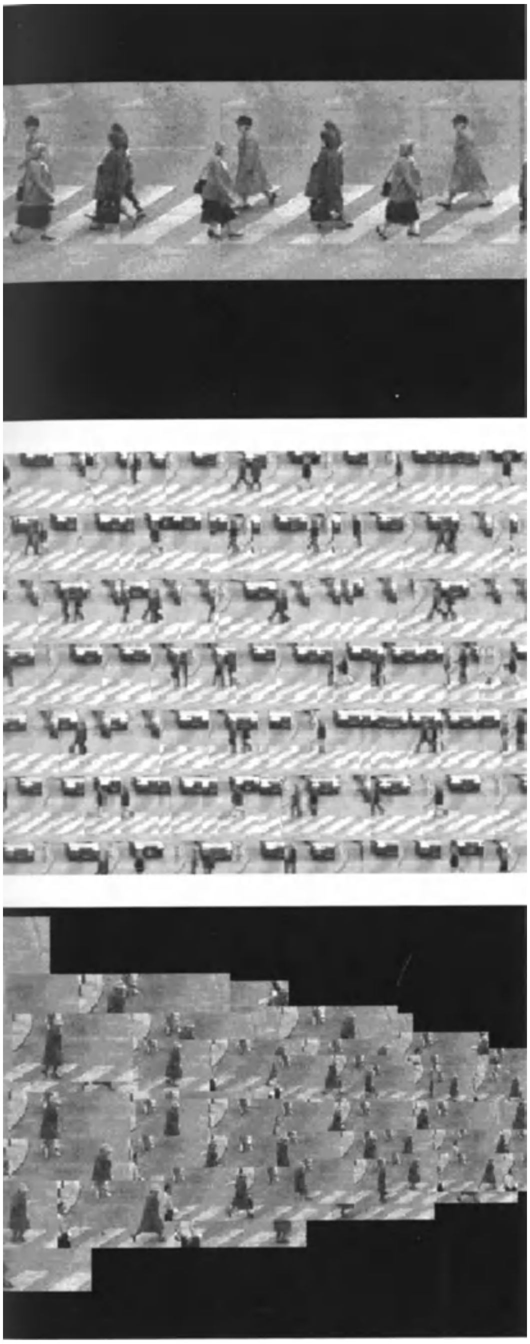
They contain single movements and sequences of motion, which would also make sense when put in reverse order. If they were disassembled and arranged in a different order, they would still be presentable. The result of this reversibility and variability is not by any means absurd, for it is too real. To create these particular motion studies, I sought material containing elemental and unified types of movements, which could easily be referenced. I then photographed each single phases of these episodes, as documentation. I did not regard these photos as images, but as signals that can be easily interpreted. Using letters of the alphabet instead of photos would have over-simplified the meaning of the images, and other graphic symbols would have been too difficult to comprehend.

These series, consisting of either three or five phases, could be regarded as a novel in pictures. It should be read from left to right, and each line or row should be comprehensible to the viewer after it has been read

For example, *Étude 1*: an empty corner — a hand with a stone in it — a stone in the corner = someone put the stone there. The same thing in reverse order = someone picked up the stone. The phases of repetition (following permutation) enrich the content: a stone in the corner — a hand with a stone in it — a stone in the corner = someone wanted to take the stone away, but didn't.

Dóra Maurer, *Verschiebungen 1972-75* (Graz: Neue Galerie am Landesmuseum Joanneum, 1975).

Herwig Turk



Herwig Turk, *Time to Time*, 1992
Computer animation

Thirty to forty different levels of time confront the observer at every moment. At the same time, this concept — of the permanent simultaneity of non-simultaneousness forms — results in a complex structure made up of individual tableaux, covering the entire surface of the monitor. Each of these moves internally and mingles with the others. This complex structure undeniably overtaxes the natural limits of the eye and the observer can only perceive it as an opaque, continuous flickering of single points, as general motion or unchanging, permanent noise without beginning or end.

If one understands duration in the Hegelian sense, as the relative non-appearance of time, then dynamic timelessness also belongs in this context.

Herwig Turk, "Reversibilität versus Irreversibilität", *Zeitschnitt 92 – aktuelle Kunst aus Österreich*, Matthias Michalka, ed. (Vienna: BMUK, 1992).

Herwig Turk
born 1947 in St. Veit/Glan. Founding member of HILUS - Intermedia project research. Lives in Vienna.

1995 Rathausgalerie, St. Veit/Glan
1996 Museum for Applied Arts, Vienna
1997 Galerie Esther Schipper, Cologne
2000 *Immer Ärger mit dem Realen*, Galerie Sechzig, Feldkirch

Group shows
1991 Biennial, Udine
1992 Biennial, Leipzig
Zeitschnitt, Messepalast, Vienna
1993 *Licht Flut*, Kärntner Landesgalerie, Klagenfurt
1994 *Trivial Circuit*, Künstlerhaus, Klagenfurt
suture – Phantasmen der Vollkommenheit, Kunstverein, Salzburg
1995 *Transmission from Austria*, Aldrich Museum, Connecticut
The Spring Project, Ambrosi Museum, Vienna
1996 *Zum Bedeutungswandel der Kunstmuseen im Zeitalter der "digitalen Revolution,"* Kunstmuseum Bonn
MirrorPage IV, St. Petersburg Biennale,
Hybrid, Forum Stadtpark, Graz (cat.)
Version 2.2, Saint Gervais de Genève (cat.)
Happy End, Kunsthalle, Düsseldorf (cat.)
1999 *Der anagrammatische Körper*, Kunsthaus Mürz, Mürzzuschlag
2000 *Körper II – Fotografie und Rauminstallation*, Fotogalerie Wien, Vienna
2003 *Christoph Steinbrener's Operation Figurini*, Vienna

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Herwig Turk, *Herwig Turk* (Vienna: 1998).

3

Harald A. Posch

Microscopic Reversibility and Macroscopic Irreversibility

Harald A. Posch, born 1942 in Graz. Studied physics and mathematics at the University of Vienna. Assistant at the University of Vienna, 1968. Employed by the Catholic University in Washington, D.C., 1971-73. Author of over ninety original works in scientific journals, a scientific film, and several essays. Employed as a professor at the Institute for Experimental Physics at the University of Vienna. Lives in Vienna.

Computer Simulations of Processes Far from Equilibrium

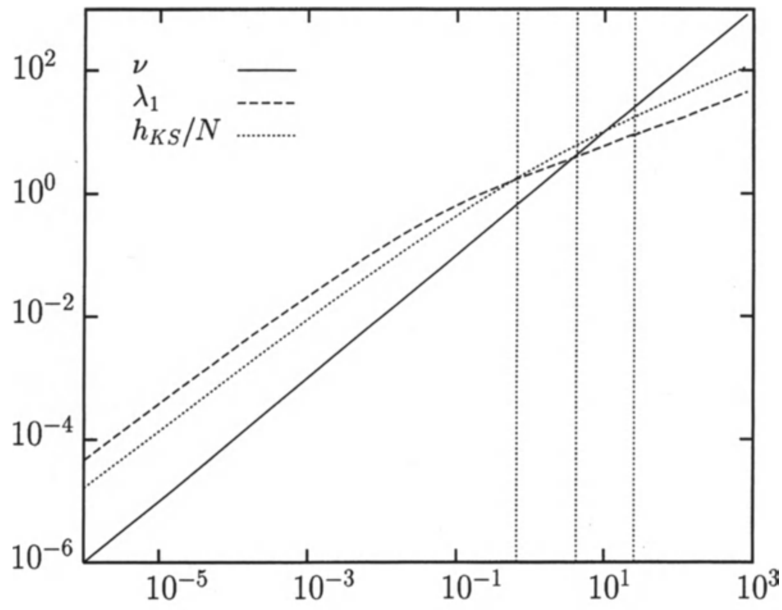
Almost all important processes in nature evolve in an open environment far from mechanical and thermal equilibrium. They involve transport and dissipation of heat and do not conserve energy, as does a closed system. Until now, such processes have escaped satisfactory theoretical analysis, and that is why computer simulations have become increasingly important in their study. Here I want to present recent results from the field of irreversible statistical mechanics that provide new insights into the irreversible behavior of such macroscopic processes, although their time evolution on the atomistic level rests upon equations in motion that are symmetrical in terms of time reversal.

More than one hundred years ago, L. Boltzmann predicted why isolated systems far from a state of thermal equilibrium undergo unidirectional, irreversible decay toward mechanical and thermal equilibrium. This prediction was based on his H-Theorem description of gas phase entropy production and is an exact consequence of the Boltzmann equation for the time development of the one-particle distribution function f(r, v, t). Here, r and v denote the space and velocity vectors of an arbitrary particle, and t is the time. The approximation underlying the Boltzmann equation is the Stosszahlansatz, which replaces the two-particle collisional probability with a product of one-particle distributions, and which is valid only for low-density gases. The Boltzmann equation predicts a monotone decrease of $< \ln f(t) >$ following the time evolution of the system, and the Boltzmann entropy $S(t) = -k < \ln f >$ in the limit of a longer time, approaches the Gibbs entropy per particle. k is the Boltzmann constant.

There were two notorious objections to this theory. J. Loschmidt objected that this predicted irreversibility is inconsistent with the underlying time-reversible equations of motion, because any trajectory going toward equilibrium could just as well be followed in the reverse direction, away from equilibrium. E. Zermelo insisted that this irreversibility is likewise inconsistent with Poincaré's theorem, which states that the phase trajectory of an isolated mechanical system will eventually return to the proximity of its initial state. Both objections certainly seem valid. However, as Boltzmann immediately pointed out, any argument based on a phase trajectory that links nonequilibrium states with equilibrium states needs to consider not only the time-reversible nature of the equations of motion, but also the probability distribution of the initial conditions. The probability for a macroscopic system is so much in favor of the equilibrium states that any dynamic evolution or even fluctuation leading from equilibrium to nonequilibrium states is practically unobservable. It also makes Poincaré's recurrence time ridiculously long. The apparent contradictions are rooted in Boltzmann's approximate statistical treatment of two-body collisions.

A necessary condition for statistical behavior and the approach to equilibrium is that successive system states are 'mixed' by the dynamics in such a way that all possible states accessible to the system are connected by a single trajectory. Such systems are referred to as ergodic. Mixing systems are also chaotic in the sense that small disturbances in their initial states exponentially grow over time, which makes it impossible to predict their final states after any finite period of time has passed. The rates for this exponential separation of neighboring system states are referred to as Lyapunov exponents and are taken as a measure for chaos. At least one of the exponents is positive for chaotic systems, and the largest will be denoted by λ_1. Its inverse, $\tau_\lambda = 1/\lambda_1$, is interpreted as the time the system requires to "forget" its past. The sum of all positive Lyapunov exponents is equal to the Kolmogorov-Sinai (dynamical) entropy h_{KS}, which denotes the rate of information production (in the sense of Shannon's information theory) required to follow the time evolution of a system within a prescribed accuracy. The Kolmogorov-Sinai time $\tau_{KS} = 1/h_{KS}$ is the characteristic time constant for mixing of system states in phase space. We have recently carried out extensive simulations to compute all Lyapunov exponents of a gas consisting of N=108 hard spheres enclosed in a three-dimensional simulation box with periodic boundaries.[1] In Fig. 1, we compare the previously defined characteristic rates λ_1 and h_{KS}/N with the collision rate ν of a particle. ν depends on the density ρ of the gas. The three vertical lines mark, from left to right, the collision rates corresponding to the particle densities $\rho=0.01\sigma^{-3}$, $0.1\sigma^{-3}$ and $0.4\sigma^{-3}$, where σ is

Fig. 1: Collision frequency ν, maximal Ljapunov exponent λ_1 and Kolmogorov-Sinai entropy h_{KS}, for a gas of N=108 hard spheres as a function of ν. All quantities are given in reduced units.



the particle diameter. λ_1, h_{KS} and ν are given in units of $(K/Nm\ \sigma^2)^{1/2}$, where K is the total kinetic energy, and m is the mass of a sphere. One observes that for small ν corresponding to low gas densities both λ_1 and the Kolmogorov-Sinai entropy per particle, h_{KS}/N, are much larger than the collision rate. This means that the 'memory' of the gas is much shorter than the typical time period between two successive collisions of a particle. Boltzmann's assumptions are clearly satisfied in this realm of density. The range of validity of his kinetic theory is limited by gas densities. The range of validity of his kinetic theory is limited by gas densities, for which λ_1 and h_{KS}/N become smaller than the collision frequency, as is the case for $\rho=0.1\sigma^{-3}$. For larger densities, successive collisions are dynamically correlated and give rise to collective behavior of the gas particles.

Up to now we have confined our discussion to the dynamics and equilibration of isolated systems. Next, we explicitly address nonequilibrium systems, which are driven away from equilibrium by mechanical or thermal forces that impose velocity or temperature gradients on them. Suitably chosen constraint forces in the motion equations help to generate a steady nonequilibrium state accessible to computer experimentation. We restrict our considerations to a class of systems for which the equations of motion are invariant under time reversal and have the general form:[2, 3]

$$dq_i / dt = p_i / m_i$$
$$dp_i / dt = F_i(q) + X_i + F^c_i\ (q, p).$$

Here, q_i and p_i are the position and momentum vectors of particle i, and m_i is its mass. The arguments q and p without index i stand for the positions and momenta of all particles. In this equation, $F_i(q)$ is the intrinsic force on particle i due to its interaction with all the other particles and possible external fields, and X_i is a mechanical or thermal force driving the system away from equilibrium. Through $X_{,i}$, work is continuously performed on the system, which — if not properly removed — would heat up the system and prevent it from reaching a steady state. This is avoided by the constraint force

$$F^c_i\ (q, p) = -\ \zeta\ p_i,$$

which assumes the role of a heat reservoir, for which the 'thermostat variable' ζ changes its sign with time reversal. This particularly simple and aesthetic form of a time-reversible constraint force is a consequence of venerable variational principles of mechanics, including both Hamilton's principle of least action and Gauss's principle of least constraint. Temperature T is defined in terms of the ideal gas kinetic thermometer.

Extensive computer simulation studies of a number of models in various nonequilibrium steady states containing up to one million particles have left us with the following general scenario:[2-4]

1. The equations of motion, both at and away from equilibrium, remain exactly time-reversible, so that a reversed movie of the motion obeys the same equations. In such reversed motion, all the momenta p_i and the thermostat variable ζ, change sign.

2. There is a nonequilibrium version of Liouville's theorem, according to which the rate of work done on the system by the external forces and the rate of heat extracted by the computer thermostat are proportional to the rate of shrinkage of an arbitrary (infinitesimal) co-moving, phase space volume element δV:

$$d\ \ln\delta V / dt = -\ \Sigma_{i=1}^{N}\ \zeta\ p_i^2 / m_i\ kT = -\ N\ D\ \zeta = (dQ/dt) / kT.$$

The sum covers all i particles; i = 1; N is the sum of the particles; D is the dimension of physical space, and Q denotes the heat.

3. The exponential growth or shrinkage of a co-moving, phase-space volume element is given by the sum of all Lyapunov exponents,

$$<d\ \ln\delta V / dt> = -\ \Sigma_{1=1}^{L}\ \lambda_1 \leq 0$$

The sum covers L exponents, where L = 2DN is equal to the dimension of the phase space. The brackets < ... > denote a suitable time average. The equal sign is applied only to equilibrium systems. In nonequilibrium steady states with a steady temperature T, the exchanges of heat lead to the < sign indicating the collapse of the corresponding phase-space probability into a strange attractor with a fractional dimension D_1. At equilibrium, the so-called information dimension D_1 is identical to the dimension D_0 = L of the allowed phase space. Away from equilibrium, this dimensionality is reduced, $D_1 < D_0$, though the motion itself; if ergodic, it continues to visit — eventually — all points of the equilibrium phase space. Thus, the full equilibrium phase

1. Ch. Dellago, H.A. Posch, "Mixing, Lyapunov Instability, and the Approach to Equilibrium in a Hard-Sphere Gas," Phys. Rev. E 55: R9 (1997); "Kolmogorov-Sinai Entropy and Lyapunov Spectra of a Hard-sphere Gas," Physica A 240: 68 (1997).
2. H.A. Posch, W.G. Hoover, B.L. Holian, "Time-reversible Molecular Motion and Macroscopic Irreversibility," Ber. d. Bunsenges. f. Phys. Chem., 94: 250 (1990).
3. H.A. Posch, W.G. Hoover, "Nonequilibrium Molecular Dynamics of Classical Fluids," Molecular Liquids. New Perspectives in Physics and Chemistry, Jose J.C. Teixeira Dias, ed., NATO-ASI Series C (Dordrecht: Kluwer Academic Publishers, 1992) pp. 527-547.
4. B.L. Holian, W.G. Hoover, H.A. Posch, "Resolution of Loschmidt's Paradox. The Origin of Irreversible Behavior in Reversible Atomistic Dynamics," in: Phys. Rev. Lett. 59:10 (1987); W.G. Hoover, H.A. Posch, "Second-Law Irreversibility, and Phase-Space Dimensionality Loss from Time-Reversible Non-equilibrium Steady-state Lyapunov Spectra," Phys. Rev. E 49:1913 (1994).
5. Ch. Dellago, H.A. Posch, W.G. Hoover, "Lyapunov Instability of Hard Discs in Equilibrium and Nonequilibrium States," Phys. Rev. E 53:1485 (1996).
6. Ch. Dellago, L. Glatz, H.A, Posch, "Lyapunov spectrum of the Driven Lorentz Gas," Thys. Rev. E 52: 4817 (1995); H. van Beijeren, J-R. Dorfman, E.G. D. Cohen, H.A. Posch, Ch. Dellago, "Lyapunov Exponents from Kinetic Theory for a Dilute, Field-driven Lorentz Gas," Phys. Rev. Lett., 77:1974 (1996); Ch. Delago, H.A. Posch, "Lyapunov Spectrum and the Conjugate Pairing Rule for a Thermostatted Random Lorentz Gas: Numerical Simulation", Phys. Rev. Lett. 78:211 (1997).

space is required to support the measure in the nonequilibrium steady state, and the attractor is ergodic.

4. The time reversibility of the motion equations guarantees, in addition to the strange attractor, an exactly similar strange repellor, too, which is constructed from the attractor points by reversing the sign of all momentum components and thermostat variables. Its support is, again, the full equilibrium phase space, and it is likewise ergodic.

5. The repellor acts as a 'source' of the space flow in the same way that the attractor acts as a 'sink.' The thermodynamically unstable ($\Sigma\ \lambda > 0$) repellor states (occupied in the distant past) are connected to the thermodynamically stable ($\Sigma\ \lambda < 0$) attractor states (to be occupied in the distant future) by ergodic trajectories in phase space that come arbitrarily close to every point of the (allowed) equilibrium phase space. A time-reversal transformation transforms stable attractors into unstable repellors and vice-versa.

6. The system always evolves from the repellor to the attractor, regardless of the direction of time along which the equations of motion are solved. This explains the existence of an arrow of time for this class of stationary nonequilibrium systems. The probabilistic conclusions reached by Boltzmann for isolated systems are even certainties here: it is theoretically impossible to violate the Second Law.

7. There is a close connection between a transport coefficient, the spectrum of all Lyapunov exponents, and the reduction in dimensionality for the associated fractal attractor.

For multiple-body systems, the information dimension D_1 is accessible in practice only through the computation of the set of all Lyapunov exponents. Numerically, this is a difficult task, since the number of differential equations to be solved increases with the square of the number of particles. However, efficient algorithms exist for the computation of the full spectrum of Lyapunov exponents, which may be applied to systems containing up to a few hundred particles, allowing a meaningful extrapolation to the limit of large particle numbers. In particular, we have recently developed methods for the computation of the Lyapunov spectra for systems of hard disks in two dimensions,[5] and for hard spheres in three. Such systems are paradigms for the study of fluids and solids both in and out of equilibrium.

In the following, we illustrate the general scenario outlined above with a particularly simple but instructive example: the externally driven periodic Lorentz gas[6] in two dimensions. It consists of a point mass, the wanderer particle, which is accelerated by an external field in the positive x direction; in the process, it suffers elastic collisions with an infinite array of fixed hard disks arranged in a triangular lattice, as shown in figure 2. The kinetic energy of the moving particle and hence the absolute value p of its momentum is kept constant with a computer thermostat.

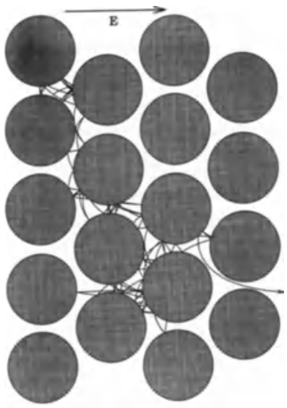


Fig. 2: Geometry of the two-dimensional periodic Lorentz gas, in which a point mass is accelerated by the external field E toward the positive x direction.

With periodic boundaries and a symmetric direction of the field E, the motion can be restricted to one half of a single unit cell. The motion of the wanderer particle could equally be viewed as the relative motion of two elastic hard disks with a vanishing center-of-mass velocity and appropriate periodic boundaries. It is arguably the simplest model, exhibiting all the essential properties of a multiple-body system with respect to irreversibility and ergodicity. The wanderer dynamics occur in a three-dimensional phase space $\{\chi, \upsilon, \vartheta\}$, where ϑ defines the direction of the particle with respect to the field as shown in fig. 3. If we observe the state of the wanderer particle only at the point of its collision with the scatterer and ignore the smooth streaming between collisions, this corresponds to the construction of a Poincaré map in a two-dimensional collision space $\{\alpha, \sin(\beta)\}$, where the collisional angles a and b are also defined in fig. 3. Each collision corresponds to a point in this space which, in the course of time, is mapped into another point defined by the following collision.

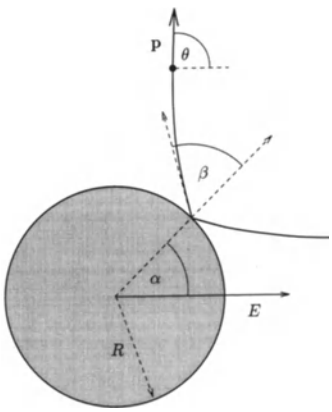


Fig. 3: Definition of the collision angle α and β during the elastic collision of the point mass with a scatterer.

Our results for four different external fields are shown in fig. 4. In the case of field-free equilibrium, all collision points are equally distributed over the Poincaré plane, indicating a homogeneous distribution of the probability measure. When the field is switched on, a fractal structure emerges, which becomes more pronounced with increasing field strength. The probability measure is concentrated on this fractal attractor, and the information dimension D_1 is less than two. Because of the mechanical stability of this attractor, all points of a long trajectory remain on the attractor, both in the forward and in the reversed direction of time, and give rise to a positive

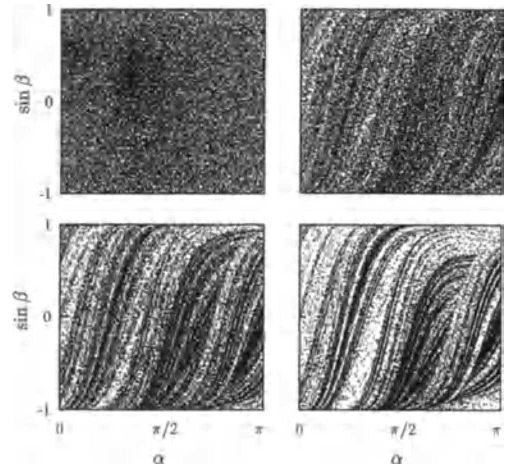


Fig. 4:
Typical Poincaré maps in the collisional {α, sin (β)}-plane for the driven Lorentz gas. The driving field vanishes for the figure top/left, and is strongest for the figure bottom/right.

conductivity coefficient in accord with the Second Law of Thermodynamics. A time-reversal transformation from {α, sin(β)} into {α, −sin(β)} allows the construction of the mechanically unstable repellor from the attractor. In fig. 5, both the repellor and the attractor are superimposed for a given finite field. Only a trajectory located entirely on the repellor generates a negative conductivity and violates the Second Law. Due to the fractal nature of the repellor, its phase space volume vanishes, and a violation of the Second Law may occur only with probability zero.

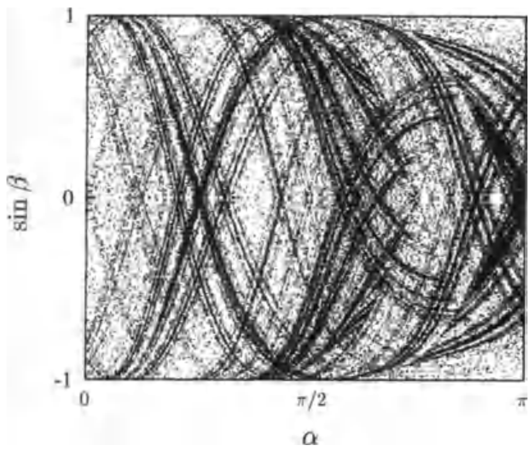


Fig. 5:
Representation of the fractal attractor and strange repellor for the periodic Lorentz gas subjected to a finite external field.

I am grateful to all my colleagues and friends who went with me along this exciting path into the mostly uncultivated field of computer simulations involving nonequilibrium processes. Professor W. G. Hoover from the University of California in Davis/Livermore and the Lawrence Livermore National Laboratory was a driving force behind this development from its beginning in 1985, and Dr. Ch. Dellago from the University of Vienna has been contributing interesting research results since 1994. The support for this scientific venture, which came from the *Fonds zur Förderung der wissenschaftlichen Forschung*, through projects P8003-PHY, P9677-PHY, and P11428-PHY, was essential for its success.

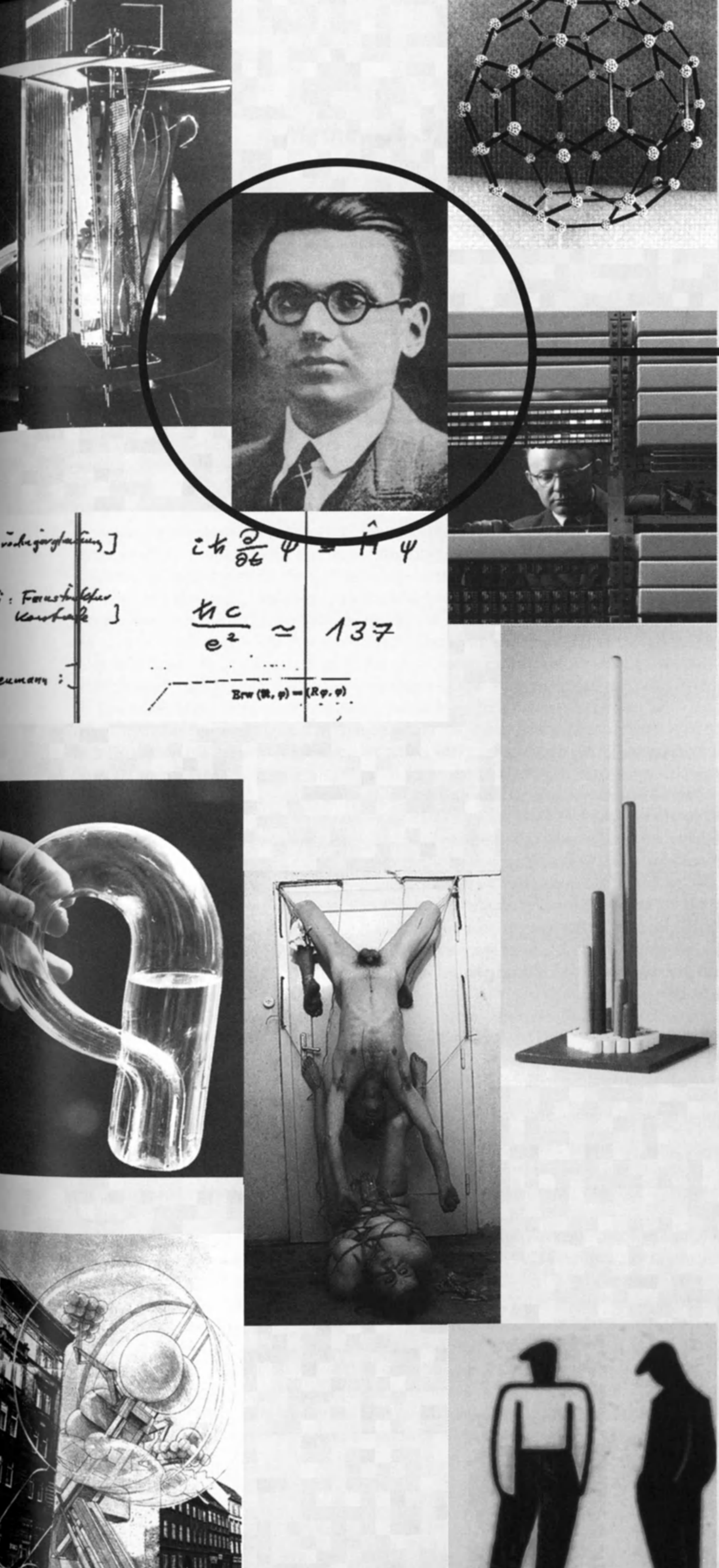
mathematics physics

In science, the countries of Austria and Hungary have probably made their most outstanding achievements in the areas of mathematics and logic. This includes the mathematical foundation of information technology and its reclaiming (in the sense of applied mathematics) by physics. In this section, the interdisciplinary paradigm of entropy will stand in for this. Gyula Staar describes several personalities scattered worldwide who founded the legendary reputation of the Hungarian mathematics scene: Lipót Féjer, György Pólya, Miklós Laczkovich, Lászlo Lovász, and others. This community of mathematicians, logicians, and theoretical physicists posed a riddle for the rest of the world via their continuous brilliance. One of the most famous, the number theoretician Pál Erdős, composed a personal contribution to this volume shortly before his unexpected death. Since the Pythagoreans, number theory in particular has equally fascinated both artists and mathematicians. Although some of its problems are understandable for any educated person, progress is measured in centuries. Already a generation younger than Erdős, the Austrian Wolfgang Schmidt, portrayed in this volume by Martin Neuwirther, has also written himself into this tradition.

Wilhelm Frank describes some of the most important Austrian mathematicians and logicians: among others, Wilhelm Wirtinger, Philipp Furtwängler, Eduard Helly, Abraham Wald, and Hans Hahn, along with the Hungarian Frigyes Riesz, one of the cofounders of functional analysis. Other Hungarian and Austrian mathematicians will be presented by Peter Weibel (Johann Radon, Alfred Tauber, Richard von Mises, John G. Kemeny, Paul R. Halmos, among others). Based on the example of Olga Taussky-Todd, Christa Binder shows the life of a female mathematician in this century. Leopold Vietoris, the Nestor of Austrian mathematicians (as presented by Gilbert Helmberg and Karl Sigmund), who died in 2002 shortly before his 111th birthday, brought algebraic strains into this topology, which were important for string theory in particular. The works of Raoul Bott are also in algebraic geometry (Martin Neuwirther). Geometry can sometimes be very abstract, but it can also be quite vivid and even playful. Via Rubik's *Magic Cube*, Gerszon Kéri and Tamás Varga offer an introduction to the basic concepts of group theory, the discipline that is mathematically based on the theory of symmetry. Geometry in the nineteenth and the twentieth centuries has gone through a revolution, one in which, for example, Farkas and János Bolyai in Hungary and Karl Menger and Kurt Reidemeister in Vienna were involved. Kurt Gödel's pioneering works have both greatly expanded the possibilities of logic while pointing out its borders. His famous Incompleteness Theorem, often called the "sentence of the century" (Peter Weibel and Eckehart Köhler), creates an unexpected bridge to problems of (mathematical) physics (Michael Stöltzner).

Entropy is an important concept for mathematical physics as well as information theory that was born in Austria and Hungary. Ludwig Boltzmann founded the area of statistic physics that is based on it. Richard von Mises decisively shaped the mathematical basis of probability theory. A general introduction to this theme is offered by Gábor J. Székely and Dénes Petz. Extracts from Leo Szilard's original essays are presented, establishing a base for the connection between entropy and information, which would later become so fundamentally important for information theory. John von Neumann and Alfréd Rényi grasped the term "entropy" in a modern way and also made it useful for quantum systems. Szilard's autobiography shows his and his friends' (Eugene P. Wigner, Edward Teller, John von Neumann) participation in the development of the atom bomb. We document the renowned letter from Einstein and the added memorandum from Szilard.

Mathematics, as the most formal of the sciences, also created fascination in the arts and served as a model for abstract and systematic image construction, particularly when the external principles of picture organization such as the reference to reality, no longer existed. Like symmetry and symmetry breaking, mathematical methods have delivered internal principles (proportion, rows, series, etc.) for the organization of the visual and sculptural elements, be it of order or disorder (Rudolf Arnheim, *Entropy and Art: An Essay on Order and Disorder*, 1971). *Visual Thinking* (Arnheim, 1969) is supported by formal-logical thought.


$i\hbar \frac{\partial}{\partial t} \psi = \hat{H} \psi$
$\frac{\hbar c}{e^2} \simeq 137$
Erw (ℜ, φ) = (ℜφ, φ)

4

4

mathematics
physics

4

Gyula Staar

Mathematics, the Lighthouse of Hungarian Science

True science is of world-wide importance, so that if we want to become true scientists as well as good Hungarians – as we should – we must raise the banner of science so high that it is visible even outside our borders and due respect can be paid to it

— so said Lóránd Eötvös, former chairman of the Hungarian Academy of Sciences.

According to numerous authorities, Hungary is a great power in mathematics. Indeed, our country has given the world many talented mathematicians. Some of them became outstanding personalities of international fame, influencing the development of mathematics. How is it possible that such a small country has produced so many good mathematicians? This question has been asked over and over again.

According to Leo Szilárd's joking remark, the reason Hungary gave the world so many outstanding scientists lies in the fact that our higher education was so poor that if the students possessed just a morsel of ambition, they had to study their subject by themselves. As a result, they were unintentionally trained to think independently.

Professor Nándor Balázs thinks that the susceptibility of Hungarians to exact mathematics is closely related to our language, which forms our way of thinking: When solving scientific problems we usually proceed from concrete cases to generalizations. The Hungarians' strong sense of concreteness is rooted in the language. The concrete things are represented by the verbs, and the Hungarian language is incredibly rich in the various modifications of the verbs. Almost any expression implies a concrete picture. When we use the verb latolgat (to ponder), we virtually see that the subject handles an object, and tries to determine its weight by moving it up and down. Thus — according to the well-known Hungarian-American professor — our gift in natural sciences and mathematics is a beautiful example of the intertwining of mentality and language.

The majority of mathematicians invoke more down to earth reasons. Hungary is a poor country, and since mathematics is the least expensive science to pursue, many of the talented young people necessarily opt for it. In Hungary, the system of selection of gifted young students is also very successful. The Matematikai és Physikai Társulat [Mathematical and Physical Society] organized the first student competition already in 1894. Since then we have had a well-organized, multilevel network of students' mathematical competitions in our country. However, an even more important and unique tool in the education of young talents is the institution of *Középiskolai Matematikai Lapok* [High school mathematics gazette]. Its first volume was inaugurated in 1894 by Dániel Arany, mathematics teacher at the high school of Győr. Since problem-solving is the essence of mathematics, in every issue of the monthly journal — with a summer vacation, of course! — interesting and challenging problems are posed and the best solutions to them are printed together with the names of the successful students. At the end of the academic year, the photos of the best problem-solvers are shown and the name of their school and mathematics teacher are recorded. This is a great honor as well as a powerful motivation for ambitious, competitive, and creative young people. In order to deepen the student's knowledge, the journal also publishes articles and essays.

The names of almost all the Hungarian mathematicians that reached world fame appear among the winners of the competitions and are listed as the best problem-solvers of *Középiskolai Matematikai Lapok*.

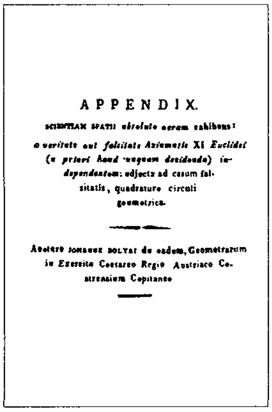
The emergence of Hungarian mathematics at the forefront of the international scene was established in the years following the reconciliation with Austria. As a result of a nationwide burst of enthusiasm, efforts were made to improve education and research in the field of the natural sciences. In order to facilitate the progress of the country, József Eötvös, at the time culture minister, introduced a public education bill into parliament. In 1871 the Technical University of Budapest was founded. Here, theoretical physics and mathematics were taught by distinguished professors whom any technical university in the world would be proud to have in their faculty: Jenő Hunyady, Kálmán Szily, Gyula Kőnig, Mór Réthy, József Kürschák, and Gusztáv Rados.

Hungary's second university was established in 1872 in Kolozsvár (now Cluj, in Romania) with strong departments in mathematics and physics. Antal Abt (1827–1902) was professor of physics, and the department of higher mathematics was headed by Lajos Martin (1827–1897). At the end of the last century, Kolozsvár University became a center of mathematics with outstanding and famous professors such as Gyula Farkas, Mór Réthy, Gyula Vályi, Lajos Schlesinger, Lipót Fejér, Frigyes Riesz, and Alfréd Haar.

Luckily for Hungarian science and education, József Eötvös's successor in the Ministry of Education was the able Ágoston Trefort (1817–1888). In order to raise the level of secondary education, he established high schools and made important steps in the improvement of higher education. The Magyar Természettudományi Társulat [Hungarian Society for Natural Sciences] for the popularization of science was revitalized. Its secretary-general, Kálmán Szily, started the publication of a high-level popular science journal, *Természettudományi*

Gyula Staar, was born 1944 in Lajosmizse. He graduated from the Roland Eötvös University in 1968 as mathematics and physics major. In the period 1974-1989 he worked as editor at the popular science monthly *Természet Világa* (World of Nature). In 1989-1990 served as deputy editor in chief at *Élet és Tudomány* (Life and Science), in 1990 has been appointed editor in chief at *Természet Világa* where he has been working ever since. He has served as member of the presidium of the Budapest Association for Dissemination of Science, the Hungarian Society for Natural Sciences, member of the Editorial Board of Mathematics Journal as well as founder and member of the Ruling Board of the Chamber of Hungarian Science Journalists.

References:
A megélt matematika (1990), *Öt magyar fizikus* (1991), *De mi az igazság... Beszélgetések Simonyi Károllyal* (1997).



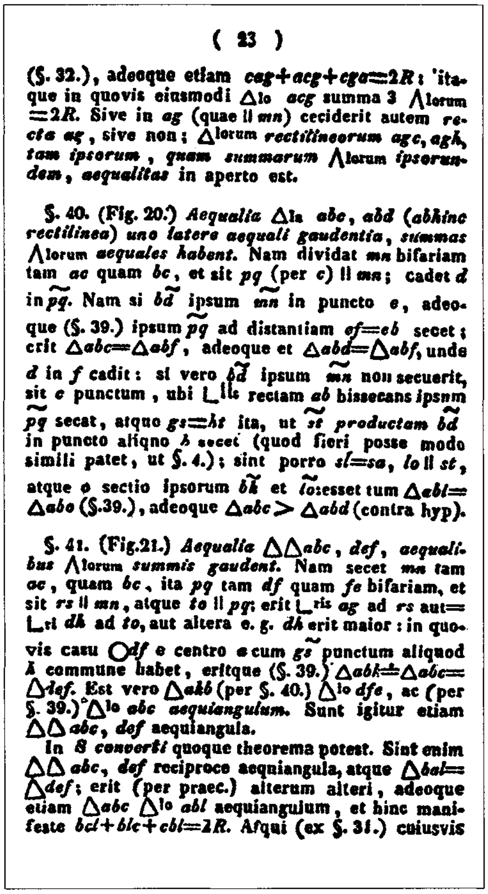
APPENDIX.

SCIENTIAM SPATII absolute veram exhibens:

a veritate aut falsitate Axiomatis XI Euclidei (a priori haud unquam decidenda) independentem: adjecta ad casum falsitatis, quadratura circuli geometrica.

Auctore JOHANNE BOLYAI de eadem, Geometrarum in Exercitu Caesareo Regio Austriaco Castrensium Capitaneo

János Bolyai, *Appendix a tér tudománya* (Appendix to *Tentamen*, 1832 of his father), 1931, Reprint: Akadémiai Kiadó, Budapest 1977.



(23)

(§. 32.), adeoque etiam *cag+acg+cga*=2*R*: itaque in quovis eiusmodi Δlo *acg* summa 3 ∧lorum =2*R*. Sive in *ag* (quae ∥ *mn*) ceciderit autem *recta ag*, sive non; Δlorum *rectilineorum agc, agh, tam ipsorum, quam summarum* ∧lorum *ipsorundem, aequalitas* in aperto est.

§. 40. (Fig. 20.) *Aequalia* Δla *abc, abd (abhinc rectilinea) uno latere aequali gaudentia, summas* ∧lorum *aequales habent.* Nam dividat *mn* bifariam tam *ac* quam *bc*, et sit *pq* (per *c*) ∥ *mn*; cadet *d* in $\widetilde{pq}$. Nam si $\widetilde{bd}$ ipsum $\widetilde{mn}$ in puncto *e*, adeoque (§. 39.) ipsum $\widetilde{pq}$ ad distantiam *ef*=*eb* secet; erit Δ*abc*=Δ*abf*, adeoque et Δ*abd*=Δ*abf*, unde *d* in *f* cadit: si vero $\widetilde{bd}$ ipsum $\widetilde{mn}$ non secuerit, sit *e* punctum, ubi ⊥lis rectam *ab* bissecans ipsum $\widetilde{pq}$ secat, atque *gs*=*ht* ita, ut $\widetilde{st}$ *productam* $\widetilde{bd}$ in puncto aliquo *k* secet (quod fieri posse modo simili patet, ut §. 4.); sint porro *sl*=*sa*, *lo* ∥ *st*, atque *o* sectio ipsorum $\widetilde{bk}$ et $\widetilde{lo}$: esset tum Δ*abl*=Δ*abo* (§.39.), adeoque Δ*abc* > Δ*abd* (contra hyp).

§. 41. (Fig.21.) *Aequalia* ΔΔ*abc, def, aequalibus* ∧lorum *summis gaudent.* Nam secet *mn* tam *ac*, quam *bc*, ita *pq* tam *df* quam *fe* bifariam, et sit *rs* ∥ *mn*, atque *to* ∥ *pq*; erit ⊥ris *ag* ad *rs* aut= ⊥ri *dh* ad *to*, aut altera e. g. *dh* erit maior: in quovis casu ○*df* e centro *a* cum $\widetilde{gs}$ punctum aliquod *k* commune habet, eritque (§. 39.) Δ*abk*=Δ*abc*=Δ*def*. Est vero Δ*akb* (per §. 40.) Δlo *dfe*, ac (per §. 39.) Δlo *abc aequiangulum.* Sunt igitur etiam ΔΔ *abc, def* aequiangula.

In *S converti* quoque theorema potest. Sint enim ΔΔ *abc, def* reciproce aequiangula, atque Δ*bal*=Δ*def*; erit (per praec.) alterum alteri, adeoque etiam Δ*abc* Δlo *abl* aequiangulum, et hinc manifeste *bcl*+*blc*+*cbl*=2*R*. Atqui (ex §. 31.) cuiusvis

One page of the famous work from J. Bolyai, which revolutionized geometry. (p. 61 from the appendix)

Farkas Bolyai, 1775-1856
János Bolyai, 1802-1860
Monument in Marosvásárhely (now Tirgu Mures, Romania) (Clausenburg) in front of the famous Reformist College. The high school is now named after its former professor, Farkas Bolyai. His son János studied there, too.

Közlöny [Review of natural sciences] that was among the first in its category in Europe. This was a publication designed for those with an interest in the sciences and was generally read by high school teachers, many of them authors as well. The monthly magazine is published today as *Természet Világa* [World of nature].

At the end of the last century, on the initiative of Budapest mathematicians, Hungarian mathematicians started to organize themselves. In June 1891, the first issue of *Mathematikai és Physikai Lapok* [Journal of mathematics and physics] was printed and on November 5 of the same year the Mathematikai és Physikai Társulat [Mathematical and Physical Society], the predecessor of János Bolyai Matematikai Társulat, was established.

Hungarian mathematics began at an international level with the activity of the two Bolyais; the father, Farkas Bolyai, and the son, János Bolyai. Their isolated activity dates back to the beginning of the last century, and this period may be regarded as the reform age of our mathematics.

He Created Another World: János Bolyai (1802–1860)

János Bolyai's father, Farkas Bolyai (1775–1860), was one of the best mathematicians of his time. He studied in Göttingen, the capital of mathematics, between 1796–1799, and made friends with Carl Friedrich Gauss, the "prince" of mathematics. Later he became professor of the Calvinist College of Marosvásárhely, where he taught mathematics, physics, and chemistry. For half a century he worked tirelessly for the fostering of scientific knowledge and supporting talents in Transylvania, a province of Hungary at that time.

Farkas Bolyai tried to ease his isolation through correspondence, sharing his ideas, joys, and sorrows with his friend, the great Gauss. He asked for advice and guidance. He wrote about his five-year-old son with paternal pride: "when in the countryside he observed the planet Jupiter, he asked how is it possible to see it both there and in the town, then it must be very far away." The father's cherished dream was to send his son to Göttingen to get his university education and live with the Gauss family. On his modest professor's salary he could not afford any other possibility. However, Gauss did not even answer his inquiring letter. Thus the talented youth had to study under the tutelage of his father in Marosvásárhely, and in 1878 enrolled at the Royal Engineering College (Military Academy) in Vienna (1818–1822).

János Bolyai graduated with honors from the academy in 1822 as a military engineer. After one year of postgraduate training he was promoted to the rank of second lieutenant in the army engineering corps and was transferred to Temesvár (now Timisoara, Romania) Fortress Command. It was here that he wrote his father in his youthful enthusiasm the frequently quoted words: "I have created a new universe from nothing!" What does this mean — what is this new universe of János Bolyai's famous result?

The story goes back to the two-thousand-year history of parallels. In the third century b.c. Euclid showed in his famous work *Elements* that geometry can be built up in an axiomatic way; in terms of a few axioms all the results can be derived. However, axiom XI, the so-called parallel axiom, caused much concern to mathematicians, since it was much like a theorem, too complicated, and not self-evident. It is important to note that in Euclid's *Book I* no use has been made of the parallel lines, defined as coplanar lines that do not meet. However, it can be proven that if AB is any line and P a point not on it, at least one line parallel to AB can be drawn through P; and axiom XI states in a complicated way that this parallel is the only one. The parallel axiom in its strongest form would be: given a line AB and a point P not on it, exactly one parallel can be drawn to AB through P.

The long series of attempts, including those of Farkas Bolyai, to prove uniqueness, using only the other postulates and axioms in the first part of *Book I*, always resulted in failure. With regard to his own experience, Farkas Bolyai warned his son: "I entreat you, leave the science of parallels alone ... I have traveled past all reefs of this infernal Dead Sea and have always come back with a broken mast and torn sail. Avoid it as you would bad company; it will deprive you of your time, health, tranquility and the happiness of your whole life."

The elder Bolyai's fanatic preoccupation with proving Euclid's parallel axiom, however, infected his son and, despite his father's warnings, János persisted in his own search for a solution. In 1820 he concluded that a proof was probably impossible and began developing a geometry that did not depend on Euclid's axiom. In 1823 he sent his father a draft of paper, written in Latin, *Appendix Scientiam Spatii Absolute Veram Exhibens* [Appendix explaining the absolutely true science of space], a complete and consistent system of non-Euclidean geometry, that appeared in his father's book *Tentamen* as the first appendix.

This masterpiece of mathematics was only 26 pages long, with two pages of figures and a one-page list of corrections. It was his first and last work that ever appeared in print.

Farkas Bolyai, wrestling with his doubts, sent the paper to the "Colossus of Göttingen":

> *Will you please judge it with your sharp, penetrating eyes, and in your answer, which I'm craving for, make your judgment without sparing my feelings ... My son has a higher regard of your opinion than of the whole of Europe!" Then came the strange and disappointing answer: "Now about your son's work. I am unable to praise this work ... To praise it would be to praise myself. Indeed, the whole contents of the work, the path taken by your son, the results to which he is led, coincide almost entirely with my meditations which occupied my mind partly for the last thirty or thirty-five years.*

Thus the eagerly awaited recognition did not come. This was a profound blow to Bolyai, even though Gauss had no claim to priority since he had never felt enough confidence in his findings to publish them.

János Bolyai died virtually unknown and abandoned on January 27, 1860. His funeral was attended by only two residents of Marosvásárhely and two army officers in official capacity. The death register of the town's Reformist Church recorded: "He was a famous and talented mathematician, first among the firsts. Unfortunately his great talent was buried unutilized."

Time served justice, however. The new universe he created, the hyperbolic geometry, which is an alternative to that of Euclid, is named after the discoverers "Bolyai-Lobatchevskii geometry" in the mathematics literature. The Hungarian Academy of Sciences established an — unfortunately short-lived — prize to honor Bolyai. The most important Hungarian mathematicians' association is called "János Bolyai Mathematical Society." His life and work have been the subject of numerous monographs and continue to be even today.

It is remarkable as well as ironic that the world's attention — and Hungary's — to Bolyai's work was first drawn by foreign mathematicians (Richard Baltzer, Boncompagni, George Bruce Halsted, Paul Stäckel, Felix Klein, etc.). The distinguished Austrian mathematician Johannes Frischauf gave a course on non-Euclidean geometries in the academic year 1871–1872 at Graz University, based mostly on the *Appendix*. It is equally significant that, in addition to the non-Euclidean geometry, some outstanding results of Bolyai's scholarly activities have also been discovered and researched by two contemporary professors in Marosvásárhel; Tibor Weszely and Elemér Kiss.

The question is often asked: why was Bolyai's genius not recognized in his time and why he did not receive well-deserved recognition? An answer — instead of absolution, but without offering comfort — can be found in the lines by Imre Tóth: "It is easy to be a genius, because you are either born with it or aren't. But there is nothing more difficult than to accommodate genius, since it requires that one becomes what one is not. One has to revive oneself."

The foundations of twentieth-century Hungarian mathematics were laid by two spiritual giants, Frigyes Riesz and Lipót Fejér. They enriched mathematical analysis with epoch-making results, and their greatness has already been recognized by the world during their lifetime. Their influence on Hungarian mathematics and the generations of our mathematicians is still felt. They were born in the same year, 1880 — Riesz on January 22, in the town of Győr, and Fejér on February 9, in Pécs.

The Pioneer of Functional Analysis: Frigyes Riesz (1880–1956)

Riesz graduated from high school in his native town, Győr. In the hope that the engineering profession would offer a secure life, he enrolled at the Zurich Technical University in 1897. However, he soon realized that he was much more interested in mathematics than engineering. He returned to Budapest in 1899 and entered the university there. He enjoyed best the lectures given by Gyula Kőnig and József Kürschák. He also spent a year in Göttingen listening to courses by David Hilbert and Hermann Minkowski. He received his Ph.D. as well


ACADÉMIE DES SCIENCES DE HONGRIE

LEÇONS
D'ANALYSE FONCTIONNELLE

FRÉDÉRIC RIESZ ET BÉLA SZ.-NAGY

QUATRIÈME ÉDITION

GAUTHIER-VILLARS — AKADÉMIAI KIADÓ

The fundamental textbook of functional analysis. The first edition of this monograph was published in 1952. The English translation was published three years later (*Functional Analysis* (New York: F. Ungar Publ. Co. 1955).

as his teacher's diploma in Budapest. He got a position as teacher first in Löcse, then in Budapest. His life, however, was considerably changed by his fundamental finding, which the world of mathematics now refers to as the "Riesz-Fischer theorem." This result was published in 1907 in the *Comptes Rendus* of the French Academy. His former student, professor Ákos Császár, himself a famous topologist, describes this result:

It is not an exaggeration to state that this finding of Frigyes Riesz influenced the development of twentieth-century mathematics in a decisive way. The basic idea that functions behave in many respects similar to the vectors of ordinary space is both the starting point and final source for a branch of mathematics called functional analysis, which even today is in intensive development. It has found numerous applications both in mathematics and physics, and, among others, it is one of the fundamental tools of quantum mechanics. While this result was also obtained simultaneously by E. Fischer, this fact by no means diminishes Riesz's merits, since he has played a leading role in the development of functional analysis all along. On the other hand, in Fischer's achievements the discovery of the Riesz-Fischer theorem remained completely isolated.

Recognition did not take very long: in 1912 Riesz was appointed professor of mathematics at the University of Kolozsvár (now Cluj, Romania). In 1916 he was elected corresponding member of the Hungarian Academy of Sciences; he became a full member in 1936.

In 1920 the Trianon Peace Treaty shrunk the territory of Hungary by two thirds, and as a consequence Transylvania became part of Romania. The Kolozsvár University moved to Szeged; so did Frigyes Riesz and Alfréd Haar. Due to the work of these two outstanding scientists, however, Szeged soon became a research center in mathematics, and many people refer to this town even today as the "Hungarian Göttingen." In 1922 Riesz and Haar founded Acta Scientiarum Mathematicarum, which quickly found a position of distinction among the mathematics journals of the world, thus considerably increasing the prestige of Hungarian mathematics.

Riesz's world fame attracted foreign mathematicians to Szeged. Edgar E. Lorch, a young American mathematician who received a fellowship to study with Riesz, arrived at Szeged in 1934. In his recollections he describes Riesz as follows:

Medal commemorating the 75th birthday of Frigyes Riesz.

Riesz was a dangerous man to collaborate with. He was constantly having new ideas, and his latest brainchild was his favorite. This could have disconcerting results for the collaborator. The experience of his former assistant, Tibor Radó, illustrated this. During the academic year Riesz lectured on measure theory and functional analysis. When summer came Riesz would leave for a cooler spot (Győr). Radó would sweat it out in Szeged for three months, writing up the lecture notes for publication in the fall. At the end of September, Riesz would put in his first day at the Institute, Radó would come to the library to greet his superior, proudly carrying a stack of eight hundred hand-written pages, which he placed in Riesz's lap with a look of great satisfaction. Riesz would glance at the bundle, and raise his eyes with a mixture of kindness and thankfulness, and at the same time with a spark of merriment, as if he had pulled off a fast one. "Oh, very good, very good. Yes, this is very nice. But I tell you, during the summer I had an idea. We will do it another way. You will see it when I give the course. You will like it!" This took place many years in a row. The book was not written until eighteen years later, with Béla Szökefalvi-Nagy as co-author.

For this book, the *Leçons d'analyse fonctionelle*, Riesz was awarded the Kossuth Prize in 1949 and 1953, together with his co-author Béla Szökefalvi-Nagy, who in the meantime also became world-famous in his own right.

Riesz spent the last ten years of his life in Budapest as professor at Roland Eötvös University. He was showered with various forms of recognition: he was elected chairman of the Mathematical Division of the Hungarian Academy of Sciences, honorary chairman of the János Bolyai Mathematical Society, and was also made a member of the French Academy, the Bavarian Academy of Science in Munich, as well as the Royal Swedish Physiography Society. On his seventieth birthday the Academy of Sciences of the Soviet Union congratulated him in a letter in which it was written: "You are one of the greatest living masters of mathematical thinking."

The Summation of Fourier Series: Lipót Fejér (1880–1959)

Lipót Fejér was born to a wealthy merchant family in Pécs and graduated from the local high school. During his school years he was one of the best problem-solvers of the *Középiskolai Matematikai Lapok*. In 1887 he won the second prize in the student mathematics competition of the Mathematical and Physical Society. At the request of his parents he enrolled at Budapest Technical University, studying mechanical engineering. However, after the first semester he transferred to Budapest University, where he majored in mathematics.

He spent the academic year 1899–1900 at the universities in Berlin and Göttingen. He was greatly impressed by the lectures of H. A. Schwarz in Berlin and David Hilbert in Göttingen. He wrote his first essay as a university student in 1900, which was presented at the Paris Academy in December of the same year and instantly earned him world fame. This paper was also published in the *Comptes Rendus* of the French Academy of Sciences. His theorem on the summation of the Fourier series was further developed and extended in his doctoral thesis two years later. This work established the path of development of the modern theory of trigonometris series. In his rich œuvre, however, he could not surpass his first outstanding result. In his papers he frequently returned to his first idea, tried to formulate more and more sharp statements and to find new applications. His main interests, beside the theory of Fourier series, were the theory of functions and the interpolation theory. With Frigyes Riesz he gave a short and elegant proof of the fundamental theorem of conform mapping.

György Pólya characterizes his working method in the following way:

> *His articles were well-written and easy to read. This was a direct consequence of his working style. If he had an idea, he handled it with great care, tried to improve and simplify it, and get rid of all the nonessential details. He worked precisely and meticulously on the idea until the presentation became perfectly clear. In such a way, he produced not too lengthy, but always perfect masterpieces. He was talented not only in mathematics, but in arts as well. He liked music and also played the piano.*

Lipót Fejér in his youth.

Sonderabdruck aus dem Jahresbericht der Deutschen Mathematiker-Vereinigung. XXV. 1916. Heft 10/12 Verlag und Druck von B. G. Teubner in Leipzig

Über Fejérs Summierung der Fourierschen Reihe.

Von Hans Hahn in Bonn.

Die Theorie der Fourierschen Reihen weist eine Anzahl von Summationsverfahren auf, die an allen Stetigkeitsstellen der darzustellenden Funktion $f(x)$ sicher gegen $f(x)$ konvergieren; die wichtigsten sind wohl die von Poisson, von Riemann, von de la Vallée Poussin und von Fejér. Für die drei erstgenannten ist bekannt[1], daß sie allgemeiner für jeden Wert von x gegen $f(x)$ konvergieren, für den:

$$(1)\qquad \lim_{t=0} \frac{1}{t}\int_0^t [f(x+2u)+f(x-2u)-2f(x)]\,du = 0$$

ist. Im Gegensatze hierzu wurde dies für das Fejérsche Verfahren nur für solche Werte von x bewiesen[2], für welche:

$$(2)\qquad \lim_{t=0} \frac{1}{t}\int_0^t |f(x+2u)+f(x-2u)-2f(x)|\,du = 0$$

1) Vgl. z. B. H. Lebesgue, Ann. de Toul. (3) 1, S. 86, 106.
2) H. Lebesgue a. a. O. S. 90.

He was elected corresponding member of the Hungarian Academy of Sciences in 1908, he became full member in 1930. In 1948 he was awarded the Kossuth Prize. He was also a member of a number of foreign scholarly societies and academies and was offered chair at numerous foreign universities. However, he chose to stay in Budapest and educated generations of mathematicians and mathematics teachers. He was always surrounded by students, and he kept in touch with most of them even after they left the country. Once he jokingly remarked: "In the last week, two of my students were appointed professors in the United States. However, this does not happen every week."

He died on October 15, 1959. The feelings of his former students and the whole mathematics community were best formulated by György Szegő "Without Fejér our life will not be the same any more."

The Father of Modern Heuristics: György Pólya (1887–1985)

One of the everlasting results of György Pólya's achievements of more than six creative decades is that he showed us how to teach our students to think. His name is known all around the world where thinking is taught.

He was born in Budapest on December 13, 1887 to a family of intellectuals. His father, Jakab Pólya, was a distinguished economist and a member of the Academy of Sciences. György Pólya went to the Markó Street high school. Recalling his school years, he said mathematics classes were rather uninteresting and tedious. He did not want to be a mathematician. Instead he preferred geography, Latin, and Hungarian language and literature. After graduating from the high school, he enrolled, according to his mother's wishes, at the Faculty of Law of the Péter Pázmány University. However, half a year of law was too much and he changed to Greek, Latin, and Hungarian literature. In 1907 he passed his basic exams and then turned to philosophy. He also took mathematics and physics, but only for the sake of acquiring some serious background for natural philosophy. However, his curiosity took him to the lectures on calculus by Professor Manó Beke. He recalls their first meeting: "Professor Beke looked at me, the unknown student, then started to turn the pages of my index, my university record. Well, well — he said — you are coming to mathematics from philosophy. You will return to philosophy, but don't do it too soon. Then he signed my index."

György Pólya, nearly at the age of ninety, giving a lecture at the Research Institute for Mathematics, Budapest (August 1977).

As it happened, György Pólya was forever chained to mathematics. Still, Professor Beke's prophecy also came true. In June 1945 the Princeton University Press published Pólya's book *How to Solve It?*, which became a worldwide bestseller. It was translated into sixteen languages — there were several Hungarian editions too — and the total number of copies exceeded one million. This is a unique feat in the history of mathematics publications. According to his own words, this book is an attempt to revive heuristics in a modern and modest form, so that in some sense it is a return to philosophy. Maybe it is not improper to make the comparison: the enormous effect of Pólya's book on shaping problem-solving thinking in the past decades reminds one of the *Elements* of Euclid, which has influenced the intellectual development of mankind for two thousand years.

Why did he choose mathematics? Pólya answered the question with his characteristic good humor: "I think I was not good enough for physics, but was too good for philosophy. Mathematics lies in between." Of course he became a mathematician not just by sheer accident. An important role in this decision can be attributed

Pólya György, *The School of Thinking*, 1969

György Pólya (right) with Gábor Szegö in Berlin, 1925, when they signed the contract with Springer Verlag for their book *Aufgaben und Lehrsätze aus der Analysis.*

1973. He has shown in his essays of literary value that mathematics is an organic part of human culture.

to the influence of Lipót Fejér, one of the outstanding personalities of the twentieth-century Hungarian mathematics.

Pólya got his Ph.D. in mathematics from Budapest University; the title of his thesis was "On Some Problems of Probability Theory and Related Definite Integrals." He continued his studies in Göttingen, where he met a multitude of distinguished mathematicians: David Hilbert, Felix Klein, Edmund Landau, Carl Runge, and from the younger generation Richard Courant, Hermann Weyl, and Otto Toeplitz. At the outbreak of the war he did not return to Hungary; therefore, he obtained his great discoveries, which earned him world fame, abroad. The major stops after Göttingen were Paris and Zurich, where he was awarded a professorship at the famous Eidgenössische Technische Hochschule (ETH), the prestigious Zurich technical university. He left Europe in 1940 for the United States. He was offered teaching positions at Brown University and Smith College. In 1942 he accepted a professorship at Stanford University, where he worked until his retirement in 1953.

György Pólya's scientific work concentrated on the field of mathematical analysis, more precisely the theory of complex variables and probability theory. He was also extremely successful in combinatorics and mathematical physics. In the course of his career from 1913 to 1983 he published 250 scientific papers and ten books. His collected works were published in four volumes by MIT Press between 1974 and 1984. He was a pioneer in several fields, which by now have been extensively researched.

The first success that brought him recognition was the book *Aufgaben und Lehrsätze aus der Analysis* [Problems and theorems in analysis], written with Gábor Szegö. This collection of problems was first published in 1925; it has been translated into five languages and is even today one of the most widely used textbooks. (The famous book "returned home" only in 1980, when the first Hungarian edition was published.)

The book covers many areas of mathematical analysis. However, the problems are grouped not according to the subject but by method of solution. The well-designed series of problems takes the reader from the basics to the highest summits. It teaches the reader to "walk" in problem solving. "Two volumes of concentrated mathematical beauty," praised J. D. Tamarkin. The Pólya-Szegö book is endowed with all the characteristics that made Hungarian mathematics world-famous in the twentieth century.

What kind of a man was Pólya? He was lively, fresh-spirited, and cheerful. He was always full of ideas, initiative; a universal talent who was always the center of the party. He liked funny anecdotes and stories, he also told many stories, mostly about mathematicians. The various forms of recognition he was given are too numerous to list here. One thing should be mentioned: the best popular science articles published in the *College Mathematical Journal* are awarded with the Pólya Prize by the American Mathematical Association.

He passed away on September 7, 1985 in Palo Alto, California.

The "Cosmic" Mathematician: Alfréd Rényi (1921–1970)

Alfréd Rényi was an extremely gifted and brilliant scientist who discovered mathematics in every aspect of life. While driving a car he constructed a probabilistic model of highway traffic. When we went on a rowing excursion he talked about the mathematical problems he had discovered when talking about a brain model with Professor Szentágothai. He discovered mathematics in everything, and tried to use the language of mathematics to explain new things. This wide-scale but at the same time profound approach can be characterized by a single adjective: cosmic. Rényi was a "cosmic" mathematician, just like János Neumann (John von Neumann), described his former teacher Professor Domokos Szász.

Alfréd Rényi was born on March 20, 1921 in Budapest. He was the only child in the family. His father was an engineer; the maternal grandfather, Bernát Alexander, a distinguished philosopher. At high school he was considered a prodigy, mostly due his wide interests and his mathematical talent. He graduated from high school in 1930, but because of the numerus clausus he was not allowed to enroll at the university. He worked for a year as a shipyard worker, and finally succeeded in entering Budapest University as a mathematics-physics major in 1940.

Rényi was a pupil of Lipót Fejér and graduated in 1944. As a Jew, in World War II, he was called up by the army for labor service but escaped. After the war he got his Ph.D. with Frigyes Riesz in Szeged; his thesis subject was the Stieltjes integrals. He spent the years 1946 and 1947 in Leningrad on a scholarship, and with J. V. Linnik as supervisor he wrote his Habilitation in just a single year, although three years were allowed. By generalizing the Linnik's large sieve method, he obtained several remarkable results in analytic number theory. His interest shifted more and more towards probability theory and its various applications. By attracting talented young people to his field, he established a school in probability theory in Hungary.

In 1959 he obtained a new version of the probabilistic generalization of the large sieve method. His important results are too numerous to list here, but a few of the subjects he was working on are: mixing sequences of sets, ergodic theory, probability limit theorems, algebra of distributions, composed Poisson distributions, the law of iterated logarithm, stochastic dependence and its measure. He was also interested in the problems of information theory and statistical physics. In addition, he obtained important results on the ergodic properties of the representation of real numbers, random graphs, and ordered samples. As for the applications, he was working on the theory of crushing, probability problems of electric engineering, logistics, and also economy. In the field of chemical reaction dynamics he derived the Gouldberg-Waage law by probabilistic methods.

Alfréd Rényi was a captivating lecturer.

In recognition of his scientific results, he was elected corresponding member of the Hungarian Academy of Sciences in 1949; in 1956 he became a full member. He won numerous prizes and medals, including the Kossuth Prize in 1949 and 1956. He was visiting professor at several foreign universities and on the editorial boards of ten international scientific periodicals.

He was a highly cultured man, full of energy and initiative. He became director of the Research Institute for Mathematics of the Academy of Sciences (at that time Institute for Applied Mathematics) at the age of 29, and was simultaneously head of the Department of Probability of the Roland Eötvös University.

He was also very active in the popularization of science and its results. He thought mathematics should be pursued for its inner beauty, charm and sparkling spirit rather than its widespread use and potential power:

Rényi discovered mathematics in every aspect of life.

Mathematics lets only those who approach its beauty with enthusiasm, and pure thirst for knowledge glimpse its secrets.

He tried to expose the beauty of his beloved mathematics to every educated person. His exceptional talent also manifested itself in his essays and writings on mathematics, which are also considered to have high literary value. The books *Dialogues on Mathematics* and *Letters on Probability* were published in several editions and have also been translated into several languages. His volume *Ars mathematica* almost instantly became a scarce commodity. His book *Diary on Information Theory* was published posthumously.

Alfréd Rényi must have been loved by the gods; he died young, at the age of 49.

The Prince of the "Hungarian Göttingen": Béla Szökefalvi-Nagy (1913–1998)

The town of Szeged is the bastion of mathematics in Hungary. Riesz and Haar founded the Bolyai Institute there, and it was also Szeged where the famous periodical Acta Scientiarum Mathematicarum began. One of the leading figures of the vivacious mathematical scene was for decades Béla Szökefalvi-Nagy, former student and later co-worker of Frigyes Riesz. He recalls the birth of their by now classic treatise *Leçons d'analyse* fonctionelle in the following way:

Riesz suggested that we should jointly write a general textbook that would be the synthesis of two parts: the first part should contain the results of Riesz on the new theory of integration and as a continuation those in the field of the modern theory of real variables, while my studies in the theory of operators would make up the second part. We could both rely on our published monographs: Riesz's book was published in 1913 in French, mine in 1942 in German. Thus we both gave our dowry to the joint book; however, we also critically examined each other's part as well. There was not very much to improve in Riesz's part, I only tried to find the best way of presentation. I made every effort to master Riesz's methods: his claim to elegance and style! We divided the labor and worked in the greatest concord. We wrote the book in French, and it was published in 1952 by the Akadémiai Kiadó in Budapest. It was later translated into German, English, Russian, Chinese, Japanese and in 1988 even a Hungarian edition was published!

This book greatly helped the young Béla Szökefalvi-Nagy to start his long and extremely successful carrier in mathematics.

He was born in Kolozsvár on June 29, 1913. He obtained his secondary education there, then he graduated from Szeged University in 1936. Between 1939 and 1948 he was professor of mathematics at Szeged College of Education (TanárképzőFőiskola). In 1948 he received his Habilitation at Szeged University and became a full professor of mathematics in 1948.

Béla Szökefalvi-Nagy, onetime student and co-worker of Frigyes Riesz, outstanding personality of the Szeged mathematics center.

He obtained important and pioneering results in several fields of mathematics: in the theory of linear operators of Hilbert and Banach spaces, approximation theory, Fourier analysis, as well as geometry. He was elected corresponding member of the Academy of Sciences in 1945, and he became a full member in 1956. He was showered with medals and prizes and was elected a member of the Soviet Academy of Sciences (1971), the Royal Irish Academy of Sciences (1973), and the Finnish Academy of Sciences (1976). In 1980 he was awarded the Lomonosov Gold Medal, the highest award given by the Soviet Academy of Sciences in natural sciences; in 1978 he received the Gold Medal of the Hungarian Academy of Sciences. He has been chairman of the Mathematics Commission of the Hungarian Academy of Sciences since 1953, honorary chairman of the János Bolyai Mathematical Society, and from 1946 to 1982 served as editor-in-chief of the famous *Acta Scientiarum Mathematicarum*; in 1991 he became honorary citizen of Szeged. In addition to a large number of scientific publications he published several important monographs besides the famous *Leçons d'analyse fonctionelle*. His book *Analyse harmonique des opérateurs de l'espace de Hilbert*, written jointly with the Romanian mathematician C. Foias, was also published in Russian and English.

The impact of his ideas and mathematical works can still be traced in the publications of numerous mathematicians around the world.

Rényi, Erdős and Hanani at Lake Louise, Canada, 1969

The Wandering Mathematician: Pál Erdős (1913–1996)

He was one of the brilliant minds of our century, "the Mozart of mathematics" (graceful and virtuoso), "Euler of our days" (productive and many-sided), "the Don Juan of science" (he was entertained every day by another problem). He sacrificed his life on the altar of science, never got married to start a family of his own; his only and burning passion was for mathematics. He was considered the "traveling ambassador" of Hungarian mathematics. Nobody did more to introduce the talented mathematicians of this small country to the world.

His parents, Lajos Erdős and Anna Wilhelm, were high school math teachers, classmates of Lipót Fejér and Tódor Kármán (Theodor von Karman) at the university. Erdős learned a lot from his parents whose intellectual horizon was very wide. His talents were evident already at the early age of five. He was a prodigy, but found the school with its limitations a nuisance.

He graduated from the Saint Stephen high school, and his name appeared at the end of the 1920s among the best problem solvers of Középiskolai Matematika Lapok. He enrolled at the Pázmány Péter University in 1930 as a mathematics and physics major. As a university student, at the age of eighteen, he proved that between the integers n and 2n there always exist prime numbers of the type 4k+1 and 4k+3. His first publication appeared with the help of László Kalmár in the famous Szeged periodical Acta Scientiarum Mathematicarum.

As a student he was most impressed by Professors Lipót Fejér and József Suták, while he was also attracted to the Technical University by the lectures of professors József Kürschák and Gusztáv Rados. At the university he met a number of young mathematicians who shared his love of mathematics. The members of this small group were Pál Turán, Tibor Gallai, György Szekeres, Endre Vázsonyi, László Alpár, as well as Géza Grünwald and DezsőLázár, who died in tragic circumstances during World War II.

Erdős graduated from the university in 1934, got his Ph.D. under Lipót Fejér, and left on a three-year scholarship for Great Britain to work with L. J. Mordell. By this time he was fully attracted to mathematics, he was continuously setting up problems of his own and working on their solutions. He visited Hungary frequently, and he soon developed his characteristic lifestyle — the eternal wandering, living out of suitcases. He came home for the last time before World War II on September 3, 1938. He did not like what he experienced at home, so he left immediately and went to the United States, where he found temporary asylum. However, he always retained his Hungarian citizenship.

His first visit to Hungary after the Holocaust was in 1948 for two months, and in 1956, when he was elected corresponding member of the Academy of Sciences. He became a full member in 1962. His friend Alfréd Rényi arranged a permanent position for him at the Research Institute for Mathematics and this post gave him the possibility of regular visits to Budapest. He returned every year and by attracting a group of talented young mathematicians soon established his world famous Hungarian school of combinatorics and set theory.

His publications number fifteen hundred, an order of magnitude more than any of his contemporaries. The number of his co-authors also exceeds five hundred. He obtained his most important results in the second half of the 1930s, when, together with Mark Lac and Aurel Wintner, he laid the foundations of probabilistic number theory. His collaboration with Pál Turán in approximation theory and the statistical theory of groups also produced lasting results.

His most cited result was achieved in 1949 when, together with Atle Selberg, he found an elementary proof of the prime number theorem, which until then could be proven only by utilizing the methods of complex variables. In the 1940s, he was the first to point out the basic fact that the mathematical treatment of stochastic processes can be reduced to the study of the Brownian motion.

In set theory he worked out the foundations of partition calculus with András Hajnal and Richárd Radó, while he collaborated with Alfréd Rényi in the theory of random graphs. Pál Erdős was the grand master of problem-posing. He liked beautiful problems that were easy to formulate — though because of this ease they usually became exceedingly difficult — and they turned out to point to something fundamental. He advertised his favorite problems everywhere and even set a cash prize for their successful solution. These prizes ranged from a few dollars to $10,000, according to the degree of difficulty of the problem. One of the $1000 problems posed jointly with Pál Turán was solved after 50 years of "siege" by Endre Szemerédi in 1972, who was elected corresponding member of the Academy shortly after this feat. Pál Erdős left behind many exciting cash-prize problems, which mathematicians try to solve for the glory rather than the money.

One of the $3000 problems goes like this: let us prove (or disprove) that if a1, a2, a3, ... ak ... is an infinitely increasing sequence of integers and the property holds, then the sequence contains an arbitrarily long arithmetic series. (If this conjecture is true, then it follows that prime numbers contain an arbitrarily long arithmetic series. This very old conjecture is still unproven.) Erdős expressed his opinion: "At the present state of science the proof seems to be hopeless. Maybe in the next century ... In any case, if I leave (I mean a destination from where there is no return) I'll leave behind money for the prize."

He helped young people to start their careers, and founded scholarships and prizes for them.

Pál Erdős was a free and self-ruling man, more so than anybody else. Family troubles, money, and property did not worry him; his personal belongings filled no more than two suitcases. He was traveling all the time, he wanted to be present everywhere where mathematics was done. In addition to the Hungarian Academy of Sciences he was elected member of the U.S. National Academy of Sciences, the Dutch, Australian, Indian, and Polish Academies of Sciences, as well as the Royal Society. He was honorary doctor of the universities of Haifa, Hannover, Waterloo, York, and Cambridge, not to mention the Roland Eötvös University of Budapest, of course.

He received numerous prizes including the Kossuth Prize (1968), the State Prize of Hungary (1983), the Gold Medal of the Hungarian Academy of Sciences (1991), and the prestigious Wolf Prize — which is considered equivalent to the Nobel Prize for mathematicians — in 1983. He did not ponder very much about the ways of spending the sizable sum that went with the prize: he founded scholarships for gifted young people.

He often said he would like to live only as long as he was able to do mathematics and could still help people. As he said:

Everything that is human, good or bad alike, will end sooner or later. But with the exception of mathematics!

At the age of eighty-three, a heart attack ended this unique and spectacular mathematical career in a hotel room in Warsaw. The whole community of mathematicians of the world mourned over the death of Pál Erdős.

The János Bolyai Mathematical Society, with the support of the Hungarian Ministry of Education, founded the Pál Erdős Summer Mathematical Research Center in 1997, which is dedicated to fostering international collaboration — in the style of Erdős — in mathematics research.

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INTERNATIONAL

Paul Erdos, Whose Math Gave Computers a Foundation, Dies

By Gina Kolata
New York Times Service

Paul Erdos, 83, a world-famous mathematician who was so devoted to his subject that he lived as a mathematical pilgrim with no home and no job, died of a heart attack Friday in Warsaw, a friend said. Mr. Erdos was attending a mathematics meeting in Warsaw.

Ronald L. Graham, the director of the information sciences research center at AT&T Laboratories, said, "I'm getting E-mail messages from around the world, saying, 'Tell me it isn't so.'"

Never, mathematicians say, has there been an individual like Paul Erdos. He was one of the century's greatest mathematicians, who posed and solved thorny problems in number theory and other areas and founded the field of discrete mathematics, which is the foundation of computer science. He was also one of the most prolific mathematicians in history, with more than 1,500 papers to his name. And, his friends say, he was also one of the most unusual.

Mr. Erdos, "is on the short list for our century," said Joel H. Spencer, a mathematician at New York University's Courant Institute of Mathematical Sciences. Another said, "He's among the top 10."

Ernst Straus, who worked with both Albert Einstein and Mr. Erdos, wrote a tribute to Mr. Erdos shortly before his own death in 1983. He said of Mr. Erdos: "In our century, in which mathematics is so strongly dominated by 'theory doctors,' he has remained the prince of problem solvers and the absolute monarch of problem posers."

Mr. Erdos, Mr. Straus continued, is "the Euler of our time," referring to the great 18th-century mathematician, Leonhard Euler, whose name is spoken with awe in mathematical circles.

Stooped and slight, often wearing socks and sandals, Mr. Erdos stripped himself of all the quotidian burdens of life: finding a place to live, driving a car, paying income taxes, buying groceries, writing checks. "Property is nuisance," he said.

Concentrating fully on mathematics, he traveled from meeting to meeting, carrying a half-empty suitcase and staying with mathematicians wherever he went. His colleagues took care of him, lending him money, feeding him, buying him clothes and even doing his taxes. In return, he showered them with ideas and challenges — with problems to be solved and brilliant ways of attacking them.

Laszlo Babai of the University of Chicago, in a tribute written to celebrate Mr. Erdos' 80th birthday, said that Mr. Erdos' friends "care for him fondly, repaying in small ways for the light he brings into their homes and offices."

Mathematicians like to brag about their connections to Mr. Erdos by citing their "Erdos number." A person's Erdos number was 1 if he or she had published a paper with Mr. Erdos. It was 2 if he or she had published with someone who had published with Mr. Erdos, and so on.

At last count, Mr. Erdos had 458 collaborators. An additional 4,500 mathematicians had an Erdos number of 2. A friend said so many mathematicians were still at work on problems they had begun with Mr. Erdos that 50 to 100 other papers with Mr. Erdos' name on them were expected to be published after his death.

Born in Hungary in 1913, he discovered negative numbers for himself at age 3 when he subtracted 250 degrees from 100 degrees and came up with 150 degrees below zero. A few years later, he amused himself by solving problems he had invented, like how long would it take for a train to travel to the sun.

When Mr. Erdos was 20, he made his mark as a mathematician, discovering an elegant proof for a famous theorem in number theory. The theorem, Chebyshev's Theorem, says that for each number greater than one, there is always at least one prime number between it and its double.

A prime number is one that has no divisors other than itself and 1.

Mr. Erdos, like many mathematicians, believed that mathematical truths are discovered, not invented.

And he had an evocative way of conveying that notion. He spoke of a Great Book in the sky, maintained by God, that contained the most elegant proofs of every mathematical problem.

László Lovász

A Discrete Mathematician: László Lovász (1948)

In 1979 the General Assembly of the Hungarian Academy of Sciences elected as corresponding member a young man of thirty-one years. The citation read: "In the last 10 to 15 years — largely due to the demands of everyday life — combinatorics, of which he is one of the leading experts, has undergone a spectacular development. New and efficient methods have been developed and László Lovász is one of the very few who developed several such methods."

It is not very often that such praise is given to a young man. But who is this man who reached world fame by studying finite sets, i.e., discrete mathematics?

László Lovász was born on March 9, 1948 in Budapest. He inherited a cheerful and balanced nature, modesty, helpfulness, and a problem-solving attitude. He studied in the best high school of Hungary, the Mihály Fazekas high school. In his special mathematics class there were several other very talented students: Baranyai, Berkes, Laczkovich, Major, Pelikán, Pósa, and so on. They shared a common passion: mathematics. Their talent has continously been challenged by the various mathematical competitions, the problem solving competition of the *Középiskolai Matematikai Lapok*, and for the best, by the International Mathematical Olympics. Due to the influence of Tibor Gallai and Pál Erdős, he chose mathematics for his career.

During his high school years he won the Dániel Arany Mathematics Competition, was second in the problem solving competition of Középiskolai Matematikai Lapok; he won a silver medal at the International Mathematical Olympics in 1963, and he won a gold medal in three consecutive years starting in 1964.

During his university years he published twenty scientific papers in scholarly journals on graph theory, universal algebra topology, number theory, and geometry. As a freshman, he won the Schweitzer mathematics competition and later was awarded the Géza Grünwald and Kató Rényi Prize for his results. While still a student, he also gave lectures at international mathematical meetings.

He graduated from the Eötvös University in 1971 and was offered a position at the Department of Geometry. In 1975 he was offered the chair of geometry at the Attila József University in Szeged, and was promoted to full professor in 1977. Two years later he became a member of the Academy of Sciences. His results were then summarized as follows:

> *As a high school student he solved one of Tarski's problems in universal algebra. This work initiated a series of studies which are still going on. His early investigations of the generalized factors of graphs led to new results in a classical chapter of graph theory. It was he who elaborated the theory of hypergraphs, his results made possible the use of methods of linear programming and led to the proof of the perfect graph conjecture. He introduced a novel application of probabilistic methods which improved a number of old estimates. He introduced the concept of geometrical hypergraph, which facilitated the full elaboration of the theory of a-critical graphs and the determination of the Shannon-capacity of the pentagon. This result is famous in itself because of its profound implications in information theory. He also obtained important results in the theory of algorithms, where he applied the methods of mathematical logic. In addition to this by no means complete list one has to add that Lovász not only applied the results of algebra, topology, geometry, and probability theory, but he established connections between them through combinatorics, and also discovered important relationships.*

His results were recognized by a series of prizes: Géza Grünwald Prize (1969), Mathematics Prize of the Hungarian Academy of Sciences (1977), Pólya-Prize (1979), Fulkerson Prize (1982), State Prize of Hungary (1985), and the Brouwer Memorial Medal (1993). He is a member of the editorial board of several leading international journals and editor-in-chief of the periodical Combinatorics.

The highly accomplished career of László Lovász confirms Alfréd Rényi's recipe of the secret of successful research: "Lucky ideas spring only from the medium of persistent and tireless work. In mathematics — contrary to the everyday experience in other fields — luck prefers those who deserve it."

Lovász was elected full member of the Academy of Sciences in 1985, from 1983 to 1995 he served as head of the Computer Science Department of Eötvös University in Budapest. In 1987 he was offered a professorship at Princeton University, he is today professor of mathematics at Yale University.

Miklós Laczkovich with Ákos Császár at the Eötvös University in Budapest.

The Man Who "Squared the Circle": Miklós Laczkovich (1948)

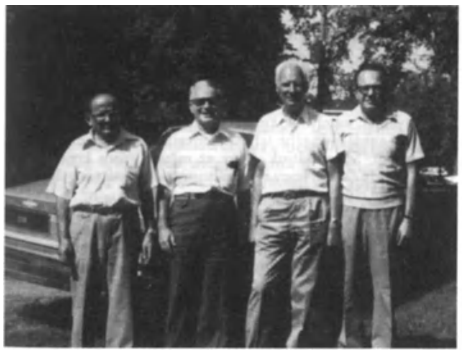
There is no Nobel Prize in mathematics. There are instead international mathematics prizes that recognize outstanding contributions, such as the Field Medal (for researchers under the age of forty), the Wolf Prize (for scientists and artists), and the Ostrowski Prize. This prize, named after the world-famous Swiss mathematician, recognizes the best mathematical results obtained in the last two years. In 1983, the international board awarded the Ostrowski Prize to Maria Ratner and Miklós Laczkovich. Miklós Laczkovich is professor of mathematics of the Eötvös University and corresponding member of the Hungarian Academy of Sciences. His citation at his election said:

His most important result, met with excitement by the international mathematics community, was achieved in 1989 when he solved Tarski's famous problem of "squaring the circle." This result states that a circle and a square of equal area are equidecomposable, i.e., can be dissected into a finite number of parts that are congruent by pairs and can be rearranged to form the other object. Aside from the classical nature of the problem and the beauty of the solution, the deep and versatile methods applied make the proof the pearl of mathematical literature of the end of our century, which also opens up important new directions for research.

As mentioned earlier, János Bolyai's brilliant work on absolute geometry was published as an appendix to a book by his father, Farkas Bolyai's *Tentamen*. The roots of the problem that made the name Miklós Laczkovich known all around the world are also anchored in *Tentamen*. Professor Laczkovich himself describes his result in the following way:

In the 1830s Farkas Bolyai proved that any two polygons of equal area can be dissected in such a way that one polygon is cut up into triangles that can be rearranged to reproduce the dissection of the other polygon. I actually proved the generalization of this classical theorem. I was able to show that with minor restrictions any two geometrical forms can be dissected into a finite number of parts which are congruent pair-wise. The original problem was posed in 1925 by the Polish mathematician Tarski. He formulated the problem in terms of a circle and a square: is it possible to dissect a circle into a finite number of parts so that they can be rearranged to a square of equal area? Of course my result has nothing to do with the old problem of "squaring the circle," that was proved to be unsolvable a long time ago. The proof of the existence of such a dissection is very difficult because the dissection cannot be given in terms of usual geometric forms. The circle has to be dissected into parts that are in some sense pathological, since they are not cut by curves. The given plane form is regarded as an abstract set of points. This set is then split up into a finite number of disjointed subsets which are regarded as geometrical objects. Thus the basic problem at the same time is of geometrical and set theoretical nature, while the roots are, in fact, in measurement theory.

The success did not make Miklós Laczkovich a different person. He is just the same modest and dedicated researcher, and teacher. He thinks that the various forms of recognition, prizes, and titles just increase the burden on the scientist because they only raise expectations. In order to be successful in the future one has to forget past honors as if they did not exist at all.



János Aczél, László Fuchs, Ákos Császár, and János Horváth in Canada

Szeged, 1928: Frigyes Riesz, Béla Kerékjárto, Alfréd Haar, Dénes Kőnig, Rudolf Ortvay (back); József Kürschák, G.D. Birkhoff, O.D. Kellogg, Lipót Fejér (middle); Tibor Radó, István Lipka, László Kalmár, Pál Szász

Hogyan lettem matematikus és világvándor és néhány közérthető ~~kedvenc~~ kedvenc problémámról és eredményemről

Erdős Pál

1913 március 26-án születtem szüleim matematika tanárok voltak az egyetemen ismerkedtek meg. Születésemkor szüleim szörnyű csapás érte. Két testvérem volt, 3 és 5 évesek, és mialatt anyuka a kórházban volt születésem ~~alatt~~ közben, 24 óra alatt ~~két~~ mindkét nővérem hirtelen skarlátban meghaltak, akkor még persze nem volt szulfa s penicillin nem volt, Anyuka később sokszor említette, hogy szerencse, hogy tanítania kellett és így kénytelen volt összeszednie magát, de sohase tudta e szörnyű csapást elfelejteni.

1914 aug elején édesapámat behívták katonának. Az orosz frontra vitték és hamarosan ~~elf~~ hadifogoly lett, még 1914 augusztusában, 6 évet töltött ~~az~~ Szibériában. Mint tisztnek nem volt túl sok dolga és a ~~hadi~~ hadifogságban jól ~~megtanult~~ megtanult angolul és franciául. Anyuka tanított és én sokszor ~~voltam~~ voltam egyedül a német [illegible] kisasszonnyal, így már három éves koromban megtanultam

Pál Erdös died unexpectedly on September 20, 1996, shortly after contributing this hand-written text for *Beyond Art.*

4

Pál Erdős

How I Became a Mathematician and World Wanderer and Some Remarks on My Generally Intellegible Favorite Problems and Results

I was born on March 26, 1913. My parents were both mathematicians who had met at university. At the time of my birth my parents suffered a terrible blow. I had two sisters, three and five years old. While my mother was in hospital for my delivery, both of my sisters died within twenty-four hours from septic scarlet fever. At that time, of course, there were neither sulfa drugs nor penicillin available. Mother later often said how lucky she considered herself, because she had to teach and was thus compelled to pull herself together, but she was never able to forget this terrible tragedy.

On the first of August 1914, my father was called up to serve in the armed forces. He was brought to the Russian front, and in the same month he was taken prisoner of war. He spent six years in Siberia. As he was an officer, he was treated quite well, and as a P.O.W. he learned to speak English and French fluently. Mother taught, and I was often alone with the Austrian governess, and so, already at the age of three, I learned to speak German; my parents also spoke German quite well. My mother was born in Vágbeszterce (now in Slovakian territory, Povazska Bystrica), and her mother tongues were Slovak and German, but she spoke Hungarian perfectly. My father was born in Hódmezővásárhely. Already at the age of three or four, I was able to count. I wanted to know when vacations would come and when my mother would not have to go to school. I played quite a lot with the calendar, and quite soon I was able to do mental arithmetic. My greatest discovery was at the age of four, when I informed my mother that if we subtract 250 from 100, we get 150 below 0, after which she of course told me that there are negative numbers. I did not go to elementary school; I studied with my mother, and when I took the exams for the first grade of elementary school, they immediately gave me the exams for the second year as well, and in this way I gained a year. In 1920, my father returned home from Vladivostok on a French ship, and soon after we began to study English. When I was 10, my father stated for me the proof that there are an infinitely large number of prime numbers, and that between the prime numbers there are erratically large gaps, and thus, my friendship with the prime numbers began early. I learned a great deal of mathematics from my parents, principally the higher mathematics of elementary school from my father. At the age of ten, I was still a Hungarian nationalist, but my father argued with me quite a lot, and by the age of 12, I had already become an internationalist. Unfortunately, Hungary was partially (half) Fascist and anti-Semitic, and I knew that if it were possible, I should go to Western Europe. I became occupied with serious mathematics quite early, but I was not such a sensational child prodigy, as my later students, Pósa and Lovász.

I would like to tell one more early story, which would perhaps explain my independence. At the end of 1919 and in 1920, it could often be seen that Jews were beaten in the street (primarily if they also were suspected of being Communists). Mother once asked, shouldn't we convert to Christianity? I answered, "You can do what you like, but I shall remain what I was born." That I was a Jew in fact did not mean a thing to me, but instinctively I did not like to be dictated by external influences. Maybe this would explain my later expression: "Neither Samu, nor József, may dictate when and where I can travel." (Samu = Uncle Sam = USA, Jószef = Stalin = Soviet Union). Perhaps this is enough about me; more details can be found in the articles of Babai and Bollobás, in a volume written as a memoire to me, on the occasion of my eightieth birthday.

Now I turn to mathematics. First of all, I would like to speak about the prime numbers. In my first article, I made a new proof for Chebyshev's theorem, according to which, for every n, there is a prime number between n and 2n. Designating p_n as the nth prime number, by the end of 1933, I established that for an infinitely large number of n:

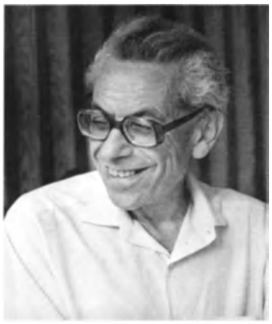
$$(1)\quad P_{n+1} - P_n > \frac{c \log n \operatorname{loglog} n}{(\operatorname{logloglog} n)^2}$$

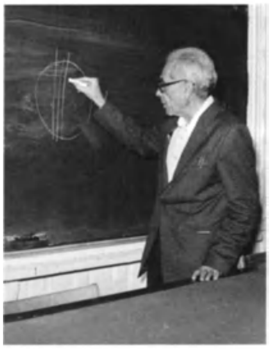
In 1938, Rankin sharpened this theorem somewhat. He added an additional loglogloglog n-factor to the numerator. Until now, no one has corrected this in essence. In short, no one has proven conclusively that there are so many f(n) which, together with n, holds to infinity, and for which, for an infinitely large number of n:

$$(2)\quad P_{n+1} - P_n > \log n \cdot \operatorname{loglog} n \cdot \operatorname{loglogloglog} n \cdot \frac{f(n)}{(\operatorname{logloglog} n)^2}$$

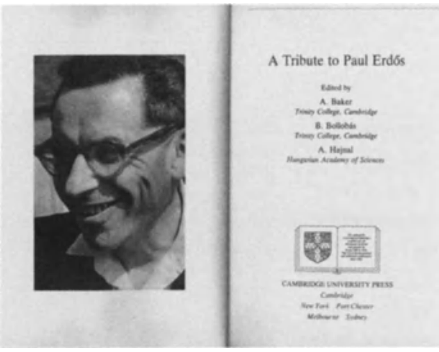
For the proof of (2), I would give at least 3000 dollars. Without a doubt, the maximum of $P_{n+1} - P_n$ will truly be on the order of magnitude of approximately $(\log n)^2$, but this question may be indeterminable for many thousands of years.

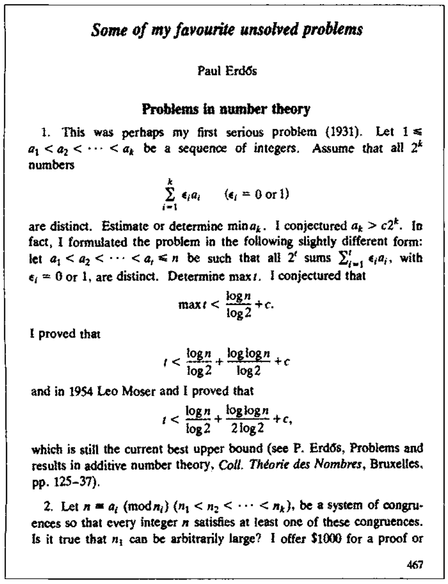
Pál Erdős, born 1913 in Budapest. Diploma at the University of Budapest, 1934. he Lived in Manchester, 1934-38; then, until 1954, in the U.S.A., since 1954 in England, Canada, Australia and the U.S.A. His fields of research included the number theory, the combination theory, the set theory, the theory of probabilities, topology, the theory of complex and real curves, the theory of approximation and interpolation, polynomials, orthogonal polynomials, the Fourier analysis. Publisher of *Periodica Mathematica*. Died in 1996.





Pál Erdős





Some of my favourite unsolved problems

Paul Erdős

Problems in number theory

1. This was perhaps my first serious problem (1931). Let $1 \leqslant a_1 < a_2 < \cdots < a_k$ be a sequence of integers. Assume that all 2^k numbers

$$\sum_{i=1}^{k} \epsilon_i a_i \qquad (\epsilon_i = 0 \text{ or } 1)$$

are distinct. Estimate or determine $\min a_k$. I conjectured $a_k > c2^k$. In fact, I formulated the problem in the following slightly different form: let $a_1 < a_2 < \cdots < a_t \leqslant n$ be such that all 2^t sums $\sum_{i=1}^{t} \epsilon_i a_i$, with $\epsilon_i = 0$ or 1, are distinct. Determine $\max t$. I conjectured that

$$\max t < \frac{\log n}{\log 2} + c.$$

I proved that

$$t < \frac{\log n}{\log 2} + \frac{\log \log n}{\log 2} + c$$

and in 1954 Leo Moser and I proved that

$$t < \frac{\log n}{\log 2} + \frac{\log \log n}{2 \log 2} + c,$$

which is still the current best upper bound (see P. Erdős, Problems and results in additive number theory, *Coll. Théorie des Nombres*, Bruxelles, pp. 125–37).

2. Let $n \equiv a_i \pmod{n_i}$ $(n_1 < n_2 < \cdots < n_k)$, be a system of congruences so that every integer n satisfies at least one of these congruences. Is it true that n_1 can be arbitrarily large? I offer $1000 for a proof or

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in: A. Baker, B. Bollobás, A. Hajnal (eds.), *A Tribute to Paul Erdős*, Cambridge University Press (Cambridge/New York/Melbourne 1990): 467.

Number theory is full of problems that are extraordinarily simple and seem to be nearly unsolvable. At the Cambridge International Conference in 1912, Edmund Landau stated four problems which, "subject to the current position of science, are inaccessible (beyond our grasp)." These problems are still unsolvable:

1. Every even number is equivalent to the sum of two prime numbers
2. There is an infinitely large number of twin prime numbers, i.e., an infinitely large number of prime numbers p_n, for which p_{n+2} is also a prime number
3. Between two square numbers there is always a prime number
4. There is an infinitely large number of $n^2 + 1$ formed prime numbers.

We already know that every sufficiently large number is the sum of three prime numbers and if n is large enough, there is below n^3 and $(n+1)^3$ a prime number.

I also would like to mention my first serious problem from 1931. I promised 500 dollars for the answer. Let $1 \leq a_1 < a_2 < \ldots < a_k \leq n$ and all its subtotals be different, for example, for the powers of 2, this property holds true. Is it true that:

$$\max k < \frac{\log n}{\log 2} + c$$

where c is a constant not dependent on n, perhaps k, not more than k + 2, if $n = 2^k$.

I have a great many additional results in number theory; perhaps some of the most significant results were from my collaborative work with Marc Kac, which gave the impetus for the application of the theory of probability in number theory, and which I hope will outlive the authors by centuries. Our work commenced in March 1935, and we would not have been able to do it alone, namely because I was not knowledgeable enough in the calculus of probability, and Kac did not know number theory well enough. It was a good example of the benefit of collaborative work. Due to the brevity of this article, I do not mention my articles in collaboration with Turán on interpolation and statistical group theory, with Hajnal et al. on our results in set theory, and with Sárközy and Szemerédi on our results in number theory. I also omit my numerous articles in collaboration with Vera T. Sós (the wife and colleague of Pál Turán) on number theory and graph theory. I would only like to mention one other theorem of number theory and geometry. Selfridge and I proved conclusively that the product of two numbers following one after the other can never be equivalent to any number raised to any power. In 1932, Eszter Klein (later the wife of Szekeres) asked: let f(n) be the smallest such number, so that if we give theoretically however many f(n) points, among which there are not any three in a straight line, then among them we can always select n number, so that they will determine a convex n-angle. f(4) = 5 was her observation; f(5) = 9 was the result of Makai (Sr.) and Turán. Szekeres and I proved that:

$$2^{n-2} < f(n) < \binom{2n-4}{n-2}$$

In all probability, $f(n) = 2^{n-2} + 1$, but already f(6) = 17 does not comply.

In all probability, I have written more articles than anyone else, as well as more collaborative articles with others, but in the old Hungarian Parliament, in which there were only noblemen, they declared that votes should not be counted, but rather, they must be weighed. In politics, this was not fair and democratic, but in science it certainly is.

Summer 1996

Pál Turán

Martin Neuwirther

Raoul Bott – The Unconventional Thinker

Raoul Bott

Raoul Bott was born in 1924 in Hungary. In his early years, he received a Master's degree in electrical engineering at McGill's, before studying mathematics at Carnegie Tech. For more than thirty years, Bott has been professor at the Department of Mathematics at Harvard University in Cambridge, Massachusetts. In 1990 he was awarded the Steel Career Prize for his life's work.

In the very beginning, Bott was well on his way to a career as an electrical engineer. But all of a sudden, "in the capricious ways of youth," as he himself said, the young man "from the Austro-Hungarian Empire," as his colleagues called him, changed to mathematics. In 1947 he came to Pittsburgh as a hitchhiker, with very uncertain prospects. But after a talk with the head of the new mathematics department, John L. Synge, he was allowed to begin his Ph.D. studies without any delay. At first he worked on an electrical networking problem, which he solved with mathematical tools. During this time, he found out how insecure and yet how well-protected his future was when the common support of the entire Carnegie Tech administration stopped the American Immigration Department from deporting him.

Afterward, Hermann Weyl invited him to Princeton, where a great number of the most influential mathematicians of that time were gathered: Ernst Specker, Kurt Reidemeister, Norman Steenrod, Armand Borel, Fritz Hirzebruch, Izz Singer, Arnold Shapiro, J.-P. Serre, and Marston Morse. In this very creative environment, Bott quickly gained first-hand knowledge of the most recent developments in topology and analysis.

Two very specific qualities distinguish Bott as a mathematician: his ability to discover relatively simple and imaginative approaches to complex mathematical facts, and the brilliant application of his fine physicist's intuition. Most of Bott's works are founded upon some basic idea, which he then varies and applies to a specific problem. The most prominent example of this is the so-called Bott periodicity — the idea that, after some iterations in certain algebraic constructions, the ground model re-emerges. Bott has applied a more formal version of this in many contexts, with great success!

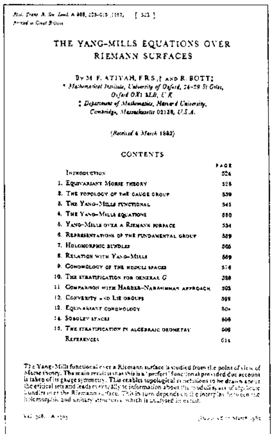
Bott has worked on a considerable number of diverse subjects. Nevertheless, most of his works are concerned with geometry in a broader sense. He was one of the first to realize that in complicated geometric structures, pictorial representation may sometimes be replaced by algebra. Of eminent importance were his publications in obstruction theory. This theory supplies tools that allow verification of the fact that some geometric absurdities can never happen. It is a wide generalization of a principle first stated by Marston Morse, which says that the topology of an object (e.g., the number of its holes) is computable by evaluating certain functions of the object.

Another very influential part of his work is the application of topological methods to mathematical physics, carried out in cooperation with Sir Michael Atiyah. This collaboration turned out to be a real revolution in mathematical physics. A landmark in this direction was their proof of the index theorem for elliptical differential operators, which states a very deep and subtle connection between analysis (such as the kind used in physics) and topology. In some sense, mathematical physicists had to wait for Bott and Atiyah to come along and provide them with a rigorous tool applicable to many aspects of modern physics.

In recent years, Bott has given many lectures around the globe, in which he has explained modern mathematical developments to a broader audience. His cooperation with E. Witten, in which they tried to solve substantial problems of mathematical physics, is of an almost visionary character.

Bott achieved many of his results in working with some of the most prominent mathematicians or mathematical physicists, such as M. Atiyah, C. Taubes, R. Seeley, H. Samelson, E. Witten, J. Milnor, J. Stasheff, G. Segal, and many more. Entire schools of mathematicians and physicists were stimulated to further research by their works.

His collected works so far were published in a compendium of four volumes in 1993.



THE YANG–MILLS EQUATIONS OVER RIEMANN SURFACES

BY M. F. ATIYAH, F.R.S.,† AND R. BOTT‡

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CONTENTS

The Yang–Mills functional over a Riemann surface is studied from the point of view of Morse theory. The main result is that this is a 'perfect' functional provided due account is taken of its gauge symmetry. This enables topological conclusions to be drawn about the critical sets and leads eventually to information about the moduli space of algebraic bundles over the Riemann surface. This in turn depends on the interplay between the holomorphic and unitary structures, which is analysed in detail.

In collaboration with M.F. Atiyah, 1982

Wilhelm Frank

Modern Logic and Mathematics in and from Vienna – A Personal View

In Vienna, mathematics attained an especially high level during the period between the end of World War I and the second half of the 1930s. External circumstances — characterized by an abiding, difficult economic situation for many people, strong social and ideological tension, and the increasing harshness of political controversies — provided poor conditions for the development of mathematics. Therefore, the attempt to discover why this discipline flowered despite the difficulties might also provide new insights, which might possibly be as relevant for current developments as they were at the time.

I have mainly used the following three sources, which are not expressly quoted: first, Rudolf Einhorn's dissertation, *Vertreter der Mathematik und Geometrie an den Wiener Hochschulen 1900 -1940* (Protagonists of mathematics and physics at Viennese universities, 1900 - 1940), published in 1985;[1] second, the 1920 to 1938 volumes of the *Monatshefte für Mathematik und Physik* (Monthly magazine for mathematics and physics). This journal was founded in 1890 by Viennese professors Emil Weyr and Gustav von Escherich. Still in existence today as *Monatshefte für Mathematik*, the journal was meant to help young Austrian mathematicians, who often had difficulties in publishing their work in German journals. My third source consisted of issues one to eight of *Ergebnisse eines Mathematischen Kolloquiums* (Results of a mathematical colloquy), published from 1929 to 1936 by Karl Menger.[2]

The high level of Viennese mathematics during this era was mainly due to the influence of the three full professors then teaching at the university, all three of them excellent scientists and strong personalities.

Inhaltsverzeichnis.

Monatshefte für Mathematik und Physik
H. Hahn and W. Wirtinger, eds., vol. XXXI (Vienna, 1921)

Wilhelm Wirtinger (1865 – 1945)

Wirtinger, the oldest of the three full professors, studied in Vienna with von Escherich, but when he was in Göttingen, Wirtinger was also very much influenced by Felix Klein, who inspired him to study the theory of analytic functions. The so-called Wirtinger calculus — for partially differentiating a function of one complex variable with respect to the variable and to its conjugates — is very useful for different applications, and Wirtinger used and refined it extensively.[3] It is still known under this name in current textbooks on the subject. In addition to his main subject, the theory of complex functions, Wirtinger also worked on geometric problems. His lectures and seminars were advanced and therefore he had fewer students then his colleagues. But nearly everyone who contributed to research in mathematical analysis and studied in Vienna during 1903 (the year of Wirtinger's appointment) to 1935 (the year he retired) wrote his (or her) thesis under Wirtinger.[4]

1. Rudolf Eichhorn, *Vertreter der Mathematik und Geometrie an den Wiener Hochschulen 1900-1940*, vols. I and II (Vienna: Verlag der wissenschaftlichen Gesellschaften Österreichs, 1985).
2. Karl Menger, ed., *Ergebnisse eines Mathematischen Kolloquiums, no. 1* (1928-1933), *no.6* (1933-1934), *no. 7* (1934-1935), *no. 8* (1935-1936) (Vienna/Leipzig: F. Deuticke, 1934, 1935, 1936-37).
3. Reinhold Remmert, *Funktionentheorie I, vol. 5,* Grundwissen Mathematik (Berlin: Springer, 1984) p. 50.
4. See the list of his most important pupils at the end of this article.

Philipp Furtwängler (1869 – 1940)

Furtwängler, a distant cousin of the conductor Wilhelm Furtwängler, succeeded Franz Mertens in 1912 as a full professor; due to illness, he retired in 1938. Furtwängler studied in Göttingen, where he was particularly impressed by the lectures of Felix Klein, which inspired his thesis. His professional career, however, started in Potsdam at the geodetic institute, where his main occupation was the measurement of absolute masses. The results of these investigations were published in 1906, in a 390-page work jointly written with F. Kühnen. Even before that, he had written a chapter called "Mechanik der einfachsten physikalischen Apparate und Versuchsanordnungen" (Mechanics of simple physical apparatuses and experimental arrangements) for the *Enzyklopädie der mathematischen Wissenschaften* (Encyclopedia of mathematical sciences). Later, he became a professor for mathematics at the College of Agriculture in Bonn-Popelsdorf (were he gave lectures on geodesy), and — as an outcome of this position — he also contributed the chapter on cartography to the encyclopedia (in collaboration with R. Bourgeois). Yet Furtwängler's main interest was still number theory. As early as 1902, following a recommendation by David Hilbert, the Göttingen Scientific Society had awarded him the full (first) prize by for his solution of a question on the law of reciprocity in algebraic number fields. With his further œuvre of about forty papers, he made major contributions to the theory of numbers. In 1931-32, his pupil, Olga Taussky (Taussky-Todd)[5] was asked to work on the edition of Hilbert's *Collected Papers on Number Theory*, a task which she completed to Hilbert's full satisfaction. In his afterword for this volume, Helmut Hasse appreciatively acknowledges Furtwängler for continuing Hilbert's work.[6]

Furtwängler was an excellent speaker and his lectures were overcrowded. Though he was increasingly handicapped by paralysis from 1916 onward, he conscientiously fulfilled his duties as a teacher. He supervised sixty dissertations; among his students were Olga Taussky (as already mentioned), Nikolaus Hofreiter, Wolfgang Gröbner, and Edmund Hlawka.

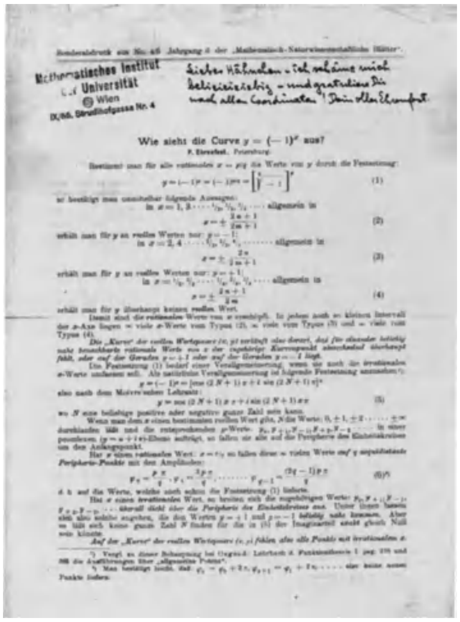
Hans Hahn (1879 – 1934)

Hahn received his Ph.D. in 1922; his dissertation was titled *Zur Theorie der zweiten Variation einfacher Integrale* (On the theory of the second variation of simple integrals), and it was written under the supervision of Gustav von Escherich. Hahn's thesis inspired Constantin Carathéodory to write his famous thesis under Hermann Minkowski in Göttingen. In his autobiography,[7] which he submitted to the Viennese Academy of Sciences, Carathéodory wrote:

> *In autumn 1903, Gustav Herglotz and Hans Hahn came to Göttingen, later followed by Heinrich Tietze. Before Christmas, Hahn gave a lecture at the Mathematical Society on Escherich's theory of the second variation of Lagrange's problem. We all were very much surprised by the fact that — according to this theory — there are some exceptional cases where the problem of variation has no solution. I tried to construct a simple geometrical example featuring this property, and a few days later I found the following...*

5. For more on Olga Taussky-Todd, see the essay by Christa Binder in this publication.
6. David Hilbert, *Gesammelte Abhandlung Band I, Zahlentheorie*, 2. ed., (Berlin: Springer, 1970) pp. 258-535. cf. D. Hilbert, *Theory of Algebraic Number Fields* (Berlin: Springer, 1998).
7. Constantin Carathéodory, *Gesammelte Mathematische Schriften, vol. V* (Munich: C.H. Beck, 1957) p. 405; *vol. IV*, 1956, pp. 302-396. cf. C. Carathéodory, *Conformal Representation* (Dover Publications, 1998).

Mathematical group portrait (with Hans Hahn and Paul Ehrenfest)



From the estate of Hans Hahn: Frigyes Riesz and Hermann Weyl, *Raum Zeit Materie, Vorlesungen über Allgemeine Relativitätstheorie (Berlin:* Julius Springer, 1918) p. 183, with handwritten notes from Hahn.


LES SYSTÈMES

D'ÉQUATIONS LINÉAIRES

A UNE INFINITÉ D'INCONNUES

PAR

FRÉDÉRIC RIESZ,

PARIS,

GAUTHIER-VILLARS, IMPRIMEUR-LIBRAIRE

1913


Über Variationsprobleme mit variablen Endpunkten.

Von

Hans Hahn in Czernowitz.

Teschen.

Hans Hahn and Heinrich Tietze

The example is of no consequence for us here; Carathéodory's passage above simply illustrates the close relationship between the young Austrian mathematicians (all three, Herglotz, Hahn, and Tietze were native Austrians and became famous representatives of their discipline) and what was then the mecca for mathematicians. Hahn heard lectures and seminars with Hilbert, Klein, and Minkowski in the winter term of 1903-04 in Göttingen. In 1905, back in Vienna, he completed his Habilitation with yet another paper on the theory of variations. Even before that, he and Ernst Zermelo had written the chapter on the "Weiterentwicklung der Variationsrechnung in den letzten Jahren" (Recent developments in the theory of variations) for the *Enzyklopädie der Mathematischen Wissenschaften*. Later, Hahn often turned his attention to topics in this field, aside from authoring important papers on set theory, topology, theory of series, Fourier integrals, and real functions. In 1909 Hahn became a professor in Czernowitz [once part of the Austro-Hungarian empire, now in Romania]. After being seriously wounded in war service, he moved to Bonn in 1916. In 1921 he succeeded his teacher, Gustav von Escherich, as a full professor in Vienna. Hahn's paper, "Über lineare Gleichungssysteme in linearen Räumen" (On linear systems of equations in linear spaces), written in 1927, contains a theorem later known as the "Hahn-Banach theorem," which is occasionally referred to as the main theorem in functional analysis — as it is, for example, in Harro Heuser's book on this subject,[8] a second edition of which has just been published. In particular, Heuser mentions that Banach expressly gave primary credit to Hahn for this theorem, but he also points out the important contributions of Eduard Helly, which Hahn acknowledged).

8. Harro Heuser, *Functional Analysis* (New York: Wiley and Sons, 1986)

Eduard Helly (1884 – 1943)*

Eduard Helly

Helly was born in Vienna on 1 June 1884. He studied in Vienna from 1902 to 1907 and in Göttingen from 1907 to 1908. In 1907 he wrote his thesis, *Beiträge zur Theorie der Fredholmschen Integralgleichung* (Contributions to the theory of Fredholm's integral equations), under the supervision of Wilhelm Wirtinger and Franz Mertens. In 1914 he enlisted in the army, was seriously wounded, and was taken to Siberia as a prisoner of war, where he remained until 1920. In 1921 Helly completed his Habilitation with a paper entitled "Über Systeme linearer Gleichungen mit unendlich vielen Unbekannten" (Systems of linear equations with infinitely many unknowns). As a lecturer, he gave "famously beautiful lectures." Helly was also the head mathematician at an insurance company. In 1938 when Helly was forbidden to work in Austria, he emigrated to the U.S.A. He died a just few years later, on 11 November 1943, in Chicago, where he was a professor at the Illinois Institute of Technology. Helly's mathematical interests concerned mostly elementary and descriptive geometry for one, and the analysis of infinitely many variables for another. His contributions to the theory of normed spaces deal with sequences of real or complex numbers. Hahn often provided the final formulation of his ideas. Alongside Minkowski, Hahn, and Banach, Helly is one of the leading figures in the theory of general spaces. His name can also be found in today's literature in connection with the Minkowski-Helly process or Helly's theorem of selection, which are mentioned, for example, in H. König's proof of a Tauberian theorem.

Witold Hurewicz (1904 – 1957)*

Hurewicz studied in Vienna and graduated in 1926. He spent the years 1928 and 1929 in Amsterdam as a Rockefeller Fellow. Beginning in 1936, he worked at the Institute of Advanced Study in North Carolina. Hurewicz is the founder of the theory of homotopy groups. He also contributed results to the theory of dimensions and to ergodic theory.

* The paragraphs on Helly and Hurewicz were inserted by the editor.

Karl Menger (1902 – 1985)


Karl Menger

Menger succeeded Kurt Reidemeister as an associate professor for geometry at the Mathematical Institute of the University of Vienna in 1927. For this appointment, combined efforts of the faculties were necessary (because of restrictions). Menger, the son of the famous founder of the Austrian school of national economy, was born in 1902. He finished secondary school in 1920, two years after his schoolmates, Richard Kuhn and Wolfgang Pauli (who both later became Nobel laureates). His studies were interrupted for three semesters because he fell ill with tuberculosis, but in spite of this interruption, he was still able to graduate fairly early, in 1924. His main interest right from the start of his studies was the question of how to define dimension and curves. In 1878 Georg Cantor showed (to his own surprise) that there is a bijection between the points in a square and a line segment. This shattered the naive concept of dimension as number of independent coordinates needed to describe the point of a domain. Cantor's example used a totally discontinuous function, but that did not help, since Giuseppe Peano gave an example of a continuous curve reaching every point of a square in 1889. This function was, however, not bijective. As late as 1913 (35 years after Cantor!), L.E.J. Brouwer in Amsterdam succeeded in proving that there exists a bijective and continuous function between the square and a line segment. But the question of how to define the dimension was still open (in spite of Brouwer's later opinion). In 1925, at nearly the same time and yet independent of each other, Menger and a Russian, Pavel Urysohn, provided a definition of the dimension of a domain using the terms "neighborhood of a point" and "boundary of the neighborhood," as well as the recursive process using these notions. They declared the domain n-dimensional if each of its points is contained in an arbitrarily small neighborhood with maximal (n-1) dimensional boundary. The dimension of the empty space is defined by -1. Thus the customary geometric notion is maintained, and curves can be defined in the same way. However, the Peano curve is not a curve according to this definition. The notion of dimension can also be regarded as part of measure theory, as Felix Hausdorff did even before Menger and Urysohn. But here it can happen that domains are assigned dimensions that are not whole numbers. Menger rejected this concept because of its lack of intuition (Anschauung).[9] Since Benoit Mandelbrot's1977 publications on fractals,[10] however, the idea of fractional dimensions has gained relevance. The *Großer Brockhaus*, vol. 14 (1991), lists Menger's special achievement as the construction of his so-called "sponge," which actually was Waclaw Sierpinski's idea. It is a domain between an area and a solid with a dimension of 2.7268, and it can be constructed in the same way as Cantor's procedure, by starting with a cube, partitioning each face into nine equal squares, removing the whole space under the four squares in the middle of the edges, and continuing on endlessly with all the leftover cubes. Menger's own results are important enough. He does not need a mistaken attribution. After finishing his studies in Vienna, Menger went to Amsterdam to study with Brouwer as a Rockefeller fellow. There he became an assistant and obtained the right to lecture. After his return to Vienna, he published a book, *Dimension Theory*, summarizing his main results.

In addition, here are some further remarks on mathematicians also working in Vienna during this time period:

Felix Frankl

Felix Frankl immigrated to the Soviet Union in 1929, where he first worked with Lev S. Pontrjagin on topology (a paper co-authored by them appeared in 1930 in the *Mathematische Annalen* / Mathematical annals). Later his interest shifted to those partial differential equations that are important for high-speed aerodynamics. These are mixed type differential equations, with a partly elliptic, partly hyperbolic domain of definition, representing the transition in aerodynamics between supersonic and ultrasonic. His results also found recognition in Western literature, and some types of problems have been known under his name since the late 1960s. The last paper by Frankl that I know of was written in 1951. Thus he survived the 1930s and 1940s in the Soviet Union, unlike some other scientists from foreign countries.

Abraham Wald

Wald died in 1950 in an airplane crash. We quote *Mathematics Today* (L.A. Steen, ed., Springer Verlag, 1978):

> *Despite his short career, he was a prolific contributor to statistical theory. In two cases, he created new subjects within statistics. One of these is sequential analysis, the other his general decision theory. Wald showed that the idea of seeking optimal methods for making decisions could be used to give a general framework for statistical problems, and he carried out a profound study of those procedures that are acceptable for use in a particular problem.*

In 1930 Wald wrote his thesis *On Hilbert's System of Axioms*. After that, he worked primarily on problems of axiomatics, topology, the theory of dimensions, analysis, and differential geometry. It was probably this broad

9. Karl Menger, *Dimensionstheorie* (Leipzig/Berlin: B.G. Teubner, 1928).
10. Benoit B. Mandelbrot, *Fractals, Form, Chance, and Dimension* (San Francisco: W.H. Freemann and Company, 1977).

interest in many fields of mathematics that later enabled him to make his widely recognized achievements in mathematical statistics. Wald was not able to obtain an academic position — his first name alone was enough to prevent that — so he worked for the Institute for Research on Economic Trends in Vienna. There is a paper from 1937 with the title "Extrapolation des gleitenden 12-Monatsmittels" (Extrapolation of the sliding 12-month mean value), which proves he was even then doing statistical research. In October 1937 he also gave a lecture in Geneva (at a meeting on probability theory; the president was Maurice Fréchet, and participants included Andrei Kolmogorov, George Pólya, William Feller, and Richard von Mises). The topic was his proof that Mises's concept of the "collective" is consistent. He was well prepared for successful work later in the United States.

Kurt Gödel (1906 – 1978)

Kurt Gödel and Olga Taussky-Todd in the 1930s

In 1949 Gödel wrote a paper for Einstein's seventieth birthday titled, "An Example of Cosmological Solutions of Einstein's Field Equations of Gravitation." In this paper, he disproved the so-called Mach principle, which explained that the proximity of masses caused the inertia of other masses. This paper was widely recognized, and it is also a product of Gödel's intensive study of differential geometry during his Vienna period. Gödel was a universal mathematician, and thanks to his participation in the lectures of the Vienna Circle, his interests were even broader. His famous theorems on the incompleteness of sufficient well-defined consistent calculations have a prehistory that is often ignored. It was Hahn who suggested to Gödel to first prove the completeness of the logical calculus of functionals. In the preface to this paper he wrote:

> *Whitehead and Russell built logic and mathematics in a way that places some evident theorems first as axioms, in order to deduce the theorems of logic and mathematics in a purely formal way, with exactly defined reasoning (without using the meaning of the symbols any further). Of course, in this type of process, the question that immediately arises is that of the completeness of the axioms and deduction principles used. Is it is really enough to deduce each logical and mathematical theorem, or might there be true theorems (which could be proved using other principles) which can not be derived from this system? The question has been positively answered for the field of logical expressions. P. Bernays, in his "Axiomatic Investigations of the Calculus of Expressions in the Principia Mathematica" (Math. Zeitschrift 15 [1926]) has shown that in fact each true expression can be deduced from the axioms of the Principia Mathematica.*

Gödel was able to show that each general formula of the calculus of predicates can be deduced from these axioms. His proof, however, provided no applicable construction process — and later, Alonzo Church was able to show that, in principle, such a construction is impossible. Herein lies the difference to the simple calculus of expressions. This was a step beyond the calculus of predicates, and, at the same time, proof of the evolutionary structure of mathematics, which forces its own development by posing its own internal problems. An understanding of the natural development of Gödel's work can only increase the admiration for his methodological work.

Here, I want to briefly introduce two more mathematicians working in Vienna at that time. Jean Diéudonné's fundamental nine-volume work, *Treatise on Analysis*,[11] is nowadays considered something of a catechism for scientific mathematicians. The last volume is devoted exclusively to topology and differential geometry. The theme is divided into fifty-three chapters; the third chapter is called "Mayer-Vietoris Sequences," and the following chapters make significant use of these sequences. It is only over the course of time that the great significance of this sequence has been realized — long after Walter Mayer first presented it in one of his works in 1929 and Leopold Vietoris generalized it in 1930.

Walter Mayer (1887 – 1948)

Mayer was born in 1887 in Graz. He wrote his dissertation on Fredholm's functional equations in 1912 in Vienna. He spent the years between 1914 and 1919 doing military service, and finished his Habilitation in 1916 with a paper on differential geometry. His 1930 book, *Riemannian Geometry* was the second volume of a monograph on differential geometry[12] (the first volume, *Curves and Areas in Euclidian Spaces*, was written by A. Duschek). Albert Einstein took notice of Mayer's book and, on the recommendation of Richard von Mises, hired him as an assistant. Einstein was very satisfied with Mayer's work, and he asked the University of Vienna to give him the title of professor and thus create a position suited to his abilities. Einstein's request was honored. When Einstein was invited to Princeton in 1932, he made it a condition that Mayer be allowed to accompany him. Mayer died in 1948 in Princeton, only 61 years old.

11. Jean Diéudonné, *Treatise on Analysis* (Academic Press, 1969).
12. Walter Mayer, *Riemannsche Geometrie* (Leipzig/Berlin ,1926); *Lehrbuch der Differentialgeometrie, vol. II* (B.G. Teubner, 1930).

Leopold Vietoris (1891 – 2002)

Vietoris, the highly regarded Nestor of Austrian mathematics, was born on 4 June 1891 in Radkersburg. After returning from Italy in 1919, where he had been a prisoner of war, he wrote his thesis on continuous sets in 1920 in Vienna, and he qualified as a lecturer as early as 1922. Vietoris was a full professor in Innsbruck from 1930 until his retirement. His main topic was topology, in which he achieved many results that gained worldwide recognition. But he also had many other interests, such as, for example, the integration of differential equations.[13]

Leopold Vietoris, 1930

It is not possible to discuss here the famous Viennese school of constructive and descriptive geometry in detail. Its unquestioned head was Emil Müller (1861 – 1927), whose three-volume book on *Descriptive Geometry*[14] was written between 1923 and 1931, in conjunction with his successors, Erwin Kruppa and Leopold Krames. There were many others who also contributed to Vienna's fame throughout the scientific world — like the maverick, Alfred Tauber.[15] As mentioned, we must restrict ourselves to the period between the two World Wars, so we have to refrain from giving more details on Herglotz and Tietze, mentioned above, as well as Austrians Wilhelm Blaschke or Paul Funk, or other mathematicians, such as Johann Radon, who studied in Vienna and began their scientific work there, but who only returned to their country of origin after World War II.

I hope that I have presented more than just a "salad of names," as Hilde Spiel would say. In addition to the natural authority and attraction of scientific personalities, other things, such as intense personal contact with each other to those in other fields or other parts of the world — with philosophy, the natural sciences, and the world centers of mathematics — were also needed to inspire young talents and shape what we now call the golden age of Viennese mathematics. Its end came rather quickly. Even before 1934, some mathematicians of the Vienna Circle, such as Carnap, were forced to leave Vienna. After February 1934, others were persecuted. The Ernst Mach Society was dissolved. When Hahn died in 1934, no successor was nominated, even though it was clear that Wirtinger and Furtwängler were slated to retire shortly thereafter.

In 1936 Moritz Schlick was murdered — an event that was applauded by fascistic clerical circles. This murder was the reason that Menger left for the United States in 1937, which meant the end of the *Mathematical Colloquy*, which he had guided with great success. Very soon, others such as Wald and Gödel had to follow. So this glorious period came to an end. Yet during this twilight, a new star began to twinkle on the horizon, and Austria, as well as others, has him to thank for the reanimation of mathematics in Austria today. As a young secondary student, Edmund Hlawka wrote his first paper in 1935 for the *Monatshefte*,[16] which was quickly followed by many others. Thanks to Hlawka, his colleagues, and pupils (to mention just a few names: Leopold Schmetterer, Wolfgang Gröbner, Hans Reiter, Johann Cigler, and, from the younger generation, Karl Sigmund, Harald Rindler, Bruno Buchberger, and Martin Goldstern as youngest), Austrian mathematics has a place in the mathematical world.

Some of the most important pupils of Gustav von Escherich (1849 – 1935) and Wilhelm Wirtinger (1865 – 1945)

Escherich	1887 Wilhelm Wirtinger (1865 - 1945)	Chairs at the Institute for Mathematics at the University of Vienna
	1888 Alfred Tauber (1866 - 1942)	
	1898 Josef Plemelj (1873 - 1967)	
	1902 Hans Hahn (1879 - 1934)	1. Escherich (1884 - 1920)
	1903 Heinrich Tietze (1880 - 1964)	Hahn (1920 - 1934)
	1919 Leopold Vietoris (1891 - 2002)	2. Mertens (1894 - 1911)
		Furtwängler (1911 - 1938)
Wirtinger	1907 Eduard Helly (1884 - 1943)	Huber (1939 - 1945)
	1908 Wilhelm Blaschke (1885 - 1962)	3. Gegenbauer (1893 - 1903)
	1919 Wilhelm Groß (1886 - 1918)	Wirtinger (1903 - 1935)
	1912 Walter Mayer (1887 - 1948)	Mayrhofer (1936 - 1945)
	1917 Hilda Geiringer (1893 - 1973)	Ass. prof. for Geometry: Kohn (1899 - 1921)
	1918 Gabor Szegö (1895 - 1985)	Menger (1925 - 1936)
	1923 Otto Schreier (1891 - 1929)	Wirtinger (1903 - 1935)
	1924 Karl Menger (1902 - 1985)	Mayrhofer (1936 - 1945)

Rudolf Haller and Friedrich Stadler, eds., *Wien-Berlin-Prag. Der Aufstieg der wissenschaftlichen Philosophie, Zentenarien Rudolf Carnap-Hans Reichenbach-Edgar Zilsel* (Vienna: hpt, 1993) pp. 619-633.

13. Leopold Vietoris died in 2002 in Innsbruck, shortly before his 111th birthday.
14. E. Müller, *Vorlesungen über darstellende Geometrie, vol. I*, E. Kruppa, ed. (Vienna: Verlag F. Deuticke, 1923); *vol. II*, L. Krames, ed. (1929).
15. S. D. Chatterji, "Tauber's Theorem – a Few Historical Remarks," *Jahrbuch: Überblicke Mathematik 1984* (Mannheim: Bibliographisches Institut) pp. 167-175; Christa Binder, "Alfred Tauber (1966-1942). Ein österreichischer Mathematiker," *Jahrbuch: Überblicke Mathematik, 1984* (Mannheim: Bibliographisches Institut) pp. 151-166.
16. Edmund Hlawka, "Eine asymptotische Formel der Laguerre'schen Polynome," Monatshefte für Mathematik und Physik, XLII (1935).

4

Christa Binder

Olga Taussky-Todd – a Mathematician from Austria Becomes Woman of the Year

Olga Taussky-Todd, 1939, by Clara P. Ewald

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Olga Taussky was born on 30 August 1906 in Olmütz, Bohemia. She had two sisters and their father was an industrial chemist. In 1909 the family moved to Vienna, and later to Linz, where she went to school. Even during her school days her main interest was mathematics, and she proved a polynomial theorem. Her father worked in a vinegar factory, and she calculated mixture proportions using Diophantine equations. As a young student in Vienna, she continued to work for the factory in Linz during the holidays.

She began her studies at the Mathematical Institute at the University of Vienna in 1925. Her main interest was number theory and especially algebraic number theory, which she studied under Philipp Furtwängler, but she also took courses from Wilhelm Wirtinger and other mathematicians. Toward the end of her studies she was also interested in philosophy and heard Moritz Schlick and some lectures given by members of the Vienna Circle. The title of her thesis was *Über eine Verschärfung des Hauptidealsatzes* (On a stronger version of the principle ideal theorem).

It was in 1932, after she finished her Ph.D., that she became aware of Hans Hahn and Karl Menger, and it was Hahn who got a position for her in Göttingen, editing the collected papers of David Hilbert. She was responsible for the sections on the theory of algebraic numbers, her special field. She did this work very carefully, correcting all the small errors Hilbert made. (For Hilbert she was too careful, since her meticulous work delayed the whole edition).

In 1933 she returned to Vienna and became Hahn's private assistant — meaning she got a very small salary from his so-called "popular lectures." She had no chance at a better position in Austria, so she applied for a fellowship at Girton College in Cambridge. In the meantime, though, O. Veblen, whom she had met in Göttingen, suggested she spend the year 1934-35 at Bryn Mawr. Emmy Noether was a Rockefeller Fellow at Bryn Mawr at the same time.

In 1935 she finally went to Girton, became a fellow, and was able to do research without the burden of any other obligations. She met some famous mathematicians, such as Hardy, Heilbronn, and Davenport — who also worked in number theory. But she found no interest for her special field, algebraic or topological number theory.

In 1937 the fellowship came to an end, and she was again forced to look for a position. The Girton College and Hardy helped her to find a teaching position at the London School of Economics. These were difficult years, with demanding teaching duties. But in spite of these obligations, she continued with her research and kept in contact with other colleges. She met and fell in love with John Todd, a mathematician from Scotland who worked in numerical analysis. They married in 1938.

During World War II, the couple met with hard times. They worked in Belfast at the Queens University and at the University of London. They were forced to change apartments eighteen times. They were also called upon to work for war projects, and Olga had to work with differential equations, a field she did not care for at first, but later came to like. Her main field became the determination of "eigenvalues" and "eigenfunctions" (see Olga Taussky-Todd and L.J. Paige, *Simultaneous Linear Equations and the Determination of Eigenvalues*, National Bureau of Standards, Appl. Math. Series 29, 1953).

In 1947 the couple moved to the United States of America, working first at the Bureau of Standards, Washington D.C., then at UCLA's Institute for Numerical Analysis in Los Angeles, and then with John von Neumann's group at the Institute for Advanced Studies in Princeton. From 1949 till 1957, they were again at the Bureau of Standards, this time in New York. In 1957 they found their final home at CALTEC (California Institute of Technology). Taussky-Todd worked in many different fields of mathematics. She published approximately 170 articles, always with relevant results. One must read her papers in order to truly appreciate the beauty of her formulas and relations. The abundance of her ideas is surprising. Her enthusiasm and love for mathematics can be felt in every word. She succeeded in showing this enthusiasm, not only in her research papers, but also in many introductory and expositional articles. In 1963 she was elected "Woman of the Year" in California.

Her greatest love was saved for the sums of squares; many papers deal with this topic. The American Mathematical Society honored her with the Ford Prize for her 1970 paper, "Sums of Squares."

She did not give up thinking about mathematical problems even after retirement, and continued to publish her work. She also kept in close contact with her colleagues and pupils, and her connection to Vienna was never broken off. In 1975 she was elected a corresponding member of the Austrian Academy of Sciences. Olga Taussky-Todd died on 7 October 1995.

Gilbert Helmberg and Karl Sigmund

*The Nestor of Mathematicians – Leopold Vietoris Turns 105**

His most recent publication, a short treatment of Euclidean geometry, is currently in print. Many of his more recent contributions have dealt with statistics. Leopold Vietoris, born on 4 June 1891, can study age distribution statistics from the fortunate perspective of an outsider. Nowadays he looks a bit frailer and sports a hearing aide, but aside from that, he is in great shape.

His surname can be traced back to an era when German intellectuals were fond of changing their names to Latin versions (such as Mercator or Regiomontanus). Leopold Vietoris's father was a railway engineer and expected his son to follow in his footsteps. Shortly after reading a book on geometry, young Leopold set his sights on becoming a mathematician. World War I broke out before he was able to finish his studies at the University of Vienna. He was one of the first to be drafted and, in 1915, he was severely injured. After his recovery, his regiment was put on the train to Bosnia. During the train ride, the orders changed and they were re-routed to South Tyrol, Austria, which borders Italy. While stationed in a snowed-in hamlet, he began to study topology and learned to ski — at a time when both skiing and science were enjoying an exciting youth.

Of course, the war caught up with him once again. He was made an officer while at the front and also served as a military mountain guide until the end of the war. After the fall of Austria, he was taken prisoner and detained in Italy until August 1919. He was treated so well in the Italian camp that he was able to finish his dissertation on *stetige Mengen* (sets of constants, or related sets). After returning to Austria, Vietoris was offered an assistantship at the university in Graz. In the beginning, he was an assistant to Weitzenböck (whose ideas had been undergoing a remarkable revival during the time). Afterward, Vietoris went on to Vienna. After completing his next paper, he was awarded the greatly desired position of lecturer at the university.

The Roaring Twenties were also a promising era for topologists, and Vienna was an outstanding place for this type of work, for contemporaries such as Hahn, Menger, Reidemeister, and, later, Hurewicz and Nöbeling were residents there. During this euphoric era, many thoughts were born both simultaneously and independent of one another, in different places. Vietoris, who was always an extremely modest person, never took part in debates in which theory was the most promising or important (in contrast to his young, hotheaded colleague, Karl Menger). Vietoris was the first to introduce filters — which he called *Kränze*, or circles — and he was also one of the forerunners in defining compact spaces, which he called unbroken (*lückenlos*, or complete, perfect) for the reason that every filter has an accumulation point. He also coined the term "regularity," and proved that (in modern terms) compact spaces are normal.

During his stay in Amsterdam with Brouwer (who was sponsored by a Rockefeller Foundation stipend, which he shared with Karl Menger), Vietoris became one of the founding fathers of algebraic topology. His

III AB 13. BEZIEHUNGEN ZWISCHEN DEN VERSCHIEDENEN ZWEIGEN DER TOPOLOGIE.

Von

H. TIETZE in München und L. VIETORIS in Wien.

Bei den Vorarbeiten für den Artikel hat Herr *Hellmuth Kneser*-Greifswald (damals in Göttingen) durch Berichte über ausländische Publikationen, die dem ersten Ref. nicht zugänglich waren, wertvolle Mitarbeit geleistet. Besonderes Interesse hat Herr *L. E. J. Brouwer* an dem Artikel genommen, vor allem an der Ausgestaltung der Abschnitte II und V über allgemeine Räume. Von ihm stammt die Anregung zur Mitarbeit des zweiten Ref. und er hat in vielen mündlichen Besprechungen mit diesem wichtige Teile des Artikels wesentlich gefördert. Zahlreiche wertvolle Bemerkungen erhielten wir außer von dem bereits genannten Herrn *H. Kneser* noch von den Herren *P. Alexandroff*, *S. Bochner*, *W. Hurewicz*, *B. v. Kerékjártó*, *K. Menger* und *A. Rosenthal*. Für alles sei auch an dieser Stelle besonders gedankt.

Wenn die Encyklopädie sich im allgemeinen zum Ziel setzte, den Stand der mathematischen Wissenschaften um das Ende des 19. Jahrhunderts darzustellen, so konnte diese Zeitgrenze nicht maßgeblich sein für das vorliegende Gebiet, wo erst in letzter Zeit eine gewisse Klärung der Begriffe sich durchsetzte. Im übrigen vgl. wegen der Gesichtspunkte, nach denen auf die Literatur eingegangen wurde, die Einleitung (Nr. 1).

Von den Nummern des Artikels stammen die erstmals 1923 gedruckten älteren Nummern 1—9, 11, 15, 19, 22—37 im wesentlichen von dem ersten, die später dazugekommenen Nr. 10, 12, 14, 17, 18, 21, 40—42 von dem zweiten Ref., soweit bei den wiederholten Besprechungen über den ganzen Artikel eine solche Aufteilung angebbar ist.

Inhaltsübersicht.

Encyklop. d. math. Wissensch. III 1, 2. 10

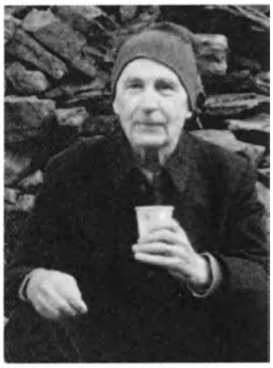
in: *Encyklopädie der Mathematischen Wissenschaften mit Einschluß ihrer Anwendungen*, 1929

* This text was written in 1996; in 2002 Leopold Vietoris died in Innsbruck, shortly before his 111th birthday.

Leopold Vietoris at the ceremony where he was awarded an honorary doctorate, 1994

contribution to this area is highly renowned. For example, sixty years later, Saunders MacLane wrote a paper called "Topology Becomes Algebraic with Vietoris and Noether." This work made use of the Vietoris-Brouwers technique of simplistic approximation in defining the concept of homologous groups within compact metrical spaces. The term "Vietoris homology" was later broadened to include general topological space as well. After Vietoris returned to Vienna, he held lectures on topology. Shortly thereafter he developed the Mayer-Vietoris sequence, which enables the homologous group of $X \cup Y$ to be expressed by those of X, Y and $X \cap Y$. (Walter Mayer, 1889-1953, was the owner of a small cafe; he later became Einstein's colleague and an assistant at Princeton.) Another fundament of topology is Vietoris and Begle's theorem, which links homologous groups of a compact metrical space to its visual space. Furthermore, Vietoris introduced the term co-cycle (at about the same time as Lefshetz, Alexander, and Pontrjagin). In 1931, along with Tietze (who had left Vienna in 1910), he published an encyclopedia entry on the relationship between the different branches in topology, which is still worth reading today.

At this point, another passion in Vietoris's life became decisive for his further career: the high Alps. He much preferred the absolute quiet of the mountains to the scholastic debates of the Vienna Circle and the heat of the Austrian capitol, which Karl Kraus once described as a "laboratory for the apocalypse." In 1927 he willingly accepted an appointment as assistant professor at the University of Innsbruck. In 1928 he returned to Vienna once more, to take a position as a chair at the Technical University (and to get married). When he was offered a teaching position in Innsbruck in 1930, once again, he did not hesitate for a second. The famous Tyrolian city, surrounded by a mountainous region, was the ideal place for him.



Leopold Vietoris, 1975

Among the faculty at Innsbruck, his passion for the mountains was quickly recognized, leading him to contacts at the local school of glaciology, which was run by the famous professor, Sebastian Finsterwalder. As a "glacier helper," he carried heavy instruments for geological measurements and set up equipment for experiments during a countless number of expeditions. Vietoris soon began to publish on the Blockstrom of the Hochebenkar glacier, which is a glacier-like formation of scree held together with ice. Through this intensive work, he became a one-of-a-kind specialist on this particular formation. He also wrote on how a mountaineer, unlike a seaman, should use a compass — Geometrie im Dienste des Bergsteigers (Geometry in the service of the mountaineer) — and on the physics of skiing. He also held patent number 199832 for a method of utilizing aerial photographs for cartography.

When World War II began, Vietoris was again called into the armed forces and wounded in Poland. On his fiftieth birthday he was granted leave to return to his teaching position at the University of Innsbruck.

From this point on, Vietoris rarely revisited topology. Instead, he started working on mechanical integration, the theory of probability, statistics, and real analysis (developing an induction of the sinus through a functional equation, which has since been incorporated in some textbooks). The majority of his developments in these topics took place during the five peaceful decades following the war. These were fruitful years, not only for the development of his scientific work and his increasing acknowledgement within academia, but also for the growth of his family. (He has six daughters, and a total of fifty-one descendents at present). He turned to geometry one more. Yet his first article on the subject, which was close to completion shortly before World War I, still remains his most influential. The mountains have never ceased to beckon him. He regularly won the gold medal in skiing at the University's annual competitions and kept entering the competition until he was the only registered competitor in his age group. Over a decade ago, his doctors advised him to stop skiing. Vietoris assured them that he would think about it.

The Mathematical Intelligence, vol. 18: 4 (New York: Springer, 1996) pp. 1-4.

Leopold Vietoris
Ski course in the Wienerwald with the Wanderfreunde (Hiking Club)

4

Peter Weibel

The Mathematical Community in Austria: Some Short Biographies

Wilhelm Blaschke (13 November 1885 – 17 March 1962)

Blaschke began his studies in his hometown of Graz, then continued in Vienna, where he graduated in 1908 with Wirtinger. Eleven *Wanderjahre* (years of travelling) followed, bringing him to Bonn (Habilitation, 1910), Greifswald (associate professor), Prague, Leipzig, Königsberg (1917, professor), and Tübingen. In 1919 he accepted a call to the newly founded University of Hamburg, and he stayed there until his retirement in 1953, despite many advantageous calls from other universities.

His bibliography contains 239 entries, including sixteen books. The most important among them are the three volumes titled *Differentialgeometrie* (Differential geometry). The first volume, which appeared in 1921, contained classical differential geometry and some of his own results. The second volume (written with Kurt Reidemeister) is an introduction to affine differential geometry, a new field introduced by Blaschke and his pupils. The third volume (written with Gerhardt Thomsen) contains differential geometry of circles and spheres. Many of his articles are on the theory of convex bodies, summarized in *Kreis und Kugel* (Circle and sphere). This book treats isoperimetric problems according to Steiner, Schwarz, and Minkowski.

Two further books, *Geometrie der Gewebe* (Geometry of texture — a term introduced by Blaschke) and *Integralgeometrie* contain topological problems of differential geometry. After his retirement in 1957, he published *Reden und Reisen eines Geometers* (Speeches and travels of a geometer), a collection of witty, ingenious speeches and tales of his travels.

Ernst Fischer (17 July 1875 – 14 November 1956)

Studies in Vienna; Ph.D. in 1899, Habilitation in 1904. Associate professor in Brünn (1910); professor in Erlangen (1911) and in Cologne (1920); worked on functional analysis (Riesz-Fischer theorem) and quadratic forms.

Olga Hahn (20 July 1882 – 20 July 1937)

One of my uncles (Rudolf Allers, philosopher and member of the Vienna Circle) introduced me to a remarkable woman, Olga Hahn-Neurath, who was the sister of Hans Hahn and the wife of Otto Neurath. Years ago, as a brilliant student of mathematics, she suffered from terrible headaches and slowly lost her sight. A brain tumor was conjectured, but the headaches vanished when her sight was gone. Blind, she lived on for many years, until she died as an immigrant in The Hague.

A group of young Viennese mathematicians 'adopted' her as a kind of aunt; they read to her and took her out walking. In return, she gave them mathematical problems to solve. We all were astonished by her ability to do complex calculations in her head. She didn't need help lighting her pipe, but to be sure that the match had really gone out, she always held her hand over it.

I was sixteen years old when I met her, and I learned a lot from her. I had invented a curious trick for calculating the focus of a parabolic mirror and was very proud of that; actually I had discovered the elements of differential calculus. She showed me how to approach these problems systematically; that was a whole year before we learned differential calculus in school. But thanks to the masterly way in which she guided my curiosity, it was much more interesting. She also taught me four-dimensional geometry, and I was captured by it; in two weeks I found all properties of all four-dimensional regular polytopes. For the most complex one, which contains 120 pentagon dodecahedrons, I needed several days of preliminary work and two hours of full concentration — the first headache in my life!

These months of continuous occupation with four-dimensional geometry proved to be an excellent preparation for the design of complex scientific apparatus. I will always remember Olga Neurath with love and gratitude.

Otto Robert Frisch, *Woran ich mich erinnere. Physik und Physiker meiner Zeit* (Stuttgart, 1981) pp. 29-30.

Georg Kreisel (15 September 1923)

Born in Graz. B.A., Cambridge University, England, 1944. M.A. 1947, and Sc.D, 1962, Cambridge University, England. Experimental Officer in the British Admirality, 1943-46. Research Fellow, University of Cambridge, 1946-48; Lecturer in Mathematics, University of Reading, England, 1949-54. Member of the Institute for Advanced Study, Princeton University, 1955-57; Visiting associate professor of mathematics, Stanford University, 1958-59. Professor of mathematics, University of Paris, since 1960;

Offprint from the "Archives for Systematic Philosophy" in collaboration with Wilhelm Dilthey, Benno Erdman and Paul Natorp, co-founded by Eduard Zeller, Ludwig Stein (eds.), 1909.

Visiting professor of mathematics, Stanford University, 1962-64; Research associate, Institute for Advanced Study, Princeton University, 1963-64. Professor of logic and foundations of mathematics, Stanford University, since 1964. Visiting professor in Los Angeles, Oxford, Munich, Graz, Vienna, Salzburg, etc. Fellow of the Royal Society of London, 1966.

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Franz Mertens (1840 – 1927)

Professor at the Institute for Mathematics at the University of Vienna from 1894 to 1912. His main interests were analytic number theory and algebra. He was famous for his ability to get profound results using simple elementary methods. At the turn of the century, Mertens was surely one of the main figures in analytic number theory. The so-called Mertens's conjecture on a sum of a series of Möbius functions was only disproved in 1983.

Richard Edler von Mises (19 April 1883 – 14 July 1953)

Richard Edler von Mises

Studied at the Technical University of Vienna until 1908, Habilitation in Brünn (1908), associate professor in Strasbourg (1909); professor in Dresden, (1919) and in Berlin (1920). Von Mises was the founder and director of the Institute of Applied Mathematics at the Friedrich Wilhelm University. In 1933 he went to Istanbul, where he had been appointed by the Turkish government to found an Institute for Pure and Applied Mathematics. In 1939 he followed a call to Harvard University, taking up a position as professor for aerodynamics and applied mathematics.

Von Mises worked in many different fields. During World War I, he constructed a 600 HP airplane bearing his name. He wrote important papers on nearly all parts of applied mathematics (mechanics, theory of elasticity, practical analysis, and statistics). One of his main interests was the theory of probability. He introduced the notion of the *regelloses Kollektiv* (literally, unregulated collective) as the basis for the probability of an event.

Von Mises recognized the inadequacy of the classical definition of probability and tried to find a new explanation, based on statistics. He explained the probability $\omega(E)$ of the event E in a series of trials by

$$\omega(E) = \lim_{n \to \infty} \frac{\mu(n)}{n}$$

where $\mu(n)$ is the number of times E occurs in *n* trials.

Despite the fact that he lived in Berlin, von Mises was close to the Vienna Circle, and he wrote the first book on logical positivism, *Kleines Lehrbuch des Positivismus* (A short textbook on positivism) in 1939. Furthermore, von Mises was an avid collector of the poet, Rainer Maria Rilke, whose works and life he researched with distinction.

Henry Otto Pollak (13 December 1927)

Born in Vienna. B.A., Yale University, 1947; M.A., Harvard University, 1948, Ph.D., Harvard University, 1951. Employed at Bell Laboratories since 1951 (mathematical communications and computer science research). Works on analysis, theory of analytic functions, theory of probability, etc.

Johann Radon (16 December 1887 – 25 May 1956)

Studied in Vienna until 1910; Habilitation, 1913. Professor in Greifswald (1922), Erlangen (1925), Breslau (1928), and Vienna (1947). Radon wrote papers on the theory of variation and functional analysis, and he made considerable contributions to the concept of measure, as well. His main interest in the theory of variation was the Lagrange problem. He succeeded in solving the problem, which had been left open for twenty-five years, despite the effort of many famous mathematicians. He also worked on the theory of differential geometry. However, his most renowned achievement was his 1913 Habilitation paper, published in the Reports of Proceedings of the Austrian Academy of Sciences. In it, he introduced a new integral.

The concept of integral calculation is something everyone learns — or should learn — in school, and the generalization of the concept seemed to be a matter of pure mathematics, without any possible applications. The title of the paper was *Theorie und Anwendung der absolut additiven Mengenfunktionen* (Theory and application of absolutely continuous set functions). But in the 1930s, a wonderful development began — one of the most beautiful things to have happened in the history of twentieth-century mathematics. The Radon integral turned out to be just the right concept for the theory of probability and mathematical statistics. His theory of relations (set valued functions) was the basis for computer tomography.

Radon was professor in Breslau for seventeen years until 1945, when he and his family were forced to flee under disgraceful circumstances. He found a new home in 1947 at the University of Vienna.

Alfred Tauber (5 November 1866 – 1942, Theresienstadt concentration camp)

Tauber studied mathematics and physics at the University of Vienna and graduated in 1889. His thesis was titled *Über einige Sätze der Gruppentheorie* (On some theorems in group theory). He finished his Habilitation in 1891. Tauber's field was analysis, mainly the theory of infinite series. It should suffice here to say that his research gave this field a new direction. An example of this claim: in 1932, a year before Tauber's retirement, Norbert Wiener, the famous American mathematician and inventor of cybernetics, published a paper, more than one hundred pages long, with the short title, *Tauberian Theorems*. Tauber must have been happy to see that his ideas had developed so nicely. He retired in 1933, having been awarded the Silver Cross of Honor by the Austrian Republic. However, he continued to lecture until 1938. No one can deny his merits in theoretical and applied sciences (he lectured on actuarian mathematics for nearly forty years, and he also contributed numerous and important ideas to this field) and his importance to the city of Vienna and to Austria. Nevertheless, he was forced to give up lecturing, was robbed of his apartment, and on 28 June 1942, he was transported to the Theresienstadt concentration camp, where he was murdered.

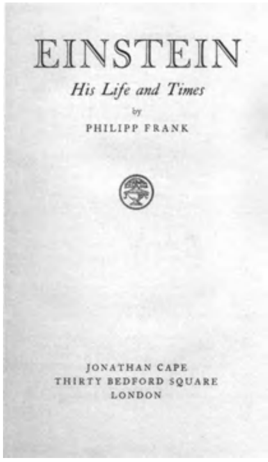
Abraham Wald (31 October 1902 – 13 December 1950)

Wald was born in Klausenburg (Transylvania) and died in an airplane crash in India. He studied from 1921 until 1931 at the universities of Klausenburg and Vienna and graduated in Vienna with a thesis titled, *Über Hilbertsche Axiomensysteme* (On Hilbert's axiomatic systems). After some years of practical work in a bank, he was forced to leave Vienna in 1938. In 1944 he became a professor at Columbia University in New York. His scientific work and his main contributions are in the theory of mathematical statistics. But in the first years of his career, he belonged to the Vienna topological school of Karl Menger. This is evident not only in his thesis, but also in his contributions to the *Ergebnisse eines mathematischen Kolloquiums* (Results of a mathematical colloquy), edited by Menger. However, he was also interested in the theory of probability. Wald proved the consistency of Mises's definition of the "collective," published as *Die Widerspruchsfreiheit des Kollektivbegriffs in der Wahrscheinlichkeitsrechnung* (The consistency of the notion of the 'collective' in the theory of probability). His book, *Sequential Analysis*, appeared in 1947. Sequential analysis — his main field after leaving Vienna — describes methods to check hypotheses and gives estimations of parameters. Normally the size of the sample is determined in advance, but in the new theory, it depends on current results. The criteria are adjusted depending on the observations. His numerous papers on the theory of probability and mathematical statistics appeared mostly in American journals. The themes include consistency of the notion of the collective, distribution functions, decision functions, indices of production, risk theory, game theory, and Bayes's solutions of problems of decisions. The best one can hope is the minimization of the maximal loss. That principle is known as the minimax principle. It was introduced to statistics by Wald and is said to be the only principle with comparative generality since the one published by Bayes in 1763. His last book, *Statistical Decision Functions*, appeared in August 1950.

Philipp Frank (20 March 1884 – 21 July 1966)

Philipp Frank was born in Vienna, as the oldest of four children (the famous architect, Josef Frank, was his brother); he died in 1966 in Cambridge, Massachusetts. Frank's interests were first focused on mathematics and theoretical physics, but in later years he turned to the philosophical foundations of the sciences. He studied in Vienna, where one of his teachers was Ludwig Boltzmann. He graduated in 1906 with a thesis titled *Über die Kriterien für die Stabilität der Bewegung eines materiellen Punktes und ihren Zusammenhang mit dem Prinzip der kleinsten Wirkung* (On criteria for the stability of the movement of a material point and its connection to the principle of lowest efficiency). As early as 1909 he qualified as a lecturer with his work, *Die Stellung des Relativitätsprinzips im System der Mechanik und Elektrodynamik* (The position of the principle of relativity in the system of mechanics and the dynamics of electricity). Under the influence of quantum mechanics, his interests also spread to Hilbert space and Fourier series.

Philipp Frank



He was appointed associate professor in 1912 at the German University of Prague (as successor to Albert Einstein, who had been an Austrian citizen for two years). From 1917 on, he was a professor for theoretical physics as well as director of the Institute for Theoretical Physics. He was one of Prague's eccentrics: his encyclopedic knowledge (only metaphysics was of little interest to him), his captivating style of speaking, and his lectures, which were full of stories and irony, were a main attraction. For more proof of this, please refer to Frank's book, *Einstein: His Life and Times*, first written in 1948, published in English in 2002. After reading it, one can say: now I know both Albert Einstein and Philipp Frank.

Frank and his lifelong friend, Richard von Mises, the master of applied mathematics, collaborated on a two-volume work, *Die Differential- und Integralgleichungen der Mathematik und Physik* (Differential and integral equations of mechanics and physics), which became a classic, having been reprinted many times over the course of forty years.

Frank was forced to leave Prague in 1938, when research and teaching at the oldest German university were seriously threatened. He lectured at Harvard University on thermodynamics and the theory of relativity, and he gave courses on scientific philosophy. It was evident that he had developed into a remarkable philosopher. This had begun in 1907 with his philosophical treatment of *Kausalgesetz und Erfahrungen* (Causality and experiences), which Einstein called "exaggerated," and Frank himself later called "sweeping and amazing." In 1932 Frank published *Kausalgesetz und seine Grenzen* (Causality and its limits) as part of a Viennese series on the scientific philosophy of life, and in 1935, he published *Das Ende der mechanistischen Physik* (The end of mechanistic physics) in volume five of the *Wiener Einheitswissenschaft* (Viennese unity of sciences). All of these works display the main principle behind his analyses of scientific logic: scientific ideas can best be explained by explicitly showing how they are used and what roles they play in various contexts. In this way, Frank remained loyal to the Vienna Circle, especially by promoting their ideas in the U.S.A., yet on the other hand, he was less doctrinaire than some of its other members.

Philipp Frank's brother, architect Josef Frank with his team in Svensk Tenn, Stockholm, c. 1940

Martin Neuwirther

Wolfgang M. Schmidt – The Geometer of Numbers

Wolfgang Schmidt was born on 3 October 1933 in Vienna. He studied mathematics and physics at the University of Vienna and received his Ph.D. in 1955. Among his teachers were Edmund Hlawka, Johann Radon, and physicist Hans Thirring. After his studies he began traveling between Vienna and the U.S.A. He has been teaching at the University of Colorado in Boulder since 1965. In 1992, some Austrian mathematicians tried to get Schmidt back to Vienna and thus began an intermezzo as a part-time professor in Vienna and Boulder. However, this experiment came too late and failed — Schmidt probably tired of traveling.

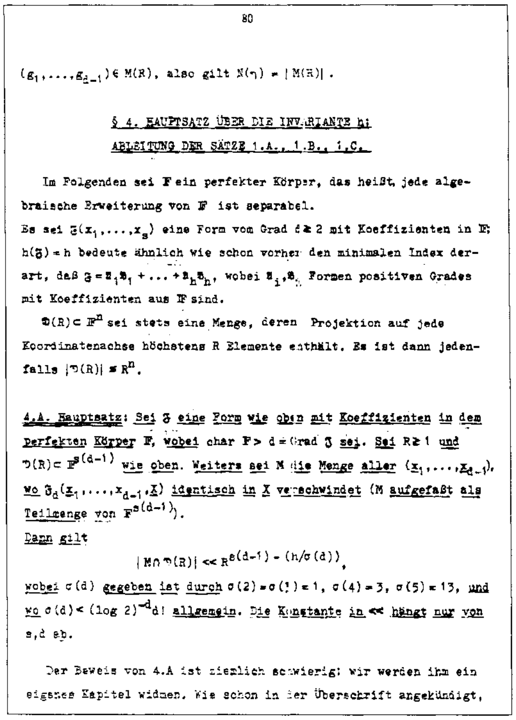
Even as early as his Ph.D. thesis, Wolfgang Schmidt was concerned with subjects dealing with number theory. This branch of mathematics has had a great tradition in Vienna ever since Furtwängler and Wirtinger, but Schmidt has gone far beyond this tradition. He likes to measure everything thoroughly — heights, densities, norms — but everything is applied to number theory! A very traditional part of number theory is the theory of Diophantine approximations. This deals with approximating irrational numbers with the help of rational ones. For instance, the golden section (also known as the golden mean or the divine proportion), which has played a very prominent role in determining proportions in architecture and art, is the most irrational number around, in a certain sense. The golden section is the number that is approximated least accurately by rational numbers. Irrational relations are also important in many other environments, such as astronomy or concert hall acoustics. The more irrational their relationship is to each other, the less the orbits of the planets interfere with each other; and for acoustic reasons, the proportions of concert halls are often built according to the measurements that have the most irrational relation to each other — as is, for example, the Viennese Musikverein concert hall.

In the 1960s Schmidt focused strongly on simultaneous approximation and the approximation of algebraic numbers using rationals as well as of irrational numbers using algebraic numbers. Don't panic: simultaneous approximation is a generalization of higher dimensions of the so-called rational approximation: a finite amount of real numbers is approximated simultaneously. A number is called an algebraic number if it is a zero of a polynomial with integer coefficients (e.g., π is not an algebraic number, whereas $\sqrt{3}$ certainly is). Algebraic numbers play a very prominent role in the theory of numbers as well as in algebraic geometry. The outcome of Schmidt's intriguing studies resulted in generalizations about the distribution of numbers and their geometry.

Schmidt thus developed his two main ideas, which were of great influence:

- the generalization of the geometry of numbers on higher dimensions and
- very detailed studies of polynomials over certain algebraic structures.

As a result, Schmidt found himself working on congruences modulo the power of a prime number. This means one assumes that two numbers are the same if they differ only by a multiple of the fixed power of some fixed prime number — such strange reasoning also relates to commonly applied cryptography. He was also exploring so-called density distributions, which, very simply put, deals with the question of how often a number occurs in some series. Schmidt always looked for the best possible results, often avoiding hard and complicated calculations thanks to his very efficient reasoning (very tricky!). In 1972 the American Mathematical Society awarded Schmidt the prestigious Cole Prize in number theory. Although he restricted his studies primarily to the subject of number theory, his works have stimulated the evolution of several other branches of mathematics. For example, Schmidt developed the so-called theory of heights of polynomials. In the late 1980s algebraic surveyor Bombieri applied Schmidt's results in order to prove effective assertions concerning the number of rational points of elliptic curves. This happened only a short time after Gerd Faltings had been awarded the Fields Medal, which is the highest award for mathematicians, for his very complicated proof of the finiteness of the number of such points. With the help of Schmidt's theory, Bombieri got more — and in an even easier way. As his assistant, I got to know Wolfgang toward the end of my studies in Vienna, when I was working in a very different — nearly opposite — branch of mathematics. Therefore I was quite amazed when I realized that the Wolfgang Schmidt, whom I had encountered in the bibliography of many publications, turned out to be the famous 'geometer of numbers.' His way of giving lectures is very factual, which corresponds well with the subject he is talking about, yet the most elegant wit of a very great thinker often gratifies the audience. Even in his dissertation, after reading several pages of tricky, hard-to-imagine assessment of the derivation of a new result, one comes across his dry comment, "After more precise consideration ... is capable of considerable improvement."



80

$(g_1,\dots,g_{d-1}) \in M(R)$, also gilt $N(\eta) = |M(R)|$.

§ 4. HAUPTSATZ ÜBER DIE INVARIANTE h: ABLEITUNG DER SÄTZE 1.A., 1.B., 1.C.

Im Folgenden sei $\mathbb{F}$ ein perfekter Körper, das heißt, jede algebraische Erweiterung von $\mathbb{F}$ ist separabel.
Es sei $\mathfrak{F}(x_1,\dots,x_s)$ eine Form vom Grad $d \geq 2$ mit Koeffizienten in $\mathbb{F}$; $h(\mathfrak{F}) = h$ bedeute ähnlich wie schon vorher den minimalen Index derart, daß $\mathfrak{F} = \mathfrak{A}_1\mathfrak{B}_1 + \dots + \mathfrak{A}_h\mathfrak{B}_h$, wobei $\mathfrak{A}_i, \mathfrak{B}_i$ Formen positiven Grades mit Koeffizienten aus $\mathbb{F}$ sind.

$\mathfrak{D}(R) \subset \mathbb{F}^n$ sei stets eine Menge, deren Projektion auf jede Koordinatenachse höchstens R Elemente enthält. Es ist dann jedenfalls $|\mathfrak{D}(R)| \leq R^n$.

4.A. Hauptsatz: Sei $\mathfrak{F}$ eine Form wie oben mit Koeffizienten in dem perfekten Körper $\mathbb{F}$, wobei char $\mathbb{F} > d =$ Grad $\mathfrak{F}$ sei. Sei $R \geq 1$ und $\mathfrak{D}(R) \subset \mathbb{F}^{s(d-1)}$ wie oben. Weiters sei M die Menge aller $(\underline{x}_1,\dots,\underline{x}_{d-1})$, wo $\mathfrak{F}_d(\underline{x}_1,\dots,\underline{x}_{d-1},\underline{X})$ identisch in $\underline{X}$ verschwindet (M aufgefaßt als Teilmenge von $\mathbb{F}^{s(d-1)}$).
Dann gilt

$$|M \cap \mathfrak{D}(R)| \ll R^{s(d-1) - (h/\sigma(d))},$$

wobei $\sigma(d)$ gegeben ist durch $\sigma(2) = \sigma(3) = 1$, $\sigma(4) = 3$, $\sigma(5) = 13$, und wo $\sigma(d) < (\log 2)^{-d} d!$ allgemein. Die Konstante in $\ll$ hängt nur von s, d ab.

Der Beweis von 4.A ist ziemlich schwierig: wir werden ihm ein eigenes Kapitel widmen. Wie schon in der Überschrift angekündigt,

Analytische Methoden für Diophantische Gleichungen. Einführende Vorlesungen, Seminar der Deutschen Mathematiker-Vereinigung, vol. 5, Birkhäuser 1984, p. 80.

4

Peter Weibel and Eckehart Köhler

Gödels Proof of Undecidability – Contours in the Philosophical History of a Famous Mathematical Theorem

Kurt Gödel

One of the most significant modern discoveries in mathematical logic or, as it is often summarized, the "theorem of the century," is not Ludwig Wittgenstein's, as some would guess, but rather must be credited to another Viennese, who, until recently, was unknown to the broader as well as the cultural public, even though his theorem had been published in the 1930s. "The subject of logic was never again to be the same," wrote John von Neumann about a work published by a twenty-five year old Viennese. It was entitled *On Formally Undecidable Propositions of the Principia Mathematica and Related Sytems, I.*[1] Its author: Kurt Gödel.

Kurt Gödel was born on 28 April 1906 in Brünn (now Brno in the Czech Republic), which was then part of the then Austro-Hungarian Monarchy. In 1924 he began his studies of physics and later mathematics and logic at the University of Vienna. There he received his Ph.D. with his dissertation, *Über die Vollständigkeit des Logikkalküls* (On the completeness of logical calculation), in which he proved his mastery in treating the most relevant problems in fundamental logic research. It was also a kind of perquisite for his work, *Unvollständigkeit* (Incompleteness, 1931), which was accepted in 1932 as his habilitation (post-doctoral) thesis. Hans Hahn, his most important teacher along with Karl Menger (the son of national economist Carl Menger), wrote:

> *The habilitation thesis, 'On Formally Undecidable Propositions of the Principia Mathematica and Related Systems I,' is an achievement of the highest order. It caused a great sensation among all experts and, as is certainly foreseeable, it will take its place in the history of mathematics. Mr. Gödel was able to show that there are problems in the logical systems of Whitehead and Russell's 'Principia Mathematica' that are undecidable according to the means of this system, and that the same holds true for every system of formal logic in which the arithmetic of natural numbers can be expressed. This shows that Hilbert's program, set up to prove the consistency of mathematics, is unfeasible.*[2]

Gödel's great feat, which so astounded his colleagues and "would long remain a milestone through space and time" (John von Neumann), was his proof of incompleteness. He worked on it during the summer and through into the autumn of 1931, and it was presented at a congress in Kalinigrad by none other than John von Neumann. For six long years, von Neumann had fought at the side of Hilbert and, in 1927, had proven the consistency of a significant subsystem of the number theory. Gödel, as von Neumann said, was the first in the history of mathematics to show

> *... that certain mathematical theorems can be neither proven nor disproven with the accepted, exact methods of mathematics. In other words, he proved the existence of undecidable mathematical theorems. He further proved that a very important specific theorem belongs to this class of undecidable problems: the question of whether mathematics is free of internal contradictions. The result is very interesting in its quasi-paradoxical 'self-negation.' It will never be mathematically possible to arrive at the certainty that mathematics does not contain contradictions. An important point that must be stressed is that this is not a philosophical principle or enlightening intellectual attitude, but instead the result of a strict mathematical proof of an especially refined type.*[3]

The Modification of the Liar

Gödel's achievement was in specifying, with extreme precision, a really pure, finitely constructed formula, which can be proved undecidable and therefore renders incomplete the formal system used to construct it. Gödel's basic premise was ingeniously simple: the undecidable formula ought to say, "I cannot be proved."

In doing this, Gödel adopted one of the oldest known antinomies — that of the paradoxical "liar," attributed to Epimenides the Cretian. Epimenides was reported to have said, "all Cretans lie," a statement that can apparently be neither true nor false when one considers that Epimenides was a Crete and that the statement then ultimately applies to him as well. Therefore, he must have lied, too, since he is thus included as a liar. If Epimenides had spoken the truth, then it could not be true that all Cretans lie, since one of them, Epimenides, had not lied. Thus Epimenides's statement must be considered false, because it has met with an exception here. That is not primarily a contradiction, but rather a paradoxical fact. It would, however, lead to an exact contradiction eo ipso, if we formulate it differently as "the statement that I am about to make is false."

Gödel replaced falsehood with undecidability and then noticed that the very similar formulation, "this statement is undecidable," was no longer antinomic, so he took on the task of showing this (with finite means of proof!). Replacing truth with provability is and was very common, especially among the intuitive logicians such as Brouwer, for people like to replace the concept of abstract, logical truth with the more human,

1. "Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme I," Monatshefte für Math. u. Phs. 38 (1938): 173-198; *On Formally Undecidable Propositions of Principia Mathematica and Related Systems*, B. Meltzer, trans. (1962; reprint, with an introduction by R.B. Braithwaite, New York: Dover, 1992)
2. Quoted in Curt Christian, "Leben und Wirken Kurt Gödels," Monatshefte für Mathematik 89 (Springer Verlag, 1980): 263. Austria, especially the Second Republic, has neglected Gödel. Before World War II, he received only a non-tenured private professorship. It was not until 1966 that he was named honorary professor for mathematics at the University of Vienna. The political experiences of the 1920s and 1930s and the ignorance of the mediocre academic system after 1945 caused Gödel to very coolly distance himself from Austria.
3. This and the earlier passage are taken from von Neumann's speech at the awards ceremony, where Gödel received the Albert Einstein Prize (New York: New York Times, 15 March 1951) p. 31.

epistemological concept of discovering proof, although they often immediately decide to dismiss as senseless those truths that cannot be proven using the methodology of finite proof.

Gödel then had two problems: first, he had to incontestably present the self-reference suggested by the words, "this statement," in a formal system à la Frege, Russell, and Hilbert. In number theory, the topics are simply numbers and their functions, not formulas. Therefore the coordination of numbers to formulas and their sequences must first be established. Second, he had to specify the concept of provability itself so precisely that it could be handled as an exact object of the formal system. Provability (as a theorem relationship over theorems of the system) can then be represented by numbers and therefore in turn result in a number-theoretical statement. In subsequent reworkings of his famous 1931 essay,[4] Gödel did not use particularly difficult number-theoretical reasoning. He showed his mastery rather in the way he used language to construct his proofs, primarily in his sure treatment of "ambiguity" or the simultaneous activation of concepts on the object level (within the system) as well as on the meta level.

Gödelization

Most impressive was Gödel's method of numerically presenting theorems and proofs, which was termed "Gödelization" in his honor. His indeterminability formula of 1931 is self-referential and self-representational. Arithmetic shows itself in itself (that is, factual arithmetic relationships such as theorems and proofs show themselves in arithmetic subjects — numbers and numerical functions). That is the idea behind Gödelization, and it has stood the test of time. Gödelization is the procedure by which each expression of a formal system is assigned a numerical coordinate, and this is done in such a way that the coordination can also be reversed, by determining whether each number corresponds to a formula and, if so, which one. The coordination can also be done in such a way that certain numbers are reserved for the class of theorem proof sequences.

In the definitive coordination of expressions and numbers, Gödel benefited from the lectures of his teacher, Philipp Furtwängler. It is well known that numbers can be divided into factors of prime numbers, and Gödel used this fact in the following way: a complex formal expression consists of a series of signs, to which certain numbers are clearly assigned. These are added as exponents of the prime numbers (the series of increasing prime numbers), and the resulting prime number potentials are multiplied with each other. This allows a number to be definitely assigned to a complex expression. This process can be clarified in a simple example. Assume that the name of individual a is assigned the number 3, and the predicate P (perhaps signifying 'mortal') is assigned the Gödel number $2^3 \cdot 3^5 = 32.768$. This assignment is now definite and thus fulfills the given conditions since the number 32.768 can only be divided again by the prime factors 2^3 and 3^5 and cannot correspond to any other expression than Pa. Gödel achieved this breakthrough by assigning prime numbers, because he had in fact discovered a code that made it especially possible to represent proof relationships among the theorems of a system within the system — through a number-theoretical theorem in the system. It was this trick that first made it possible to express both formally and correctly the self-reference in the statement, "this statement cannot be proved." Naturally, it also shows that this is only possible if the formal system is rich enough in content, since the possibilities of the codification must be given.

Gödel-Satz, Möbius-Schleife, Computer-Ich. Franz Kreuzer im Gespräch mit Paul Watzlawick, Werner Schimanovich, Eckehart Köhler, Paul Badura-Skoda und Werner Leinfellner
(Vienna: Franz Deuticke Verlagsges.m.b.H., 1986) pp. 72-101.

4. See 1. For further study of Gödel's proof, please see Ernst Nagel and James Newman, *Gödel's Proof* (New York: New York UP, 2002); Douglas R. Hofstadter, *Gödel, Escher, Bach: An Eternal Golden Braid* (Basic Books, 1999); and Werner DePauli Schimanovich, Peter Weibel, *Kurt Gödel – Ein mathematischer Mythos* (Vienna, 1997), based on the film of the same title. Thanks to the initiative of the Schimanovich School in Vienna, the International Kurt Gödel Society was founded in 1987. They publish an annual yearbook and organize a Kurt Gödel symposion every two years. See also W. DePauli Schimanovich, E. Köhler, F. Stadler, *The Foundational Debate: Complexity and Constructivity in Physics* (Kluwer, 1995).

Josef Linschinger

Josef Linschinger
born 1945 in Gmunden. Studied and teached at the Academy of Creative Design in Linz. Founder of the Gmundner Symposia. Lives in Traunkirchen.

1981 Galerie Maerz, Linz
1991 Galerie Awangarda, Wroclaw; Galerie Orms, Innsbruck
1992 Stadtturmgalerie, Braunau (with I. Dick, G. Frömel, B. Muthofer)
1994 Galerie Peter Lindner, Vienna
1995 Städtische Galerie Übelacker Haus, München; Museo Casabianca, Malo (with H. Bruch, H. Gappmayr); Galerie Orms, Innsbruck
1999 etc., Galerie Lindner, Vienna
2002 *Thomas Bernhard – Konkret*, MUWA, Graz
2003 *ride on*, Galerie Lindner, Vienna

Group Shows
1988 Künstlerhaus, Bregenz; Museum für moderne Kunst, Bozen; Kärntner Landesgalerie, Kärnten
1989 Centro Culturale de la Villa, Madrid
1990 Kunsthaus, Hamburg
1992 Museum für konkrete Kunst, Ingolstadt; Tiroler Kunstpavillon, Innsbruck
1993 Landesmuseum Ferdinandeum, Innsbruck; Galerie Orms, Innsbruck; Galerie Thurn & Taxis, Bregenz
1994 Wilhelm Hack Museum, Ludwigshafen
1995 Gesellschaft für Kunst und Gestaltung, Bonn
1999 *the one dimension*, Läns Museet, Härnösand, Sweden
2003 Kammerhofgalerie, Gmunden

References:
Josef Linschinger. Mappen und Multiples, Galerie Peter Lindner, Wien 1994.
Josef Linschinger. Bilder, Galerie Orms, Innsbruck 1995.

For a long time, numerical sequences were simply an aid for creating works of art (for calculating perspective in previous centuries, and later, at the beginning of the twentieth century, for creating works such as Bauhaus sketches, for example). However, today, a sequence itself can be the content of a work of art (Indiana, Mields, etc.).

Josef Linschinger created a series of graphic prints, directly transferred from mathematics into art with unusual consistency. He selected six numerical sequences, and then produced an interlocking set of squares with each of them. In the process, he established the sequence of the lateral lengths as given by the individual series.

The six sequences are:

I	Square numbers sequence (1x1, 2x2, 3x3, 4x4...)	1, 4, 9, 16, 25, 36, 49
II	Fibonacci sequence (1,1+1,2+1, 3+2, 5+3...)	1, 1, 2, 3, 5, 8, 13
III	Prime numbers sequence	2, 3, 5, 7, 11, 13, 17
IV	Lucas sequence (1,3, 3+1, 4+3, 7+4...)	1, 3, 4, 7, 11, 18, 29
V	Bernoulli sequence (1,...+1,...+2,...+3,...)	1, 3, 6, 10, 15, 21, 28
VI	Product numbers sequence (1, 1x2, 2x3, 3x4, 4x5)	1, 2, 6, 12, 20, 30, 42

More interesting than examining the numerical sequences themselves is to study the sequence of the gaps between the individual numbers: the observer recognizes them, discovering them (halved) as gaps between the adjoining squares. Inversely, this means that the difference between succeeding numbers has a more intense optic effect on the work of art than the sequence originally given.

Linschinger relativizes the merely mathematical austerity of the works in different ways. He places the squares on the point of an angle, thus creating an impression of dynamics in the picture. For each sequence, there is both a white print and a black one, each with silver lines. Whereas the white print is more a construct made of lines, the black prints show the obvious fragmentation of the planes. The sheets can be structured in pairs (a black print of planes and a white print of lines) or in clusters (all the prints of planes and all the prints of lines). In this way, the great redundancy of these works is accordingly dissolved into complexity.

Dietmar Guderian, *Josef Linschinger, Mappen und Multiples* (Vienna: Peter Lindner Gallery, 1994).



Josef Linschinger
Fibonacci Numbers, Prime Numbers, and Multiplication of Natural Number Sequences, 1994
from his work *Number Sequence*
6 serigraphies
30 × 30 cm

Dóra Maurer

Fixations/Changes

Dóra Maurer's art operated with pairs of opposites in favor of a new aesthetic knowledge. A mathematical consciousness runs through all her works. It was evident as early as 1972, in the idea behind the *Set Boards*, which feature sets of objects. Based on mathematical thinking, series of similar objects are examined with regard to their morphological differences. In these series, problems concerning numbers and the elements they define or specify are explored. All of the objects compete with one another in the pictures, while some of them are covered and disguised, and therefore made invisible, so that they are only legible as numbers. Still others are openly contrasted with each other. Different scales of reality, connected to the diverging sizes of the objects, are played off each other or interact. The more simplistic the form, the more primitive the material; the more simplistic the placement, the more the construction of the image becomes transparent to the observer. This is a principle of Italian arte povera, a contemporary movement at the time these pieces were made. The less emotional the objects, the more legible they are — such as *Set Board 4*, which simply uses pieces of wood and painted sticks to create a magical square.

Set Board 4 is equipped with a descriptive pictogram in the right-hand corner that offers an explanation, a key to the images depicted. In the work, the number one hundred can be read in every direction; this is a revisualization of the number one hundred, representing its use in set theory. The arrangement of objects is in accordance with certain types of systematic experiments dedicated to discovering the magic square by shifting the layers of colors. These arrangements result in series, such as the Displacements, whose common quantities are dislocated or displaced in order to enhance their artistic qualities. This allows new visual forms to appear — new images belonging to the 'shaped canvas' — which surpass the traditional limits of squares, rectangles, or ovals.

Dieter Ronte

Dieter Ronte, Lázló Beke, *Dóra Maurer. Works 1970-1993* (Budapest: Present Time Foundation, 1994) pp. 43-45.

Dóra Maurer, *Set Board 3,* 1972
Wheat, gauze, watercolor, pressboard, 90.5 × 62 cm

Dóra Maurer, *Set Bard 4, 500 Values, Magic Square, 1972*
Twigs, acrylic, pressboard, 90.5 × 62 cm

Dóra Maurer
born 1937 in Budapest. Studied at the Academy of Fine Arts in Budapest. Lives in Budapest and Vienna.

1975 Neue Galerie, Graz
1976 Szent István Király Múzeum, Székesfehérvár
1979 Pécs Galéria, Pécs
Hedendaagse Kunst, Utrecht
1984 Ernst Múzeum, Budapest
1986 Galleri Herzfeld, Stockholm
1993 Szombathely Képtár, Szombathely
1996 Kiscelli Museum, Budapest
1998 *Arbeiten 1974-1977*, Josef Albers Museum Quadrat, Bottrop
2002 Collegium Budapest
2003 Gutmann Galéria, Budapest
2004 Galerie Peter Lindner, Vienna

Group shows
1967 São Paulo Biennial
1971 Trigon '71, Neue Galerie, Graz
1975 *Neue ungarische Konstruktivisten,* Städtisches Museum, Bonn
1979 *Photography as Art – Art as Photography,* ICA, London
1980 *Ein Künstler – ein Prinzip,* Museum moderner Kunst, Vienna
1981 *Erweiterte Photographie,* Secession, Vienna
1983 *BBS-films,* Centre Georges Pompidou, Paris
1985 *Raumkonzepte,* Fészek Galéria, Budapest
20 Years of Hungarian Experimental Film, Museum of Modern Art, New York
1986 *Experimental Films from Budapest,* Museum of Fine Arts, Boston
1988 *Das Licht der Peripherie,* Museum des 20. Jahrhunderts, Vienna
1994 *Hommage au carré für Vera Molnár,* März Galerien, Mannheim
1996 *The Butterfly Effect,* Műcsarnok, Budapest
2001 Műcsarnok, Budapest
2004 *Gegen-Positionen,* Museum Moderner Kunst - Stiftung Wörlen, Passau

Peter Weibel

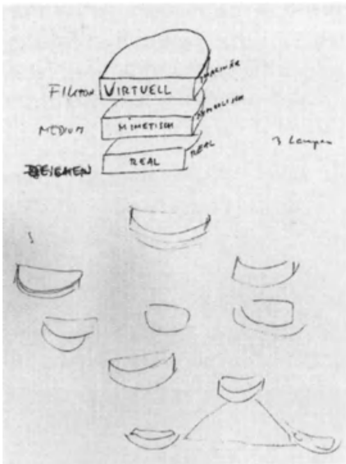
You are (not) part of the program. You are (not) part of the problem zone, 1990

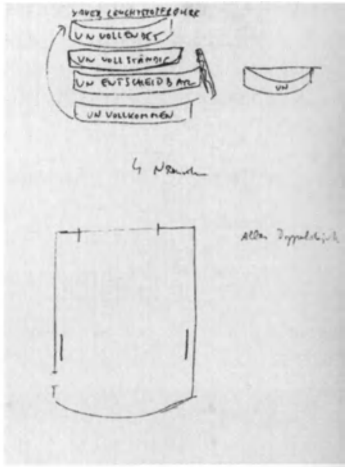
The terms "incomplete," "undecidable," etc. are presented in such a way that they cannot be read as whole. In this way they fulfil their meaning or program. The overall scheme is hidden from the internal observer, who is part of the program. Only external observers, who have the opportunity to take different points of view, can free themselves from the problem zone. As in nearly all of Peter Weibel's works, formal considerations imply political statements.

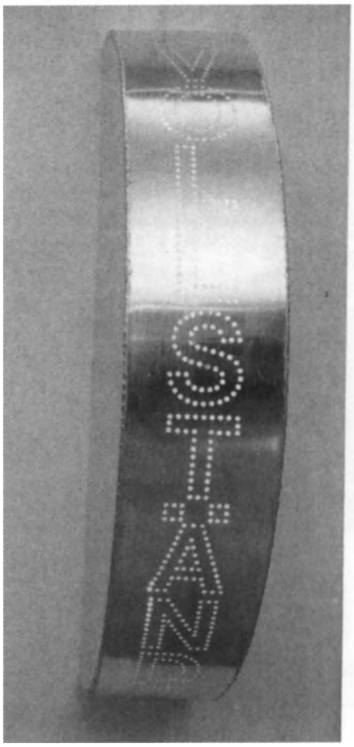
Anyone reading a program is programmed, becomes part of the program. The sender becomes part of the problem or system, which the program has to solve. The solver of the problem may become a problem himself.

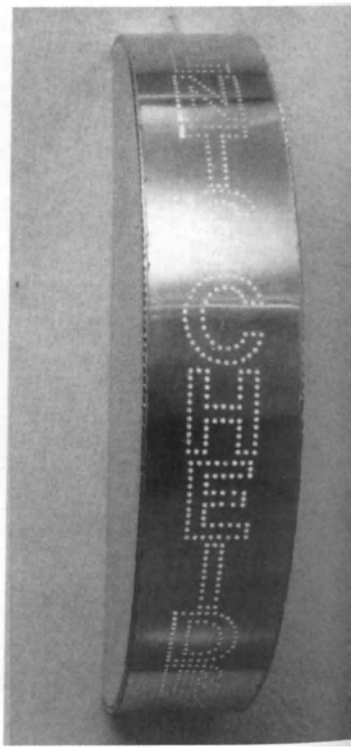
Is the program part of the problem, the problem itself, or the solution of the problem? Who decides what a problem is? The program itself?

Romana Schuler, ed., *Peter Weibel. Bildwelten. 1982-1996* (Vienna: Triton, 1996) p. 142f.









Peter Weibel
You are (not) part of the program.
You are (not) part of the problem zone
1990
2 neon tubes, 2 aluminium boxes perforated with the words "incomplete" and "undecidable"
40 × 55 × 20 cm (2 parts)

Gerzson Kéri and Tamás Varga

Ernő Rubik's Cube and Its Groups of Rotations

The various ways of rotating a Rubik's Cube represent transformations — a word which, in itself, means to reshape. Aided by the series of possible movements, we reshape the cube, either into a different state — by changing the visible pattern of the cube — or into its original state.

After each transformation, it is possible to perform any other transformation, either a different one or the same; the result is always a transformation. However, this would not be true if we decided that transforming the Cube into its original state was not actually a transformation. Each transformation can also be performed in reverse.

This is enough for us to make the following statement: the rotations of the magic cube constitute a group, and so they must be considered a transformation in the mathematical sense. The elements of the group are also transformations. If a series of movements changes the Cube in the same way as another series of movements, i.e., if they both start in the same state and produce the same pattern, they are then one and the same element of the group. From the transformational aspect, it does not matter whether the change is produced this way or a different way, via a shorter or longer path — the result is all that counts.

(...) In order to describe the series of several rotations, mathematicians have arbitrarily opted for the conventional representation of multiplication, writing the numbers in succession. The logical consequence of this decision was that, in the case of identical rotations, exponentiation gradually replaced multiplication. This convention of denotation can be partly explained by the fact that the common result of two rotations generally depends on the order of both rotations. (If a group operation is commutative — that is, if the result depends on the order of the elements of the group — we often use the plus sign, even if no numbers are added.) We can confine the group of rotations by imposing restrictions on the rotations. Let us first consider the case in which only double rotations of two adjacent surfaces are allowed. In this way, only twelve different patterns can be generated; fig. 4 shows the patterns generated from the starting state.

A maximum of six movements is required to order these patterns. Not only that, it is also possible to move from one of the twelve patterns to another with a maximum of six movements. In other words, the diameter of the group consists of six movements. (We should not imagine the geometrical diameter of the circle; in the language of geometry, we would instead refer to a semi-circumference.) Now, in addition to the first two surfaces, let us allow half-rotations of a third surface (intersecting both other surfaces), e.g., S^2, F^2, K^2. From the starting state, the Cube may be transformed into three different states with one movement (fig. 5). In all three cases, we can obtain a new pattern in two ways, depending on which of the other two surfaces is rotated (fig. 6). Hence, in addition to the four previous states, we can generate twelve other states with a third movement, and so on (fig. 7). But for how long? If the number of final points (patterns differing not only from each other, but from all other previous patterns, as well) that can be obtained with the next movement were doubled, we would see the figures indicated in table 1.

Total number of patterns: 2592							
Number of movements	1	2	3	...	9	10	
Number of possible new patterns	3	6	12	...	768	1536	
Number of all possible patterns (including the basic pattern)	4	10	22	...	1534	3070	or less

Table 1: The number of patterns made by double-rotations of three corner sides.

(...) Although we have not drawn the map of this subgroup with 2592 elements, we do know that all the points of this map are triple branch points. Let us consider another group, of which we know that the same applies. We will allow half-rotations of all six surfaces, albeit only in pairs. Only two opposite (parallel) surfaces may be rotated at once — or successively (this is of no importance).

(...) Let us now allow double rotations of all six faces, albeit without the previous restriction: the order may be arbitrary. In this way, there are six possible rotations at each point, including undoing the last rotation. The drawing order should now start as indicated in fig. 10. The number of new end points is multiplied at each beginning by a factor of five (table 2).

Instead, after just two movements, we find congruencies, for the double rotations of two opposite faces produce the same pattern, regardless of order. The second drawing will thus be as indicated in fig. 11, and in the table, the number 30 will be replaced by 27, and 37 is replaced by 34. As can be calculated, it is possible to produce 663 552 different patterns by means of double rotation of all surfaces. The only certain fact is that it is not possible to obtain all patterns with eight movements, meaning the diameter of the group (the number of movements required to order) is at least nine.

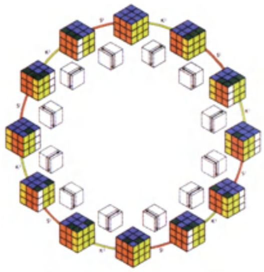


Fig. 4: The number of patterns created by a double rotation of three corner sides.

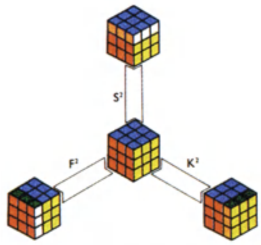


Fig. 5: Half rotations of three surfaces; this state can be achieved with one rotation.

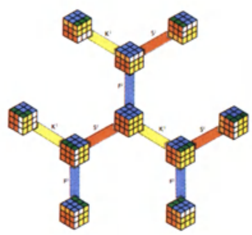


Fig. 6: Half rotations of three surfaces; six more states can be reached with a second movement.

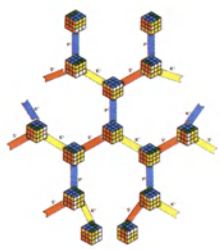


Fig. 7: Half rotations of three surfaces; twelve new states can be reached with a third movement.

Ernő Rubik, born 1944 in Budapest. Studied architecture at the Technical University, Budapest, 1962-67, and interior design at the Collage of Applied Arts, 1967-71. Employed by the govermental engineering institute as an architect, 1968-75. Assistant, and then later professor at the College of Applied Arts, 1970-88. He created several logic games, the most famous was the "Magic Cube" in 1974. In 1988 he founded the International Rubik Foundation. In 1990, he became chairman of the Combine of Hungarian Engineers.

References:
Ernő Rubik, *Rubik's Cubic Compendium*, 1987.

Total number of patterns: 663 552							
Number of movements	1	2	3	...	8	9	
Number of possible new patterns	6	30	150	...	468 750	2 343 750	
Number of all possible patterns (including the basic pattern)	7	37	187	...	585 937	2 929 687	or less

Table 2: The number of patterns made by double rotations of the sides.

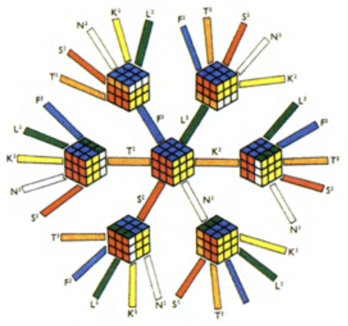


Fig. 10: Half rotations of six sides; does the second lead to 6 x 5 new states?

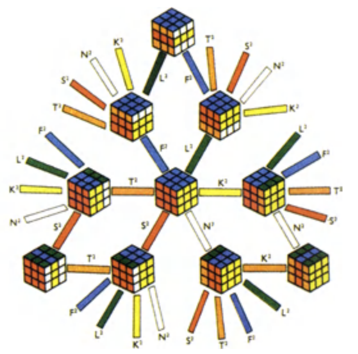
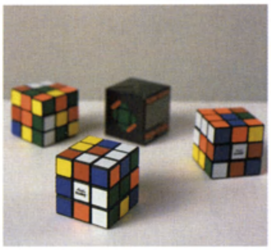


Fig. 11: There are already congruencies among the patterns created by the second movement.



Let us now begin to draw the complete map of rotations of the cube; we can also allow quarter rotations of any surface. We can perform three different rotations on the six faces. Hence, from the starting position (the simple pattern), we can obtain eighteen new patterns in one movement (fig. 12).

(...) Table 4 presents an overview of how many different patterns can be produced in the cases we have investigated, as well as of the minimum number of movements required to put the Cube in order or to create a pattern using other, most distant patterns.

Allowable movements	Number of states (patterns)	Greatest distances (number of moves to put Cube in order)
Double rotations of two neighboringsides	12	6
Double rotations of three corner sides	2592	10 or more
Double rotations of inner sides	8	3
Double rotation of randomly selected sides	663 552	9 or more
Random number of rotations of randomly selected sides	approx. 43 trillion ($4.3 \cdot 10^{19}$)	18 or more

Table 4: The numbers in the right column must refer to the units listed in the left column.

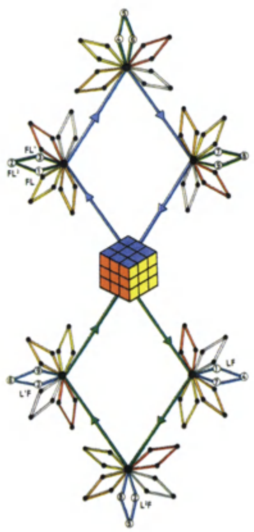


Fig. 12: Random rotations of the six sides; one movement can lead to eighteen different patterns.

Ernő Rubik, ed., *A bűvós kocka* (Műszaki Kónyvkiadó: 1981) pp. 160-172 (abbreviated version).

Michael Stöltzner

Gödel on the Relationship Between Mathematics and Physics

Kurt Gödel and Albert Einstein

Nowadays, Gödel's seminal incompleteness theorem figures quite prominently in various philosophical arguments, most especially to save human intelligence from being reduced to a computer program, however complex such a program may be. More recently Gödel's theorems have also been used to disturb a tenacious dream of modern physics, the final theory. It is the aim of this essay to elaborate Gödel's unexpectedly optimistic position regarding this dream. To this end, I will investigate the close relationship between mathematics and physics that results from Gödel's rejection of mathematical conventionalism.[1]

In the old days, when Newtonian mechanics was the only physical theory, this dream found its expression in Laplace's demon. If a superhuman intelligence knows the initial positions and momenta of all material particles in the universe, then by mere calculation it can predict (or retrodict) the state of the universe at arbitrary times. For the mechanical world runs like clockwork, and its rules are stated in Newton's axioms. Although many new areas of physical phenomena have been detected since the 1850s, although Poincaré discovered dynamic systems (today termed "chaotic") for which the unavoidable measurement errors render Laplacian determinism utterly meaningless, and although quantum mechanics excluded a simultaneously precise knowledge of a particle's position and momentum (even in principle), the old Laplacian dream found new names and destinies.

The importance of mathematics for physical science has increased considerably since the beginning of the twentieth century. From serving as a mere calculating tool for solving equations, mathematics has developed into a formal analysis of physical concepts that allows one to derive many highly interesting general properties, such as dynamic stability. For this reason, some dreamers of a final theory pinned their hopes on some distinguished mathematical structures that could replace the outdated natural substances and reveal the 'natural order.' Metaphysical realism, which considered particles the constituents of the world, changed into Poincaré's structural realism. This development can be best seen in the so-called principle of least action, which provides an integral formulation of dynamic laws. Whereas in the eighteenth century, the minimalism of the action integral was considered an expression of an all-embracing principle of parsimony governing any process in nature, our century admired the applicability of this formal principle to widely different areas of physics. Accordingly, Max Planck proclaimed in 1915 that "the principle of least action is perhaps that which, as regards form and content, may claim to come nearest to that final aim of theoretical research"[2] of embracing all natural phenomena in a single and simple principle.

With the advent of atomic physics and quantum theory, length and energy scale became a new measure of finality. Microscopic physics turned out to be not only drastically different from classical macroscopic physics, but also mathematically more fundamental. Hence, for many decades physicists have sought the most fundamental entities in elementary particle physics. Einstein's attempts to define a unified field theory, Heisenberg's *Urgleichung*, and Schrödinger's "final affine laws" were typical for the endeavors of the 1940s and 1950s. After big bang cosmology had won, physicists hoped to discern in our universe traces of epochs when the universe as a whole would have been the size at which elementary particle physics becomes effective. String theorists who intend to wed elementary particle physics and gravity into a single theory have coined the presently fashionable wording for the old dream: *Theory of Everything (T.O.E.)*.[3]

With string theory, a new epistemological feature emerged. Since the energies involved in string processes exceed those of earthbound accelerators by several orders of magnitude, any experimental test — except for cosmology — appears illusive. During such an epistemological state of emergency, aesthetic, mathematical, and philosophical arguments become more important in the justification of physical theory than they usually are. Mathematicians have entirely replaced experimental physicists as the partners who independently verify or falsify theoretical physicists' claims. Often the motivation of string theorists is, in turn, mathematical in first place.[4] One of the most prominent advocates of finality, Nobel laureate Steven Weinberg, not only repeats the classical argument that the most fundamental theory can be expressed in a few simple principles. He even believes that one could check finality by mere consistency considerations, "The final theory [is] one that is so rigid that it cannot be warped into some slightly different theory without introducing logical absurdities like infinite energies."[5] Hence, "[i]n [such] a logically isolated theory every constant of nature could be calculated from first principles; a small change in the value of any constant would destroy the consistency of the theory."[6] Weinberg's finality criterion raises questions as to whether such a check for logical isolation within an axiomatized physical theory would not contradict Gödel's incompleteness theorem.

In criticizing final theories, physicists resort to Gödel in an even more general setting. Nobel laureate Freeman J. Dyson views it as an antidote against the alleged "end of physics":

1. For a more detailed account, see my "Gödel and the Theory of Everything," *Gödel '96. Logical Foundations of Mathematics, Computer Science and Physics — Kurt Gödel's Legacy*, Petr Hájek, ed. (New York: Springer, 1996) pp. 291-306.
2. For example, see Max Planck, "Das Prinzip der kleinsten Wirkung," *Wege zur physikalischen Erkenntnis* (Munich: 1944) p. 68.
3. For an introduction, see John D. Barrow, *Theories of Everything: The Quest for Ultimate Explanation* (Oxford: Clarendon Press, 1991).
4. These problems prompted a very interesting debate on the standards of mathematical rigor prevailing in this new 'intercultural' amalgamate. See Arthur Jaffe and Frank Quinn, "'Theoretical Mathematics': Toward a Cultural Synthesis of Mathematics and Theoretical Physics," Bulletin of the American Mathematical Society 29 (1993): 1-13; Michael Atiyah et al., "Responses to 'Theoretical Mathematics: Toward a Cultural Synthesis of Mathematics and Theoretical Physics,'" Bulletin of the American Mathematical Society 30 (1994): 178-211; Arthur Jaffe and Frank Quinn "Response to Comments on 'Theoretical Mathematics,'" ibid, pp. 208-211.
5. Steven Weinberg, *Dreams of a Final Theory* (London: Vintage 1993) p. 12.

6. Weinberg, p. 189.
7. Freeman J. Dyson, *Infinite in all Directions* (London: Penguin Books, 1990) p. 53.
8. Thomas Breuer, *Quantenmechanik — ein Fall für Gödel* (Heidelberg: Spektrum-Verlag, 1997).
9. Paul A. Schilpp, ed., *Albert Einstein: Philosopher-Scientist, vol. 7, The Library of Living Philosophers* (Evanston, Ill., 1949). Gödel's essay is reprinted in *Kurt Gödel's Collected Works, vol. II*, Solomon Feferman et.al, eds. (New York, Oxford: Oxford UP, 1990).
10. Kurt Gödel, "Some Observations about the Relationship between Theory of Relativity and Kantian Philosophy," *Collected Works, vol.III*, Solomon Feferman et.al, eds. (New York, Oxford: Oxford UP, 1995) p. 257.
11. Palle Yourgrau, *The Disappearance of Time. Kurt Gödel and the Idealistic Tradition in Philosophy* (Cambridge: Cambridge UP, 1991) p.14f.
12. Kurt Gödel, "Some Basic Theorems on the Foundations of Mathematics and Their Implications" (Gibbs lecture), *Collected Works, vol. III*, p. 314.

No matter how far mathematics progresses and no matter how many problems are solved, there will always be, thanks to Gödel, fresh questions to ask and fresh ideas to discover. It is my hope that we may be able to prove the world of physics as inexhaustible as the world of mathematics … If it should turn out that the whole of physical reality can be described by a finite set of equations, I would feel disappointed.[7]

Can Dyson really count on Gödel? In the first place, it seems rather unlikely that any physical theory ever reaches a state of formalization that suffices to be strictly Gödelized. Moreover, empirical confirmation and the values of certain fundamental parameters seem to be necessarily outside any axiomatization. In this way, a safe haven appears on the horizon, even for Weinberg, because he believes that the value of the cosmological constant cannot be deduced from first principles. In quantum theory, a further feature arises — the integration of measurement into the theory itself. Hence, one could frankly ask, "quantum mechanics – a case for Gödel?"[8]

For a long time, Gödel's general ideas about physics were known only from his essay in Schilpp's volume on Einstein.[9] In it, Gödel interprets his freshly discovered solution of Einstein's equation as an indication of the ideality of time and does not draw any connection to his own incompleteness theorems. Nor does he comment on the relationship of mathematics and physics in general — quite a surprising silence for someone whose major was physics almost until he began his Ph.D. dissertation. Gödel's papers, however, contain elucidating typescripts that have recently been published in the third volume of the *Collected Works.* They reveal that Gödel's views on universal theories are far more subtle than references to them, such as Dyson's, suggest. In effect, Gödel is rather optimistic about the prospects of obtaining objective knowledge at least with limits.

In an unpublished, philosophically more elaborate version of his Schilpp essay, Gödel is at pains to show that such a position can be reconciled with Kantian philosophy.

"If one wants to establish agreement between his [Kant's] doctrines and modern physics; i.e., it should be assumed that it is possible for scientific knowledge, at least partially and step by step, to go beyond the appearances and approach the things in themselves."[10]

This successive objectification of subjective appearances stands side by side with Gödel's distinction between subjective, i.e., provable, and objective mathematics. While the former suffers from the limitations imposed by the incompleteness theorem, there is no objective limitation for the human mind to transcend each single axiom system by way of new and stronger intuitions. This connection provides a basis for comparing Gödel's mathematical and physical results. According to Palle Yourgrau:

Just as the incompleteness theorem demonstrated that — as far as the Hilbert program is concerned — mathematical truth cannot be simulated by formal proof in that particular context, so — as far as Einstein goes — did the construction of a formal mathematical model of the Gödel universe demonstrate, according to Gödel, that in this context it cannot be given the intuitive, contentful interpretation denoting the successive, unfolding time that issues in objective, temporal becoming.[11]

The first step in justifying such a parallel is to study what philosophical conclusions Gödel has drawn from the incompleteness theorems.

Although Gödel was usually very cautious in his judgments, his theorems established that Hilbert's formalistic program was untenable in its epistemological interpretation. Presupposing a system of logic that was sufficiently strong enough to allow for a foundation of arithmetic, one could prove — even according to the strongest foundationalist standards — that the consistency of this system could not be established within the system itself. This conclusion is tantamount to the fact that one cannot define a truth-predicate inside the system of axioms so that undecidable propositions remain. Thus, Hilbert's conviction (shared by Gödel's Vienna Circle colleagues as well) that mathematical concepts were merely syntactic conventions was irreconcilable with the epistemological optimism that maintained that each mathematically well-posed question was decidable. Since Gödel strongly believed in the latter, he had to reject conventionalism:

If mathematics were our free creation, there still might be ignorance about the objects we create, it is true — but only because we lack a clear understanding of what we have created [or perhaps due to the practical difficulty of too complicated computations]. Therefore this ignorance would have to disappear…as soon as we attain perfect clarity.[12]

Since this does not happen, Gödel favored mathematical Platonism. Mathematical concepts and truths exist independently of our knowledge about them, independently of our present ability to prove the respective theorems. Yet they can be experienced through a kind of intuition that cannot entirely be made to fit syntactic rules. If, in this way, the ontological abyss between empirical and mathematical truths is at least partially bridged because one can almost assign a sixth sense to the latter,[13] then the question of consistency has empirical consequences. According to the rules of logic, a false mathematical theorem implies arbitrary propositions, some of which will also concern empirical objects. Gödel contemplates practical consequences: if, in constructing a bridge, we rely on a false mathematical theorem, then its stability is at stake.

This connection led Gödel to a very modern conception of mathematical physics, which he illustrates with the example of an old-fashioned computer:

> *If it is argued that mathematical propositions have no content because by themselves they imply nothing about experiences, the answer is that the same is true of laws of nature. For laws of nature without mathematics or logic imply as little about experiences as mathematics without laws of nature does. That mathematics, at least in most applications, does add something to the content of the laws of nature is at best seen from examples where one has very simple laws governing certain elements, e.g., laws concerning the reactions of electronic tubes. Here, mathematics clearly adds the general laws governing how systems of tubes connected in a certain manner will react. That the latter laws are not contained in the former is seen from the following facts: (a) the latter laws may contain concepts not definable in terms of those occurring in the former (e.g., the concept of a combination of any finite number of elements); (b) in order to understand the laws of nature it is sufficient, as far as the pertinent mathematical concepts are concerned, to know the rules that decide on their applicability or non-applicability in each particular case. However, such rules by no means imply the general laws governing them; (c) these general laws may even require new empirical inductions, in any case in which the mathematical problem in question should be unsolvable. For instance, this may occur in a case like Goldbach's conjecture, which evidently implies a certain law concerning the reactions of a computing machine. Note that the general mathematical laws may even be required for predicting the result of a single observation, for example, in case the latter depends on an infinite number (such as a continuum) of physical elements. It is true that mathematical propositions do not express the physical properties of the structures concerned, but rather the properties of the concepts in which we describe those structures. However, this only shows that the properties of those concepts are something quite as objective and independent of our choice as the physical properties of matter. This is not surprising, since concepts are composed of primitive ones, which (as well as their properties) we are as little able to create as we are capable of creating the primitive constituents of matter and their properties.*[14]

One of the most important results of postwar mathematical physics, the KAM-theorem,[15] provides a nice illustration of what Gödel has in mind. Our solar system already represents a multiform problem that is analytically unsolvable and which — without approximations — quickly exceeds the capacities of present-day computers. Nonetheless, using pure number theory, one obtains strict results concerning the stability properties of the solar system, which are largely independent of the precise form of the gravitational force. Except for direct crashes, any celestial body can be thrown out of its orbit only if the small disturbances exerted by the other planets, Jupiter foremost, do not compensate for each other, but are amplified by resonances. Those are maximally strong for a small rational ratio ($r=p/q$, where p and q are small natural numbers) of the revolution times; they are least harmful if r is equal to the golden ratio, or the most irrational number. Now the concept of resonance falls under category (a) in Gödel's classification because it is entirely meaningless as far as single planets are concerned. In the case of celestial mechanics, the general law governing the elements is known, but the problem cannot be solved rigorously. Often, however, the inverse situation occurs and it is possible to devise phenomenological theories made up of approximate rules that are only valid for limited scales. The spectroscopic rules before the advent of quantum mechanics provide a classical example of type (b). The Feynman rules of quantum field theory are a more recent example. Since, in most cases, the integrals to be calculated do not exist as well-defined mathematical objects, we make do with empirically determined coupling constants, attempting to find an explanation for them in the sense of (c). Such an inductive procedure is, at least to a certain extent, consistent with Gödel's general views, because he also conceives of a wide realm for inductive procedures in mathematics proper.

> *"If mathematics describes an objective world just as physics does, there is no reason why inductive methods should not be applied in mathematics, just as they are in physics."*[16]

13. Cf. Eckehart Köhler, "Gödels Platonismus," *Kurt Gödel: Wahrheit und Beweisbarkeit*, E. Köhler et al, eds. (Vienna: Hölder-Pichler-Tempsky, 1999).
14. Kurt Gödel, "Is Mathematics Syntax of Language?", *Collected Works, vol.III*, p. 360.
15. For Kolmogorov, Arnold, and Moser.
16. "Some Basic Theorems...," *Collected Works, vol. III*, p. 313.

In this respect, Gödel emphasizes the value of non-standard analysis, which is based on an extension of the limit concept in abbreviating proofs. By virtue of a meta-theorem, each proposition of non-standard analysis corresponds to a proposition of standard analysis. Although the latter might be quite different from the former, one has nevertheless obtained a very useful theoretical laboratory.

But Gödel's Platonism yields an even closer connection between mathematics and physics. Not only is mathematics useful in scrutinizing the conceptual structure of physics, but physics also contributes to finding or intuiting new, genuinely mathematical truths.

> *There exists no other rational (and not merely practical) foundation for these axioms, except for either directly perceiving them (or propositions implying them) as true (owing to the meaning of the terms or by intuiting the objects assigned to them), or by assuming them (like physical hypotheses) on the grounds of inductive arguments, such as their success in applications. It is not possible to eliminate mathematical intuition or empirical induction by positing the mathematical axioms as true by convention.*[17]

Presupposing that certain laws of nature hold true, one can even empirically verify (although not to the same degree of rigor provided by a mathematical proof) or falsify certain mathematical theorems, since these laws can be expressed and verified in a different manner without relying on the mathematical theorem in question — although, of course, not entirely without mathematics. While induction is based on probabilistic reasoning, intuition refers to criteria that are essentially of an aesthetic nature, such as simplicity, fertility, and symmetry. Thus, Gödel's intuition is not directed to 'given' things in the sense of philosophical phenomenology, but to abstract structures. In recognizing these basic structures, human beings are, in Gödel's mind, capable of gradually approaching things in themselves bit-by-bit — and thus of crossing a border that Kant had erroneously considered impassable. The reason for this belief lies in Gödel's conviction that the human mind exceeds the powers of every finite Turing machine.[18] Thus, the incompleteness theorem does not apply to any mind that at least believes it can exceed each specific axiom system and approach Platonic truths by means of increasingly replete systems. Opponents of universal theories, accordingly, cannot count Gödel among them.

Irrespective of his criticism of Kant's skepticism, Gödel believed to have verified another core doctrine of Kant's critical philosophy, since his solution to the Einstein equations confirmed the subjectivity of time. In contrast to the special theory of relativity, all cosmological solutions to the basic equations of the general theory known before 1949 allowed cosmological time to be defined using the mean motion of matter. In Gödel's globally rotating universe this was impossible because of the existence of closed, time-like curves, inside of which an observer could travel on an extremely fast spaceship into his or her own past. Gödel was aware of the fact that this journey was likely to be practically unfeasible and that his initial solution contradicted the observations of a cosmological red shift. Later he was able to generalize his solution in this respect.

Since time cannot globally lapse in the rotating universe, there exists no objective notion of change within it. For change presupposes existence, and observers cannot relativize the concept of existence without destroying its meaning completely. Thus, the question of time had to be settled on the level of natural laws, not only by imposing subsidiary conditions that excluded time travel ex post facto. Simply defining an absolute time in those universes was also not an alternative, because there was no basis for such a concept in general relativity.

Gödel considered the question of an objective lapse of time as a problem of consistency, because if general relativity is axiomatized so that it corresponds to our intuitive notion of time, it does not hold true for all solutions of the theory. As I shall argue in the rest of this contribution, this problem is, in several respects, analogous to the incompleteness theorems. And at this point, critics of universal theories are justified in counting on Gödel, who, I shall argue, also contributed to restricting Hilbert's plan to axiomatize the sciences.

When, in a lecture at Göttingen, Einstein presented an abstract characterization of the field equations meant to express general relativity, Hilbert himself was able to obtain the right Einstein equations by using an action principle. He furthermore coupled the terms expressing pure gravity to Gustav Mie's electrodynamics and hoped to have thus served the field theoretic ideal of unity. When Hilbert's axiomatization of the theory was published under the rather ambitious title, *The Foundations of Physics*, Einstein deemed it "too great an audacity to draw a picture of the world at this time, since there are still so many things that we cannot remotely anticipate."[19] Although Hilbert apparently had hoped for a unified theory in 1915 (not too unnatural, considering the principle of least action, which many physicists had regarded as a true candidate for a 'world formula'), in later years, he did at least waver, and in 1922, his former assistant, Max Born, was at pains to distinguish the plan to axiomatize science from all claims of finality.

> *[I]n Hilbert's terms the axiomatic treatment of a discipline does not signify the final assertion of certain axioms as eternal truths, but it signifies the methodological requirement: state your assumptions at the beginning of*

17. "Is Mathematics...," p. 346.
18. For the scope of this paper, it suffices to consider a Turing machine as a machine that materially expresses mathematical proof procedures.
19. Quoted from Abraham Pais's *Subtle is the Lord* (Oxford: Oxford UP, 1982) p. 261.

your considerations, stick to them, and investigate whether these assumptions are not partially superfluous or even mutually inconsistent.[20]

But at least Weinberg's exalted hopes for consistency teach that there is a genuine problem in basing physical properties on the axiomatic level too soon. More concretely, this is most evident in two conditions of Hilbert's axiomatization, which are too restrictive from the point of view of modern cosmology. First, Hilbert regarded all singular solutions as nonphysical, while today, we have become quite accustomed to black holes. Second, he believed that general covariance suffices to re-establish Laplacian determinism in general relativity. Gödel's universe was the first of a series of counterexamples that contained closed, time-like curves that violate causality.

To draw the parallel to the foundational debate in logic, Gödel's incompleteness theorem demonstrated that no sufficiently rich system of axioms allows proof of consistency from within, because, in the attempt to do so, the respective propositions fall outside the system. Similarly, the rotating universe shows that it may become impossible to maintain the physical meaning of a concept as it was attained during axiomatization by reference to intuition or with respect to a set of examples. If one interprets finding a solution as a kind of proof, then Gödel's universe demonstrated that Hilbert's axiomatization of general relativity was semantically incomplete. Typically, physicists will use a subsidiary condition to exclude unintended solutions as nonphysical. Such conditions are, however, always open to dispute and taste, and it might be very difficult to phrase them to satisfactory precision. So John Earman concludes after four decades of debates about the Gödel universe and its offspring, "I do not see any prospect for proving that time travel is impossible in an interesting sense."[21] At any rate, the existence of subsidiary conditions will be inconsistent with the universality and finality imagined in physics. Still, the Platonist could hold that such conditions simply foreshadow better concepts that will lead us one day to a final and universal theory. But, as both kinds of incompleteness teach, this theory could not be coined in a single set of axioms that would allow a sort of post-Laplacian demon to operate, because the simple division between axioms or laws and contingent initial conditions does not exist any more. Instead, this intelligent being would have to cosmologically develop all physical theories — from string theory to macroscopic physics — without being able to reduce them to one single universal and complete theory.

20. Max Born, "Hilbert und die Physik," Die Naturwissenschaften 10 (1922): 91.
21. John Earman, *Bangs, Crunches, Whimpers, and Shrieks. Singularities and Acausalities in Relativistic Spacetimes* (New York & Oxford: Oxford UP, 1995) p. 194.

4

Gábor J. Székely and Dénes Petz

Entropy

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In our world, there are two opposing processes that we naturally believe to be irreversible, and which we therefore use not only to distinguish between past and future, but to determine the direction of time as well. One of these processes is development — that is, the process of evolution, in which complex systems and structures come into being in both the organic and the inorganic realm (like the stars in the sky, for example). The other process is the decay of complex systems — that is, dissolution. If, for example, we put a sugar cube into water, the crystalline structure of the sugar disappears forever, and sugar molecules slowly start to appear everywhere in the water. Why is this process irreversible? Why do we believe that it is impossible for the particles of sugar dissolved in our coffee to suddenly find their way back to their places — for the sugar cube to reassemble itself? Such a process would not contradict Newton's laws. There is no doubt at all that any individual molecule can reverse its motion after a collision and slowly return to where it started. That is why the physical laws that control the motion of individual molecules cannot answer the question of why it is not possible to reverse the dissolution process. If, however, we take all of the sugar molecules into account all at once and examine their motions statistically, it will immediately be clear why a film that reverses the dissolution of a sugar cube looks unnatural. In such a reverse film, we would see the overwhelming majority of sugar molecules moving — without any apparent external influence — toward a very small fraction of the available physical space, to the exact spot where we originally threw in the piece of sugar. In looking at the process of dissolution, it seems natural that once they are 'set loose,' the molecules will begin to evenly distribute themselves throughout the coffee, in every possible direction. However, the opposite process looks unnatural, because of the apparent lack of a guiding force. One of the main laws of thermodynamics (the branch of physics that deals with the heat motion of microscopic bodies) precisely expresses the impossibility of this kind of reconstitution. The law is generally formulated as such: in systems isolated from their environment, the only changes that happen by themselves are the ones that increase disorder among the particles, as well as uncertainty about them. The introduction of a measure to express the degree of disorder, i.e., the internal destructuring of material systems, has proven very useful. This quantity is called entropy, and it is closely related to the name and the work of Rudolf Clausius.

The word 'entropy' made its first appearance in May 1864 in a book called *Abhandlungen über die mechanische Wärmetheorie* (Studies on the mechanical theory of heat) by Rudolf Clausius. Entropy is of Greek origin. The first half is reminiscent of the word 'energy,' and the second comes from *tropos*, or turning point. Clausius's work laid the foundation for classical thermodynamics. The change in the entropy of a physical system is related to the interweaving of mechanical and thermal energy. According to Clausius, the change of the entropy is expressed by dividing the small amounts of warmth in the system with the absolute temperature at which the given energy import (or export) takes place, and then adding up the resulting sums. This definition is mathematically satisfying and corresponds to the computation of an integral. At the same time, however, it rests on no physical consideration or intuition. Entropy, as Clausius defined it, remained mysterious for a long time, precisely because of the lack of a supporting physical concept.

The concept of entropy in the modern sense was clarified in the works of Ludwig Boltzmann. When the best scientists of the world gathered in 1994 to celebrate Boltzmann's 150th birthday, they commemorated at the same time the birth of modern statistical physics. Boltzmann's scientific work consisted of grounding thermodynamics in the motion of individual microscopic bodies, in order to construct a theory that offers a global description of systems constituted by numerous identical particles. At the end of the nineteenth century, this allowed Boltzmann to take the first groundbreaking steps toward developing a statistical point of view in science — something universally applied today. His great idea was to couple entropy with thermodynamic probability. In 1872 he wrote, "problems with the mechanical theory of heat are simultaneously problems of probability theory." In the same year, he invented his famous formula, $S = k \log W$, which can be read today on his tombstone in Vienna's central cemetery (Zentralfriedhof). In this formula, S denotes entropy, k is a constant named after Boltzmann, with a value of 1.38 million erg/centigrade, and W stands for thermodynamic probability, the concept of which was mentioned above.

In Boltzmann's formulation, the entropy of a macroscopic system is the logarithm of the number of microscopic states needed to realize the given macroscopic state. For simplicity's sake, let us say that the macroscopic system is a drinking glass imaginarily split into two hundred pieces. Each of the two hundred shards of glass can be placed in the room in a variety of ways, and each of these shards represents a microscopic state. One of the macroscopic states of this two-hundred-shard-system is the intact glass. Only a very few microscopic states, i.e., arrangement of the shards in the room, will lead to this macroscopic state, because there are just a few possible ways to arrange the two hundred small shards so as to form a drinking glass. Accordingly, the entropy of the state of the intact glass is relatively small. The number of arrangements that produce a broken glass is incomparably large, because the individual pieces can be in literally any position except the right one. This does not lead us to the actual value of the entropy of either an intact or broken glass, but we realize that the entropy of the latter must be considerably greater. Although a drinking glass is not literally a thermodynamic system, this simple example is sufficient to see how plainly Boltzmann's concept of entropy yields the well-known fact that broken glasses will not reconstruct themselves.

The formula S = k log W was engraved on Boltzmann's tombstone not only because it expresses his life's work in a compact form, but also because it significantly contributed to his suicide. At the time, a significant number of physicists even doubted the existence of atoms, to say nothing of the theory based on them. One could claim that it was just a few days — so to speak — after Boltzmann's death that the view of the world based on atoms won a knockout victory.

The next revolutionary step in the history of the concept of entropy is represented by the activities of electric engineer Claude E. Shannon in the 1940s. Shannon gave communications technology a statistical basis and initiated the branch of science we know today as information theory. Information theory deals with the most effective ways of transmitting, coding, and decoding messages. At first glance, it is surprising to see that there is a connection between mixing sugar into coffee and optimal coding. But if we think about the fact that the longer the code required to express a given piece of arbitrary information, such as a telegram, the more complex and therefore more clear the message will be, then we understand immediately that information and uncertainty are antagonists. However, before going into the details concerning Shannon's work, we should mention a few other scientists who have also contributed to the development of the concepts of entropy and information quantity.

Interestingly enough, we have to mention three consecutive years: 1927, 1928, and 1929. At the end of the 1920s, mathematician John von Neumann (who was born in Hungary but spent most of his life in the U.S.A.) investigated the mathematical basis for the new physics — quantum mechanics. In his 1927 work, *Thermodynamics of Quantum Mechanical Assemblies*, he extended Boltzmann's notion of entropy to quantum systems. In 1929 R.V.L. Hartley attempted to introduce a measure for information quantity. He realized the logarithmic nature of the information quantity. According to Hartley, if we have to choose among one thousand possibilities, every individual choice has three units of information. The situation can best be understood if we think of a one-thousand-word dictionary, where each word is numbered from zero to 999. So, in order to find the location of a word, all we need is a number with three digits — that is, we need three digits of information.

Leo Szilard was the first to make a connection between physical — meaning thermodynamic — entropy and information in 1929. Prior to that, in 1871, James Clerk Maxwell came up with the paradox of an imaginary creature capable of harming the second law of thermodynamics. This law excludes the possibility that a volume of gas can spontaneously separate itself into warmer and cooler halves. If, however, two compartments of a single chamber are separated so that there is a little hole on the wall between them through which a molecule can pass, a creature with demonic power could allow the fast molecules to go and stop the slow ones by temporarily closing the leak. In the reverse case, he could let in the slow molecules, but not the fast ones. Thus the 'demon' could create a state in which, after a while, there will be mostly slow molecules in one compartment and mostly fast molecules in the other. Expressed differently, the gas cools down in the first and heats up in the second compartment. Szilard connected the decrease in entropy with the informational needs of the demon: the demon exchanges knowledge — that is, information — for entropy.

No question that there was something similar in the starting positions of Boltzmann and Shannon. Boltzmann approached thermodynamics and the study of heat from a statistical perspective, and Shannon used the same perspective for communications technology. Shannon believed the apparatus for the transfer of information (the communications channel) would deal with signals of stochastic arrival at the input side (whether the signals are Latin letters or otherwise). Messages may be transformed before transmission. The messages can be corrupted while transmitted, yet the ultimate goal is for the end user to have a high degree of certainty regarding the content of the message. For the development of his stochastic information theory, Shannon first needed a way to measure information or uncertainty. His solution of the problem brought him to Boltzmann's formula. Tradition has it that he came to the name entropy like this:

When I found the quantity I needed, my biggest problem was to give it a name. First I thought to call it just information, but as this is a word used so often, I chose uncertainty. When I talked to John von Neumann, he had a better idea. "It should be called entropy," he said. "First, because this measure is known in statistical mechanics under this name; second, because nobody knows what entropy really is, and that is an advantage in conversation."

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The situation is not quite as bad as von Neumann implies. Entropy is the amount of uncertainty, the degree of disorder and the total lack of information. With the aid of von Neumann's playful example, we can learn 'how to make money' using the concept of entropy. It's not about how one can earn a great deal of money, but about how one can take a pile of gold coins and, with the aid of a simple scale, find out which coins are fake by seeing which ones weigh less than the others. The information content of an answer to a question that can only be answered by yes or no is one unit, called a bit. If the number of possible answers is not two but four, eight, sixteen, and so on, then we need not one but two, three, four, and so on bits of information to obtain certainty. So, for example, one of sixteen possibilities has four bits of information. Since $1024 = 2^{10}$, one of a thousand possibilities means almost ten bits of information. We saw above that the same information quantity is equal to 3 Hartley, so we could almost convert information quantities in the way one converts yards to centimeters. But to come back to the weighing of gold coins: first, we observe that weighing with a scale can lead to three possible outcomes (balance, or that or one or the other plate is up). With one pass we can therefore obtain $\log_2 3$ bits of information, but of course only if all possible outcomes have the same probability, otherwise we gain less. For example, with two passes, we can obtain $2 \log_2 3 = \log_2 9$ bit information, and accordingly, with three measurements, we can find the fake coins among the nine possibilities.

It is natural to think that when the probabilities of the possible results are uniformly distributed, the highest possible uncertainty is identical to entropy. This fact can be proven in a number of different ways. We know that the distribution of human height, just as that of a great number of other properties, shows a bell curve, the peak of which is the mean value. In this case, the values around the mean value are a lot more probable than others, and as the distance from the mean increases, the probability of a value decreases accordingly. This regularity can also be explained by entropy: at an arbitrary mean value, with arbitrary distribution, it is the bell curve that maximizes entropy. One can also use entropy to explain the Heisenberg uncertainty relation in quantum mechanics and a number of other natural and maybe social laws. Erwin Schördinger wrote a book in 1946 entitled *What is Life?*, about how organisms feed on negative entropy, just as Maxwell's demon did. Since then, the concept of entropy has been introduced into a number of fields: not only genetics and economy, but also art and aesthetics.

Defined in the exact sense, entropy should always be coupled with the use of a stochastic thinking and a statistical view. In addition, Hungarian and Austrian experts played an important role in the further developments of the concept. Alfred Rényi, founder of the Hungarian school of information theory, succeeded in defining entropy measures, which are applicable when the costs of information transfer are not proportional to the length of messages, but grow exponentially. Rényi's a-entropy was used by Péter Szépfalussy in new models for statistical physics. Imre Csiszár, a follower of Rényi, has achieved notable results in information removal, winning the Shannon Prize in 1996. In the context of quantum entropy, Walter Thierring and his Vienna school of mathematical physicists should also be mentioned. The coupling of quantum mechanics and information theory is corroborated by the recent introduction of new information transfer media such as fiber optics.

4

Leo Szilard

On the Decrease of Entropy in a Thermodynamic System through the Intervention of Intelligent Beings

The objective of this investigation is to find the conditions that apparently allow the construction of a perpetual-motion machine of the second kind, if one permits an intelligent being to intervene in a thermodynamic system. When such beings make measurements, they make the system behave in a manner distinctly different from the way a mechanical system behaves when left to itself. We show that a sort of a memory faculty, manifested by a system where measurements occur, might cause a permanent decrease of entropy and thus violate the second law of thermodynamics, were it not for the fact that the measurements themselves are necessarily accompanied by the production of entropy. At first we calculate this production of entropy quite generally, using the postulate that full compensation is made, in accordance with the second law [equation (1)]. Second, by using an inanimate device able to make measurements — while at the same time continually producing entropy — we shall calculate the resulting quantity of entropy. We find that it is exactly as great as is necessary for full compensation. The actual production of entropy in connection with the measurement, therefore, need not be greater than equation (1) requires.

There is an already historical objection to the universal validity of the second law of thermodynamics, which indeed looks rather ominous. The objection is embodied in the notion of Maxwell's demon, which still appears today in a different form; perhaps not unreasonably, inasmuch as quantitative connections, which have not been clarified to date, seem to be hidden behind the precisely formulated question. The objection in its original formulation concerns a demon that captures the fast molecules and allows the slow ones to pass. To be sure, the objection can be met with the reply that we cannot, in principle, predict the value of a thermally fluctuating parameter. However, one cannot deny that we can very well measure the value of such a fluctuating parameter and could therefore certainly gain energy at the expense of heat by organizing our intervention according to the results of the measurements. Presently, of course, we do not know whether we commit an error by excluding the creature intervening in the system.

Apart from this unsolved problem, we know today that, in spite of the fluctuation phenomena, no perpetuum mobile (perpetual motion machine) of the second kind (or, more exactly, no "automatic machine of continual finite work-yield which uses heat at the lowest temperature" can operate in a system left to itself. A perpetuum mobile would have to be a machine, which, in the long run, could lift a weight at the expense of the heat content of a reservoir. In other words, using fluctuation phenomena in order to gain energy at the expense of heat is just like playing a game of chance in which we may win certain amounts now and then, even though the expected value of the winnings is zero or negative. The same applies to a system where the intervention from outside is performed strictly periodically, say by periodically moving machines. We regard this as established[1] (Szilard, 1925) and the intent here is merely to consider what difficulties might occur when intelligent beings intervene in a system. We shall try to discover the quantitative relations having to do with this intervention.

Smoluchowski writes[2]:

As far as we know today, there is no automatic, permanently effective perpetual motion machine, despite molecular fluctuations. However, such a device might, perhaps, function regularly if it were appropriately operated by intelligent beings...

A perpetual motion machine is therefore possible, if — according to the general method of physics — we consider the person doing the experiments a sort of deus ex machina, someone who is continuously and exactly informed of the existing state of nature and who is able to start or interrupt the macroscopic course of nature at any moment without expenditure of work. Therefore he would definitely not have to have the ability to catch single molecules, like Maxwell's demon, yet he would definitely be different from real living beings in the points mentioned above, since eliciting any physical effect by activating the sensory and motor nervous systems of a human being always involves a depletion of energy — quite apart from the fact that the very existence of a nervous system is dependent on continual dissipation of energy. Considering these circumstances, it is very doubtful that real living beings could continually or at least regularly produce energy utilizing the heat of the lowest temperatures, even though our ignorance of the biological phenomena does not allow a definite answer. However, the latter questions go beyond the scope of physics in the strict sense.

It appears that ignorance of biological phenomena need not prevent us from understanding what seems to be the essential thing. After all, we can be sure that — as far as their intervention in a thermodynamic system is concerned — intelligent living beings can be replaced by non-living devices, whose "biological phenomena" can be traced in order to determine whether there is, in fact, compensation for the decrease in entropy, which would be caused by the intervention of such a device in a system.

In the first place, we want to attempt to understand under what condition a decrease in entropy is produced when an intelligent being intervenes in a thermodynamic system. We shall see that this depends on a special kind

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Cover of *The Collected Works of Leo Szilard. Scientific Papers*, Bernard T. Feld, Gertrud Weiss Szilard, eds. (London/Cambridge: The MIT Press, 1972)

1. See e.g., L. Szilard, Zeitschrift für Physik, 32 (1925): 753.
2. Smoluchowski, *Vorträge über die kinetische Theorie der Materie und Elektrizität* (Leipzig, 1914) p. 89.

3. Translator's note: the author evidently uses the word "ominous" (*bedrohlich*) in the sense that the possibility of realizing the proposed arrangement threatens the validity of the second law.

of coupling among various parameters of the system. We shall consider an unusually simple type of these ominous couplings.[3] For brevity's sake, we shall refer to a 'measurement' if we succeed in coupling the value of parameter y (for instance, the coordinates of the position of a hand of a measuring instrument) at one moment with the simultaneous value of a fluctuating parameter x in the system in order to derive from the value of y the value of x at the moment it was measured. Then x and y are uncoupled after the measurement, so that x can change, while y retains its value for some time. Such measurements are not harmless interventions. A system in which such measurements can be made displays a kind of capacity for memory, in the sense that one can recognize in parameter y what value another parameter x had at an earlier moment. We shall see that this kind of memory would violate the second law if the measurement were to be done without compensation.

We shall realize that the second law is not threatened as much as one might think by the decrease in entropy, as soon as we see that the decrease in entropy resulting from the intervention would be compensated for completely in any event, as long as the execution of such a measurement were, for instance, always accompanied by production of $k \cdot \log 2$ units of entropy. In that case, it will be possible to find a more general entropy law, which applies universally to all measurements. Finally we shall consider a very simple (of course, not living) device that is able to make measurements continually and whose "biological phenomena" we can easily follow. Through direct calculation, one does in fact find a continual production of entropy of the magnitude required by the more general entropy law mentioned above, which is derived from the validity of the second law.

The first example we are going to consider more closely is a typical one: a standing hollow cylinder, closed at both ends, can be divided into two possibly unequal sections of volumes, V_1 and V_2 respectively, by inserting a partition from the side at an arbitrarily established height. This partition forms a piston that can be moved up and down in the cylinder. An infinitely large heat reservoir of a given temperature T insures that any gas present in the cylinder undergoes isothermal expansion as the piston moves. This gas will consist of a single molecule which, as long as the piston is not inserted into the cylinder, tumbles about in the whole cylinder by virtue of its thermal motion.

Imagine, specifically, a person who, at a given time, inserts the piston into the cylinder and somehow notes whether the molecule is caught in the upper or lower part of the cylinder, that is, in volume V_1 or V_2. If he should find that the former is the case, then he would move the piston slowly downward until it reaches the bottom of the cylinder. During this slow movement of the piston the molecule remains, of course, above the piston. However, it is no longer constrained to the upper part of the cylinder, but bounces many times against the piston, which is already moving in the lower part of the cylinder. In this way the molecule performs a certain amount of work on the piston. This work corresponds to the isothermal expansion of an ideal gas — consisting of a single molecule — from volume V_1 to volume $V_1 + V_2$. After some time, when the piston has reached the bottom of the container, the molecule has again the full volume $V_1 + V_2$ to move about in, and the piston is then removed. The procedure can be repeated as many times as desired. The person moves the piston up or down, depending on whether the molecule is trapped in the upper or lower half of the piston. In more detail, this motion may be caused by a weight, for instance, that has to be elevated by a mechanism that transmits the force from the piston to the weight in such a way that the latter is always displaced upward. It is certain that this way, the potential energy of the weight constantly increases. (The transmission of force to the weight is best arranged so that the force exerted by the weight on the piston at any position of the latter equals the average pressure of the gas.) It is clear that in this manner energy is constantly gained at the expense of heat, as long as the biological phenomena of the intervening person are ignored in the calculation.

The best way to understand what the person is actually doing for the system is to imagine that the movement of the piston is machine-driven, and that the person's entire activity consists only in determining the altitude of the molecule and in pushing a lever (which steers the piston) to the right or left, depending on whether the molecule's height requires a down- or upward movement. This means that the intervention of the human being consists only in coupling the two position coordinates (coordinate x, which determines the altitude of the molecule, with coordinate y, which determines the position of the lever and therefore also whether the piston is guided up or down). It is best to imagine the mass of the piston as large and its speed sufficient enough so that the thermal agitation of the piston at the temperature in question is negligible.

In the typical example presented here, we wish to distinguish two periods, namely:

1. the period of measurement when the piston has just been inserted into the middle of the cylinder and the molecule is trapped either in the upper or lower part; so that if we choose the origin of coordinates appropriately, the x coordinate of the molecule is restricted to either the interval $x > 0$ or $x < 0$;

2. the period of utilization of the measurement, 'the period of decreasing entropy,' during which the piston is moving up or down. During this period, the x coordinate of the molecule is certainly not restricted to the original interval $x > 0$ or $x < 0$. Rather, if the molecule was in the upper half of the cylinder during the period of

measurement, that is, when $x > 0$, the molecule must hit the piston moving downward in the bottom half of the cylinder if it is to transmit energy to the piston, meaning that the coordinate x has to enter the interval $x < 0$. On the other hand, during the whole period, the lever retains its position on the right, corresponding to downward motion. If the position of the lever on the right is designated by $y = 1$ (and correspondingly, the position on the left is signified by $y = -1$), we see that during the period of measurement, the position $x > 0$ corresponds to $y = 1$. Afterward, however, $y = 1$ remains, even though x passes into the other interval $x < 0$. We see that in utilizing the measurement, the coupling of the two parameters x and y disappears.

We shall say, quite generally, that parameter y 'measures' parameter x (which varies according to a law of probability) if the value of y is guided by the value of parameter x at a given moment. A measurement procedure underlies the entropy decrease effected by the intervention of intelligent beings.

One may reasonably assume that a measurement procedure is fundamentally associated with a certain definite average entropy production, and that this restores concordance with the second law. The amount of entropy generated by the measurement may of course always be greater than this fundamental amount, but not smaller. To put it precisely: we have to distinguish here between two entropy values. One of them, S_1, is produced when during the measurement y assumes the value 1 and the other, S_2, when y assumes the value -1. We cannot expect to get general information about S_1 or S_2 separately, but we shall see that if the amount of entropy produced by the 'measurement' is to compensate for the decrease in entropy affected by utilization, the relation must always hold good.

$$e^{-\frac{S_1}{k}} + e^{-\frac{S_2}{k}} \leq 1 \qquad (1)$$

One sees from this formula that one can make one of the values, for instance S_1, as small as one wishes, but then the other value S_2 becomes correspondingly greater. Furthermore, one can notice that the magnitude of the interval under consideration is of no consequence. One can also easily understand that it cannot be otherwise.

Conversely, as long as the entropies S_1 and S_2, produced by the measurements, satisfy the inequality (1), we can be sure that the expected decrease of entropy caused by the later utilization of the measurement will be fully compensated.

Bernard T. Feld, Gertrude Weiss Szilard, eds., *The Collected Works of Leo Szilard. Scientific Papers* (London/Cambridge: The MIT Press, 1972) pp. 840-856. Translated by Anatol Rapoport and Mechthilde Knoller from the original article, "Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen," Zeitschrift für Physik, 1929.

4

Leo Szilard

*Curriculum Vitae**

* Written by Leo Szilard as part of a grant application to the General Medical Sciences Division of the National Institute of Health, Bethesda, Maryland, June 1959; later expanded by Gertrude Weiss Szilard.

I was born in Budapest, Hungary, in 1898. I went through officers' school in Budapest during the First World War and also studied engineering there.

In 1920 I left Hungary to continue my engineering studies in Berlin. However, the attraction of physics proved to be too great. Einstein, Planck, Von Laue, Schrödinger, Nernst, Haber, and Franck were at that time all assembled in Berlin, and their physics colloquia were also open to students. I switched to physics and obtained a doctorate in physics at the University of Berlin under von Laue in 1922. My thesis proved that the second law of thermodynamics not only refers to the mean values, as was believed up to then, but also determines the general form of the law that governs the fluctuations of these values. Subsequently, I was a research scientist at the Kaiser Wilhelm Institute in Berlin and later joined the teaching staff (as Privatdozent) at the University of Berlin, where I remained until 1933. During this period, some of the papers I published were experimental and some theoretical in nature. The last one established the connection between entropy and information, which is part of present-day information theory.

In 1933 I went to England. At that time, I considered becoming a biologist, and A.V. Hill said that he would find a position for me as a demonstrator in physiology. However, I was interested in working on the idea that a nuclear chain reaction might be possible if we could find an element that would emit neutrons when bombarded by neutrons. A few months later, Joliot discovered artificial radioactivity, and it seemed to provide an important new research tool in nuclear physics. And so I decided to go into nuclear physics.

In the summer of 1934, I started work as a guest researcher at St. Bartholomew's Hospital in London, and this work resulted in the establishment of the Szilard-Chalmers reaction and the discovery that beryllium emits slow neutrons if it is exposed to radium gamma rays. In 1939, after the discovery of uranium fission, the slow beryllium neutrons made it possible to see that uranium emits neutrons when bombarding slow neutrons.

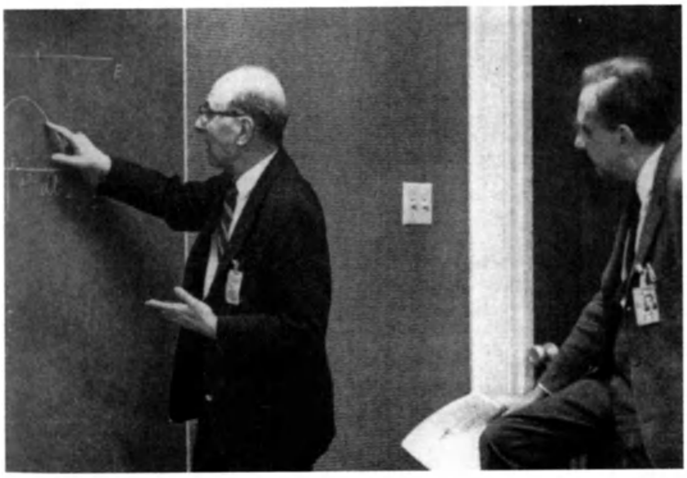
In 1935, after a visit to New York, where I spent a few months as a research associate at New York University, I accepted a position at the Clarendon Laboratory at Oxford University. During this period I worked in the field of nuclear physics. In 1938 I came to America under an arrangement with Oxford University, which permitted me to spend half my time in the United States. I was in the United States during the time the Munich Agreement was negotiated. After Munich, I decided to stay in the United States on a full-time basis, and so I resigned from my position at Oxford.

In January 1939 I learned of the discovery of fission. It seemed extraordinarily important to clear up the question of whether neutrons were emitted in the process, for if that were the case, a chain reaction in uranium had to be regarded as a serious possibility. I therefore asked permission of Columbia University to work there as a guest researcher and perform an experiment in order to settle this question. The experiment that Walter Zinn and I conducted led to the discovery that uranium emitted neutrons, which is the basis for a chain reaction. The same discovery was made independently at about the same time by Fermi and his colleagues, as well as by Joliot and his group.

The "Emergency Committee" of the nuclear scientists in the late 1940s.
in the back (from left to right): Victor F. Weisskopf, Leo Szilard, Hans A. Bethe, Torfin R. Hogness, Philip M. Morse; in front (from left to right): Harald C. Urey, Albert Einstein and Selig Hecht.

In July 1939 I recognized that a chain reaction might be set up in a system composed of graphite and uranium. Because of the serious consequences of this possibility, it seemed that this was a matter in which the government ought to take an interest. I therefore went to see Professor Einstein to enlist his help in approaching the government. After several consultations, in which E. P. Wigner and Edward Teller participated, Einstein wrote a letter to President Roosevelt; in response to this letter, the President appointed a committee under the chairmanship of the Director of the National Bureau of Standards.

Albert Einstein and Leo Szilard writing the famous letter to Franklin D. Roosevelt, August 2, 1939.



Eugene P. Wigner and Edward Teller, the "father of the H-bomb"

John von Neumann and Robert Oppenheimer

In February 1940 I described the uranium-graphite system, which would cause a chain reaction, in a paper I sent to the *Physical Review* (February 1940). This paper was classified as secret and therefore not published at the time. In November 1940 a government contract was given to Columbia University for the development of the graphite-uranium system, and I became a member of Columbia University's National Defense Research Staff. Early in 1942, our group was moved to the University of Chicago, and on December 2, 1942, a chain reaction was created. Soon afterward, the Atomic Energy Commission patented the graphite-uranium system capable of causing a chain reaction under the names of both Enrico Fermi and myself.

In 1943 I became a naturalized citizen of the United States of America. In October 1946 I joined the staff of the University of Chicago as professor of biophysics at the Institute of Radiobiology and Biophysics. The institute never fulfilled the hopes had for it; it had a succession of directors and was soon dissolved. I remained on the staff of the University of Chicago as professor of biophysics and was transferred to the Enrico Fermi Institute for Nuclear Studies.

When, in 1946, I was faced with the task of converting myself into a biologist, I teamed up with Dr. Aaron Novick, a physical chemist I had met while working on the uranium project. We both got our training in biology through summer courses, such as Dr. Delbrück's course in bacterial viruses at Cold Spring Harbor and Dr. Van Niel's course in bacterial biochemistry at Pacific Grove. Dr. Novick and I worked as a team until the Institute of Radiobiology and Biophysics was dissolved.

When we started out, we tried to understand a striking phenomenon that had just been discovered by A. Kelner, who showed that bacteria killed by ultraviolet light can be reactivated by shining visible light at them. After thoroughly investigating the phenomenon, we concluded that it could be explained by assuming that there is a poisonous material produced by ultraviolet light and decomposed by visible light. This explanation seemed at first to contradict Dulbecco's work on the reactivation of bacterial viruses killed by ultraviolet light, but at the same time, it was widely accepted in many circles. My own interest in the subject waned after I could realized that we were dealing with a phenomenon in the lives of bacteria that had no useful biological purpose.

Since we assumed that viruses were much simpler than bacteria, we then turned our attention to the study of viruses. We obtained some very interesting results, but decided after a while to return to the study of bacteria. We were particularly interested in two phenomena: (a) mutations and (b) the formation of adaptive enzymes, as the latter promised to be an important tool for the study of protein synthesis.

We were dissatisfied, however, with the methods that were available for the study of these phenomena. Our opinion was that it was necessary to study the development of bacterial populations under steady conditions, and so we thought up the notion of a continuous flow device. We developed such a device, which we called a Chemostat. This device made it possible to modify the rate of growth of the bacteria so that we the could determine the concentration of the selected growth factor as we wished.

We started out by using the Chemostat to study mutations and obtained quite unexpected results at the very outset. It turned out, for instance, that the frequency of mutations does not alter when we change the rate at which the bacteria divide; we could vary the rate of growth within a wide range without changing the rate at which these mutations occurred. We found one family of chemical compounds, purines, which increased the frequency of mutations in bacteria tenfold without any appreciable destruction. We also found antimutagens, which, in very small concentrations, were able to fully counteract the effect of purine-type mutagens.

There were evolutionary changes in the bacterial population maintained in the Chemostat. One strain of bacteria was quickly replaced by a mutant strain, which grew faster under the prevailing conditions in the Chemostat. We observed successive evolutionary steps of this sort, and when the experiment was of sufficient duration, we were able to analyze the phenomenon in detail.

After the dissolution of the Institute of Radiobiology and Biophysics, I did not maintain a laboratory. Over the past few years, my interests have centered mainly on quantitative studies of general biological phenomena, with a strong emphasis on molecular biology. My most recently published paper constituted an attempt to provide a quantitative theory of the process of aging, which should be applicable to mammals.

Bernard T. Feld, Gertrude Weiss Szilard, eds., *The Collected Works of Leo Szilard. Scientific Papers* (London/Cambridge: The MIT Press, 1972) pp. 3-5.

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Einstein Letter to President Franklin D. Roosevelt
(August 2, 1939)

Albert Einstein
Old Grove Road
Nassau Point
Peconic, Long Island

August 2nd, 1939

F. D. Roosevelt
President of the United States
White House
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an inofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the cooperation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,
[Signed] Albert Einstein

Szilard Memorandum
Attached to Albert Einstein's Letter to the President
(August 15, 1939)

MEMORANDUM

August 15, 1939

Much experimentation on atomic disintegration was done during the past five years, but up to this year the problem of liberating nuclear energy could not be attacked with any reasonable hope for success. Early this year it became known that the element uranium can be split by neutrons. It appeared conceivable that in this nuclear process uranium itself may emit neutrons, and a few of us envisaged the possibility of liberating nuclear energy by means of a chain reaction of neutrons in uranium.

Experiments were thereupon performed, which led to striking results. One has to conclude that a nuclear chain reaction could be maintained under certain well defined conditions in a large mass of uranium. It still remains to prove this conclusion by actually setting up such a chain reaction in a large-scale experiment.

This new development in physics means that a new source of power is now being created. Large amounts of energy would be liberated, and large quantities of new radioactive elements would be produced in such a chain reaction.

In medical applications of radium we have to deal with quantities of grams; the new radioactive elements could be produced in the chain reaction in quantities corresponding to tons of radium equivalents. While the practical application would include the medical field, it would not be limited to it.

A radioactive element gives a continuous release of energy for a certain period of time. The amount of energy which is released per unit weight of material may be very large, and therefore such elements might be used—if available in large quantities—as fuel for driving boats or airplanes. It should be pointed out, however, that the physiological action of the radiations emitted by these new radioactive elements makes it necessary to protect those who have to stay close to a large quantity of such an element, for instance the driver of the airplane. It may therefore be necessary to carry large quantities of lead, and this necessity might impede a development along this line, or at least limit the field of application.

Large quantities of energy would be liberated in a chain reaction, which might be utilized for purposes of power production in the form of a stationary power plant.

In view of this development it may be a question of national importance to secure an adequate supply of uranium. The United States has only very poor ores of uranium in moderate quantities; there is a good ore of uranium in Canada where the total deposit is estimated to be about 3000 tons; there may be about 1500 tons of uranium in Czechoslovakia, which is now controlled by Germany; there is an unknown amount of uranium in Russia, but the most important source of uranium, consisting of an unknown but probably very large amount of good ore, is Belgian Congo.

It is suggested therefore to explore the possibility of bringing over from Belgium or Belgian Congo a large stock of pitchblend, which is the ore of both radium and uranium, and to keep this stock here for possible future use. Perhaps a large quantity of this ore might be obtained as a token reparation payment from the Belgian Government. In taking action along this line it would not be necessary officially to disclose that the uranium content of the ore is the point of interest; action might be taken on the ground that it is of value to secure a stock of the ore on account of its radium content for possible future extraction of the radium for medical purposes.

Since it is unlikely that an earnest attempt to secure a supply of uranium will be made before the possibility of a chain reaction has been visibly demonstrated, it appears necessary to do this as quickly as possible by performing a large-scale experiment. The previous experiments have prepared the ground to the extent that it is now possible clearly to define the conditions under which such a large-scale experiment would have to be carried out. Still two or three different setups may have to be tried out, or alternatively preliminary experiments have to be carried out with several tons of material if we want to decide in advance in favor of one setup or another. These experiments cannot be carried out within the limited budget which was provided for laboratory experiments in the past, and it has now become necessary either to strengthen—financially and otherwise—the organizations which concerned themselves with this work up to now, or to create some new organization for the purpose. Public-spirited private persons who are likely to be interested in supporting this enterprise should be approached without delay, or alternatively the collaboration of the chemical or the electrical industry should be sought.

The investigations were hitherto limited to chain reactions based on the action of *slow* neutrons. The neutrons emitted from the splitting of uranium are fast, but they are slowed down in a mixture of uranium and a light element. Fast neutrons lose their energy in colliding with atoms of a light element in much the same way as a billiard ball loses velocity in a collision with another ball. At present it is an open question whether such a chain reaction can also be made to work with *fast* neutrons which are not slowed down.

There is reason to believe that, if fast neutrons could be used, it would be easy to construct extremely dangerous bombs. The destructive power of these bombs can only be roughly estimated, but there is no doubt that it would go far beyond all military conceptions. It appears likely that such bombs would be too heavy to be transported by airplane, but still they could be transported by boat and exploded in port with disastrous results.

Although at present it is uncertain whether a fast neutron reaction can be made to work, from now on this possibility will have to be constantly kept in mind in view of its far-reaching military consequences. Experiments have been devised for settling this important point, and it is solely a question of organization to ensure that such experiments shall be actually carried out.

Should the experiments show that a chain reaction will work with *fast* neutrons, it would then be highly advisable to arrange among scientists for withholding publications on this subject. An attempt to arrange for withholding publications on this subject has already been made early in March but was abandoned in spite of favorable response in this country and in England on account of the negative attitude of certain French laboratories. The experience gained in March would make it possible to revive this attempt whenever it should be necessary.

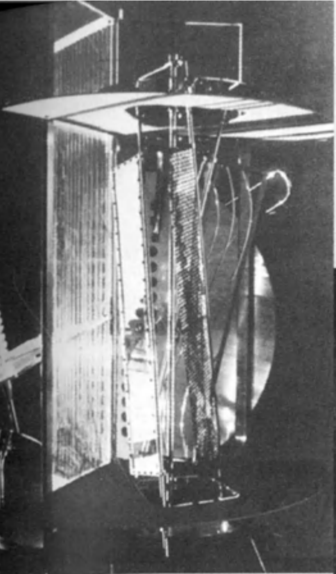
Leo Szilard

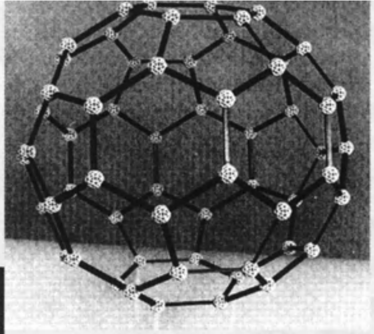
cybernetics computer science computer art

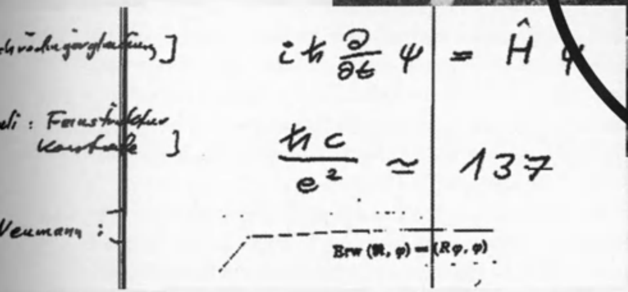
Automaton theory and cybernetics arose from the efforts to technically transpose the results of mathematical logic and abstract information theory. The comparison of machines and lives from the perspective of their capacity to be controlled is expressed in the subtitle of the book that is the basis for cybernetics, Norbert Wiener's *Cybernetics or Control and Communication in the Animal and the Machine*, 1948.

Innovative contributions to the development of cybernetics were accomplished not only in the U.S.A., England, and France, but also in Austria and Hungary. Heinz von Foerster, who confessed that he owed much to the Vienna Circle's style of thought, co-published the first conference series on cybernetics, *Cybernetics. Circular Causal and Feedback Mechanisms in Biological and Social Systems*, from 1951to 1955. John von Neumann built one of the first computers and delivered pioneering ideas for automaton theory, such as cellular and self-reproducing automata, which are still relevant today (Peter Weibel). Gőző Kovács provides portraits of the most important Hungarian pioneers in calculation techniques and cybernetics (John von Neumann, István Juhász, Tihamér Nemes, László Kozma, and László Kalmar). Tihamér Nemes and Heinz Zemanek give an overview of the history of cybernetic machines, in which they themselves were also involved. Among other things, Hermann Maurer also reports on his networked data bank system, Hyper-G, which reveals problems similar to those of the World Wide Web.
From guidance theory and the control of guidance mechanisms comes the knowledge that the observational process itself must be observed. Heinz von Foerster differentiates between cybernetics of a first order, the cybernetics of observed systems — and cybernetics of a second order, the cybernetics of observing systems. The realization of the crucial significance of this kind of feedback from observing systems leads to the hypothesis that similar processes of loop formation also play an important role in the construction of reality. Adding a logical communications theory to all of this, Heinz von Foerster, Ernst von Glasersfeld, Paul Watzlawick, and others founded a school of radical constructivism. From the constructivist question of what does the eye tell the brain (Warren McCulloch) comes the question of how the brain and neuronal networks construct the world. Thomas Natschläger's article on the works of Wolfgang Maass and his team provide information about theoretical computer science, which is involved with neuronal networks.

Telematic information technology, perception equipment, and calculating machines opened up a completely new territory for art. Attila Kovács developed cybernetic sculptures out of the concept of automated machines, and Nicolas Schöffer developed cybernetic cities. Art also discovered that the process of seeing itself can be observed, and this observation mechanism of a second order can be perfected with mechanical support. In video art, these kinds of feedback and loops are employed in closed-circuit installations. The computer not only makes it possible to model and simulate both real and unreal scenarios, but it also creates a new relationship to the work of art itself: interaction (Peter Weibel). Axel Pinz provides an introduction to current computer vision and computer graphics. Miklós Peternák offers an overview of the high quality of Hungarian computer art (e.g., Gábor Body, Krisztián Frey) and of the work of Hungarian computer artists abroad (such as Charles A. Csuri, Tamás Waliczky, and George Legrady). Austrian pioneers such as Otto Beckmann and Richard Kriesche show the entire spectrum of machine art, from digital to telematic. Following them, Karel Dudesek, knowbotic research, Franz Xaver, and Konrad Becker present their current developments (interactive TV, electronic gallery, net art, etc.).



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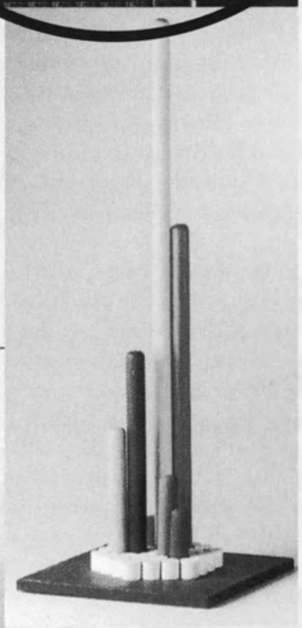

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cybernetics
computer science
computer art

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Heinz von Foerster

Circular Causality
The Beginnings of an Epistemology of Responsibility

The pieces and period I wish to talk about fall into the immensely fruitful decade between 1943 and 1953. It was the decade of catalytic conferences — the New York Academy of Science, the Macy Foundation, the Hixon Symposium, et cetera; of McCulloch's formidable papers on a calculus of ideas, a heterarchy of values, how we can come to know universals, etc.; and of the publication of Norbert Wiener's *Cybernetics* in 1948, the midpoint of this period. It was the decade of a con-spiracy, a sort of 'breathing together,' where a score of curious, fearless, articulate, ingenious, and pragmatic dreamers conformed by letting diversity be their guide. I am fascinated by the stream of concepts and insights, invented relations, perceptions, thoughts, ideas, and the questions unanswered and answered that poured forth from these people.

Were we witnesses to the emergence of a new paradigm, a model, a new way of seeing things at a different angle? No! What was talked about then was not a model of 'something.' Seeing things at a different angle requires 'things,' but there were none. The problem was not things, it was seeing. Here I shall talk about seeing.

I left Vienna for the United States and arrived on the Queen Mary in New York in February 1949. My luggage was minimal: a small suitcase, an Austrian passport with a three-month visitor's visa, a minimal English vocabulary, and ten copies of a short monograph on memory I had written the year before, which I planned to mail to old friends whom I had not seen for more than fifteen years. The title of the monograph was *Das Gedächtnis: Eine quantenphysikalische Untersuchung* (Memory: a quantum physical treatise).

For the benefit of their audiences, world travelers always discover the comforts of home even if they have arrived on the remotest planets: everything is just as it is at home; even the same language is spoken. But this was not the case in going from Vienna to New York in 1949: they were two worlds apart.

In the almost four years that had passed between the two great plagues (Hitler's invasion and Stalin's conquest) and my departure, life in Vienna had improved. It was no longer necessary to walk the streets in convoys; the long lines of women raped at gunpoint, who waited for abortions at the few hospitals, were gone. Gone was the haunting fear, flooding mind and heart, that friends who did not arrive punctually for an appointment had, as so many others, vanished without a trace — although they might simply have been late. Gone were the huge posters that had appeared when the Western allies joined the Russians in administering the affairs of Vienna. What posters? Enormous photographs taken in concentration camps: the mangled, emaciated, naked corpses tossed onto piles; the caption: "This is your responsibility."

I had to explore New York immediately the night I arrived. Times Square, flooded in light, people pouring from theaters, restaurants, bars, busy stores, cars squeezing through crowded streets, sailors, mink coats, beggars, posters high above our heads. What posters? One very high up, five hundred square feet of an enormous photograph of the face of a man smoking a cigarette, puffing real smoke. The caption: "Smoke Camels."

A telegram from Chicago three days later was the first response to my mailings, "Want to know more about your monograph. Come at once." Capital Airlines had a night flight for $18.00 leaving New York soon after midnight, arriving in Chicago at six in the morning. At nine I was at the Neuropsychiatric Institute of the University of Illinois Medical School and met the man who wanted to know more: tall, lanky, a grayish beard, an inviting grin, and the eyes! Eyes that supported the Greek notion of vision. Not the light falling on the eyes, but the look beaming forth from them, which touches what they see with joy. And so I met Warren McCulloch.

We immediately immersed ourselves in my paper: the assumptions, the mathematics, the results. I had the feeling that we were inventing the whole story then and there, every step an adventure, every understanding a celebration. My limited knowledge of the language is no obstacle (I sense this with growing wonderment). That day I learned two things. First, my theory's numerical consequences came close to the physiologist's hope that such numbers could be derived from some general notions, notions whose significance I was then unaware of. Second, that these notions ("feedback," "closure," "circularity," "circular causality," etc.) are conditions sine qua non — the seeds, the nuclei for a physiological theory of mentation. Moreover, McCulloch invited me to present my story three weeks later at the "Macy meeting," and told me to read at once a recently published book, *Cybernetics*, by Norbert Wiener. That meeting was The Sixth Conference on Circular Causal and Feedback Mechanism in Biological and Social Systems, held in New York, March 24th to 25th, 1949. The host was the Josiah Macy Jr. Foundation, whose major contribution to medical research was its conference program. About two dozen conferees from various fields or disciplines attended the five annual (or biannual) conferences to discuss a dozen or so critical topics.[1] Guests were invited for one or more meetings.

If Frank Fremont-Smith, the Foundation's conference program director, did not coin the word "interdisciplinary," then at least he may well have invented the concept. Fremont-Smith was a gregarious, elitist intellectual who sensed and set a trend in medical research by recognizing and bringing together people with new ideas, allowing them access to his foundation's financial and organizational apparatus in order to hold such conferences. McCulloch was the chairman of the conference I was going to attend, and I was about to become part of a myth — although a small part, indeed. A kind of Aristodemus, who attended a gathering of friends

Heinz von Foerster, born 1911 in Vienna. Studied physics at the Technische Hochschule in Vienna and the University of Breslau. Emigrated to the United States in 1949, and was named professor for computer science in the same year. Appointed professor for biophysics and physiology at the State University of Illinois in 1958. That same year, he founded the Biological Computer Laboratory (BCL), an interdisciplinary research institute, which he led until his retirement thirty years later. Von Foerster received many awards and was an honorary professor at the University of Vienna since 1996. He died in 2002 in Pescadera, California.

Heinz von Foerster

1. Damaged livers, regulation of blood pressure, biological antioxidants, infancy and childhood, blood clots, metabolism, problems of aging, adrenal cortex, kidney function, nervous impulses, planes of consciousness, diseases of the connective tissue.

celebrating Agathon, the fabulous symposium at Agathon's house. As Plato tells us, Aristodemus could not quite remember precisely what was said when he tried to describe the events of that night to Apollodorus. So what we know today (if we can trust Plato) comes only from Apollodorus, who admits he had to make up for occasional slips of memory when he re-told it to Glaucon while walking with him from Phalerum to Athens. "How long ago was this celebration?" Glaucon asked, assuming it had just taken place. But that assumption did not agree with the facts. "Most of the people who were there are dead now."

Like its early precursors in Athens, where participants were sensors and shapers, the driving forces behind an integral understanding of thought, language, and action (today only understood within narrow categories such as 'philosophy,' 'poetry,' 'politics,' etc.), the New York meeting gathered minds that were sensors and shapers, the driving forces behind a new view of science, of a new "scientific paradigm," as it was referred to two decades later.

However, unlike the meeting in Agathon's house, there was no orderly sequence of presentation, no way to find out who would speak next or what he would say. Instead there was a continuous stream of dialogue among people who asked, listened, told, clarified, doubted, argued, admonished, supported, admitted ignorance, hypothesized, erred, and who vastly enjoyed maintaining that continuous stream of dialogue. At first I was not quite sure what all these people were conversing about. In fact, it looked to me as if the discussion was a Ping-Pong game with only a single ball, played by the twenty participants as fast as could be played — but not so fast that the ball could not be returned. Of course, my understanding grew during the meeting; for moments I thought I knew what it was all about. But I sensed that there was something that drove this group on and on, something that I was missing.

Heinz von Foerster and James W. Beauchamp, eds., *Music by Computers* (New York/London /Sydney/Toronto: John Wiley and Sons, Inc., 1969)

Kindness and politeness interrupted the Ping-Pong game when I was asked to report on my theory of memory (which I stumblingly did). Afterward, the game was immediately continued, first with my theory as the ball, later shifting to more general aspects of recognition and recall.

As a guest, I was not included in the official meeting that night. But when I was called in again, the chairman, Warren McCulloch, announced to me that because my poor English was poor, they had been trying to find a way for me to acquire this language quickly and efficiently. They had found it, I was told: they were appointing me editor of the Proceedings of this conference, to be published as soon as possible. I was flabbergasted! When I had found my voice, I said that since I felt that the conference title — *Circular Causal and Feedback Mechanisms in Biological and Social Systems* — was too cumbersome, and wondered whether it could not simply be called *Cybernetics*, with the present title as subtitle. When this motion was immediately and unanimously accepted with laughter and applause, Norbert Wiener, eyes wet, walked out of the room to hide his emotion.

Four weeks later I received a stack, three inches thick, of legal-sized green paper, the transcript of the steno-recordings typed during the conference by a most remarkable lady stenographer. At the very beginning of the conference, she asked each person to say his name, along with a few extra words for voice identification. During this exercise she had her eyes fixed to the ceiling, giving the appearance of a blind woman. After that she prefixed every utterance during the entire conference with three letters indicating the speaker — with no single error I could discover.

Working through the transcript at my own speed, I began to see what was beneath the polished surface of the dialogue, which had been burnished by all the previous dialogues until it was "smooth as a Brancusi egg," as McCulloch said, and I took pains to keep it this way. He finally told us in his summary at the last Macy conference:

> *I am compelled to watch your faces and to guess, before I let you have the floor, whether you will speak to the point or not, and from which side of the fence. With malice aforethought I have given the malcontent the floor, because he doubted, or disagreed, however unreasonably. Before I knew you so well this happened by accident, but as time went on, and we learned one another's languages, I learned that it was the best way to keep our wits on their toes.*

Heinz von Foerster, *KybernEthik*, from the series *Perspektiven der Technokultur*, Peter Weibel, ed. (Berlin: Merve Verlag, 1993)

I saw, and saw it ever more clearly at later conferences that as a surprisingly diverse number of themes were under discussion — such as psychological moment, neurotic potential, sensory prosthesis, digital notions in the central nervous system, maze solvers, homeostasis, mechanical chess machines that outplay their designers, learning processes in the octopus, the growth of enormous shells in freshwater crabs, reduction of the number of possible Boolean functions, nucleocytoplasmic feedback systems in Paramecium Aurelia, measures of semantic information, communication among animals, humor, meaning, learning processes in wasps and ants, narcolepsy, hypnosis, grief, laughter, circular causality, and much more — a door was being opened slowly yet forcefully to let someone in, a person excluded from all these orthodox scientific investigations: the investigators; the observer; me, who now asks, "who am I?" "But let us compel our physicist to account for himself..." suggests McCulloch in one of the introductory paragraphs of *Why the Mind is in the Head*; and he continues:

In all fairness, he must stick to his own rules and show in terms of mass, energy, space, and time how it comes about that he creates theoretical physics. He...will be compelled to answer if theoretical physics is something he can discuss in terms of neurophysiology. To answer 'no' is to remain a physicist undefiled. To answer 'yes' is to become a metaphysician — or so I am told.

It was this very ambitious paper that he read to participants at the Hixon Symposium, a small group of leading neurophysiologists, psychiatrists, and experimental psychologists centered around John von Neumann, the mathematician, the "inside outsider." Most of the participants knew or had heard about the McCulloch-Pitts paper, *A Logical Calculus of the Ideas Immanent in Nervous Activity*, published five years earlier. They knew, too, of the other crucial contribution of a year before, *How We Know Universals: The Perception of Auditory and Visual Form*, also written by Pitts and McCulloch. In fact, in his opening talk, John von Neumann gave full credit to the earlier paper on the logical calculus of ideas. He devoted a whole section to formal neural networks and to "...the remarkable theorems of McCulloch and Pitts on the relationship of logics and neural networks."

The stage is set, and McCulloch's talk, which followed von Neumann's, catapulted into a grand panorama, weaving anew the magnificent tapestry of interrelation between logic, neural activity, neural organization, computation, perception, cognition, will and consciousness, and finally, the limits of structures and the potential of creations.

Or so it appears when one is looking at the pattern on the front of that tapestry. However, if we turn it over to see how it holds together, it becomes clear that McCulloch had taken the part of the physicist who answered "yes" when asked to account for his physics with neurophysiology, i.e., to account for himself. Was this, therefore, an essay in metaphysics? Most certainly not, in the orthodox sense. It was the development of the contextual structure, inside of which we can speak of reflection, meaning seeing oneself through oneself, meaning causing oneself: the shortest causal loop. The knowledge of one's knowledge, an epistemology showing us where knowledge comes from, not what we know: an experimental epistemology.

Not metaphysics, but epistemology was at the core of this lecture. Metaphysics, and not epistemology, however, is what some of the participants thought they had heard, and some among them did not like it. "Dr. McCulloch's explanation...introduces more histological assumptions ad hoc than seem compatible with usual standards of plausibility." A major discussion developed, which (in transcript) was more than four times as long as the paper. Questions were asked whose answers generated ever more questions, until Hank Brosin, a skillful chairman of gentle wisdom, returned the floor to McCulloch for a major reply.

The reply was about half the length of the formal presentation given before. The reply had no title. But if there had been one, it might have been, *Why I Mind What's in the Head*, for in it, he tells us what moved him to see the way he sees. He opens with a reminder: "If you will remember, I suggested that we ask the theoretical physicist to account for himself..." and then he tells us how he, Warren McCulloch, accounts for himself. "I believe...," "I think...," "I don't think...," "I would try...," "I am sure...," and so on, referring more than a hundred times to himself, while in his formal paper he does so only twice, including this final sentence,

The job of creating ideals, new and eternal, in and of a world, old and temporal, robots have it not. For this my mother bore me.

I do not know when McCulloch first met Frank Fremont-Smith. It could well have been in 1942, when McCulloch participated in a conference on central inhibition in the nervous system, sponsored by the Macy Foundation. Norbert Wiener says in his introductory (essentially historical) chapter in *Cybernetics* that it was at this meeting that he, together with Julian Bigelow and Arturo Rosenblueth, distributed a draft of what later became their seminal paper, *Behavior, Purpose and Teleology*, which was published the following year — the same year that saw the publication of McCulloch's and Pitts's *Calculus of Ideas*. Soon afterwards, John von Neumann joined this group, and, early in 1944, arranged a most fruitful meeting[2] where "engineers, physiologists, and mathematicians were all represented." "But," as Wiener continues, "Drs. McCulloch and Fremont-Smith have rightly seen the psychological and sociological implications of the subject, and have co-opted into the group a number of leading psychologists, sociologists, and anthropologists."

This was what set the ten Macy Conferences in motion (1946-1953). Of the first five, alas, there are no records, either published or in the files of the foundation; and the published transactions of the last five have long been out of print. They have become an 'oral tradition,' a myth. Two other conferences, complementary to the Macy Meetings and sandwiched between them, were most likely stimulated by the Macy Meetings' catalytic action. One was the Hixon Symposium mentioned earlier, and the other was the conference on Teleological Mechanisms, sponsored by the New York Academy of Sciences, which included Norbert Wiener, Evelyn Hutchinson, W.K.

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2. The "Princeton Meeting" on regulation.

Erwin Lang, *The Dancer Grete Wiesenthal*, 1912

Trude Fleischmann
Grete Wiesenthal, 1929

A family chronicle from the days of the Austro-Hungarian Empire: The mother of Heinz von Foerster, Lilith Lang, had a brother, graphic artist Erwin Lang. Uncle Erwin Lang married the dancer Grete Wiesenthal, whose son, Martin Lang, the cousin of Heinz, became his lifelong friend. Heinz von Foerster's brother, Uzzi, was one of the most important jazz musicians of Austria after 1945. Lilith Lang was a fellow student of Oskar Kokoschka at the Kunstgewerbeschule (school of arts and crafts) in Vienna. She appears in his poem, *Die träumenden Knaben* (The dreaming boys) as "Mädchen Li" (girl Li). Viennese poet Peter Altenberg also adored her. Lilith's younger brother, Heinz Lang, fell in love with Lina, the first wife of Adolf Loos, when he was about eighteen. Lina's proposal for separation was met by Loos in such a generous way that she returned to Loos. Heinz Lang sought advice from Peter Altenberg, who jokingly told him to commit suicide — which Heinz actually did in 1904. Arthur Schnitzler wrote about this incident in an unfinished and unpublished drama, *Das Wort* (The word). Shortly afterward, Lina and Adolf Loos were divorced. **(The editor's short biographical note on Heinz von Foerster.)**

Livingston, and Warren McCulloch as speakers. In the Annals of the Academy, a foreword by Lawrence K. Frank is added to their papers. The first lines of this foreword of more than thirty years ago, perplexing as they may sound, provide a historical context. "The title of this conference, *Teleological Mechanisms*, may be somewhat perplexing or difficult to accept to some who are encountering it for the first time."

One might have expected Norbert Wiener to take the title of this conference as the central theme of his opening address. But telos, goal, purpose, appear only peripherally in his presentation, Time, Communication, and the Nervous System. Its main thrust was to demonstrate a link between the unidirectional flow of events in statistical thermodynamics with the unidirectional flow of events in communication. It was to become a cornerstone in the development of what is now called "information theory."

The other speakers, however, squarely took on the theme of the conference: *Circular Causal Systems in Ecology* (Hutchinson), *The Vicious Circle in Causalgia* (Livingston), and finally, Warren McCulloch spelled out the central questions of a twentieth century teleology.

What characteristics of a machine account for its having a Telos, or end, or goal? And what characteristics of a machine define the end, or goal, or Telos?

In this address, as on two other occasions, he gives a historical perspective to the fate of Aristotle's fourth category of cause, causa finalis, the final cause, the succubus of the concept of Telos, in its use from pre-Aristotelian times to the present. In contrast to the historian of science who would write, "Ptolemy believed...but we know...," McCulloch, the scientist seeing himself in the past, tells us, "Ptolemy knew...but we believe...."

The two other occasions for such flashbacks are McCulloch's accounts of the last Macy conference, and his farewell to all participants, which concluded the series of immensely stimulating and constructive conferences. He calls it *Summary of the Points of Agreement Reached in the Previous Nine Conferences on Cybernetics*.

As with men, who, at the end of their efforts, knew that they knew and allowed this knowledge to cloud their insight with melancholy ("Whereof we cannot speak, thereof we must remain silent," the last proposition in Wittgenstein's *Tractatus*), so McCulloch's sense of responsibility made him voice his apprehension that the successful and celebrated brain children of this group might be misbegotten. His last words of farewell were, "it is my hope that by the time this session is over, we shall have agreed to use very sparingly the terms 'quantity of information' and 'negentropy.'"

I have no doubt that Warren McCulloch, the experimental epistemologist, sensed that his warnings might not be heeded, as is shown by the outcome of an experiment of his own design:

Ten years ago I tried an experiment. There was a meeting of the American Psychiatric Association in Detroit. I was then intrigued by the Lear Komplex, which is the subject of a paper coming out of Vienna concerning the play of King Lear, and it proves that Mrs. Lear is the all-important person, because she is not once mentioned. My experiment was the following: in the hotel in Detroit there was a rather large and comely bear. Drs. Frank Fremont-Smith and Molly Harrower cottoned on to the bear and they paraded it through the hotel. They gave me the idea of what I think is the nicest of all yarns I have ever invented. The story is the following. They brought the bear to the conference room. One psychiatrist after another would look at the bear sitting among them, and then snap his head back to the front. You could count ten, and each one would take a second look and snap his head back to the front. Several years later I asked Drs. Fremont-Smith and Harrower whether any of the psychiatrists had said anything to either of them about seeing a bear at the meeting. They said, 'no.' I have told this story wherever psychiatrists were gathered together and shall continue to tell it. My esteemed friend, Dr. Alexander Forbes, heard me tell the story and at once went to Dr. Harrower and asked, 'did you really have a bear at the meeting?' She replied, 'no.'

Heinz von Foerster, "Circular Causality. The Beginnings of an Epistemology of Responsibility," *The Collected Works of Warren S. McCulloch*, 121 (Salinas 1989).

Lilith Lang, a personal photograph with an inscription by Peter Altenberg

5

Heinz von Foerster

Cybernetics of Cybernetics

As you may remember, I opened my remarks at earlier conferences of our Society with theorems which, owing to the generosity of Stanford Beer, have been called "Heinz von Foerster's Theorems Number One and Number Two." This all is now history. However, building on a tradition of two instances, you may rightly expect me to open my remarks today again with a theorem. Indeed I shall do so, but it will not bear my name. It can be traced back to Humberto Maturana,[1] the Chilean neurophysiologist, who, a few years ago, fascinated us with his presentation on "autopoiesis," the organization of living things. Here is Maturana's proposition, which I shall now baptize Humberto Maturana's Theorem Number One: "Anything said is said by an observer." Should you at first glance be unable to sense the profundity that hides behind the simplicity of this proposition, let me remind you of West Churchman's admonition of this afternoon: "You will be surprised how much can be said by a tautology." This, of course, he said in utter defiance of the logician's claim that a tautology says nothing. I would like to add to Maturana's Theorem a corollary which, in all modesty, I shall call Heinz von Foerster's Corollary Number One: "Anything said is said to an observer." These two propositions establish a nontrivial connection among three concepts, the first being that of an observer who is characterized by the ability to describe. This is due to Theorem One. Of course, what an observer says is a description. The second concept is that of language. Theorem One and Corollary One connect two observers through language. But, in turn, with this connection we have established the third concept I wish to consider this evening, namely that of society: the two observers constitute the elementary nucleus of a society. Let me repeat the three concepts that are connected to each other in a triadic fashion. They are: first, the observers; second, the language they use; and third, the society they form by the use of their language. This interrelationship can be compared, perhaps, with the interrelationship between the chicken, the egg, and the rooster. You cannot say who was first and you cannot say who was last. You need all three in order to have all three. In order to appreciate what I am going to say, it might be advantageous to keep this closed triadic relation in mind.

I have no doubts that you share with me the conviction that the central problems of today are societal. On the other hand, the gigantic problem-solving conceptual apparatus that evolved in our Western culture is counterproductive, not only for solving social problems, but also for perceiving them in the first place. One root for our cognitive blind spot that disables us to perceive social problems is the traditional explanatory paradigm that rests on two operations: one is causation; the other one, deduction. It is interesting to note that if something that cannot be explained — that is, if there is something for which we cannot show a cause or for which we do not have a reason — then we do not wish to see it. In other words, something that cannot be explained cannot be seen. This is driven home again and again by Don Juan, a Yaqui Indian, Carlos Casteneda's mentor.

It is quite clear that in his teaching efforts Don Juan wants to fill a cognitive blind spot in Castaneda's vision with new perceptions; he wants to make him 'see.' This is doubly difficult, because, on the one hand, Castaneda dismisses as "illusions" experiences for which he has no explanations, and, on the other hand, because of a peculiar property of the logical structure of the phenomenon known as the "blind spot," which is that we do not perceive our blind spot by, for instance, seeing a black spot close to the center of our visual field: we do not see that we have a blind spot. In other words, we do not see that we do not see. This I will call a second order deficiency, and the only way to overcome such deficiencies is with therapies of second order.

The popularity of Castaneda's books suggests to me that his points are understood: new paradigms emerge. I'm using the term "paradigm" in Thomas Kuhn's sense; Kuhn uses this term to indicate a culture- or language-specific stereotype or model for semantically linking descriptions. As you may remember, Kuhn argues that there is a major change in paradigms when the one in vogue begins to fail, shows inconsistencies or contradictions. I, however, argue that I can name at least two instances in which it is not the emergent defectiveness of the dominant paradigm that is the cause for its rejection, but its very flawlessness. One of these instances was Copernicus's novel vision of a heliocentric planetary system, which he perceived at a time when the Ptolemaeic geocentric system was at its height in terms of the accuracy of its predictions. The other instance, I submit, is being brought about today by some of us who cannot — by their life — any longer pursue the flawless, but sterile path that explores the properties seen to reside within objects, but instead turn around to explore the very properties seen now to reside within the observer of these objects. Consider, for instance, 'obscenity.' At aperiodic intervals, the supreme judges of this land perform a ritual, in which they attempt to establish once and for all a list of all the properties that define an obscene object or act. Since obscenity is not a property residing within things (for if we show Mr. X a painting and he calls it obscene, we know a lot about Mr. X, but very little about the painting), when our lawmakers finally come up with their imaginary list, we will know a lot about them, but their laws will be dangerous nonsense.

With this I come now to the other root of our cognitive blind spot, which is a peculiar delusion within our Western tradition, namely, 'objectivity,' as in "the properties of the observer shall not enter the description of his observations."

1. H. Maturana, "Neurophysiology of Cognition," *Cognition. A Multiple View*, F. Garvin, ed. (New York: Spartan Books, 1970) pp. 3-23.

2. P.E. Weston, H. von Foerster, "Artificial Intelligence and Machines that Understand," Annual Review of Physical Chemistry, 24, H. Eyring, C.H. Christensen, H.S. Johnson, eds. (Palo Alto: Annual Review Inc., 1973) pp. 358-378.
3. F. Varela, "A Calculus for Self-Reference," International Journal of General Systems, 2: 1 (1975): 1-25.
4. G. Pask, "The Meaning of Cybernetics in the Behavioral Sciences (The Cybernetics of Behavior and Cognition: Extending the Meaning of ,Goal')," *Progress in Cybernetics, vol. 1*, J. Rose, ed. (New York: Gordon and Breach, 1969) pp. 15-44.

But I ask, how would it be possible to describe something in the first place if the observer did not have properties that allow for a description to be made? Hence, I submit in all modesty, the claim for objectivity is nonsense! One might be tempted to negate 'objectivity' and then stipulate 'subjectivity.' But, ladies and gentlemen, please remember that if a nonsensical proposition is negated, the result is again a nonsensical proposition. However, the nonsensicalness of these propositions — in either their affirmation or negation — cannot be seen in the conceptual framework in which these propositions have been uttered. If this is the state of affairs, what can be done? We have to ask a new question: "What are the properties of an observer?"

Let me at once draw your attention to the peculiar logic underlying this question. For whatever properties we may come up with, it is we — you and I — who have to make the observation — that is, we have to observe our own observing and ultimately account for our own accounting. Is this not opening the door for the logical mischief of propositions that refer to themselves ("I am a liar"), propositions that have been so successfully excluded by Russell's Theory of Types that they should not bother us ever again? Yes and no!

It is most gratifying for me to report to you that the essential conceptual pillars for a theory of the observer have been worked out. One is a calculus of infinite recursions;[2] the other one is a calculus of self-reference.[3] With these calculi we are now able to rigorously enter a conceptual framework that deals with observing — and not just with the observed.

Earlier I proposed that a therapy of the second order has to be invented in order to deal with dysfunctions of the second order. I submit that we may consider the cybernetics of observed systems to be cybernetics of the first order, while cybernetics of the second order is the cybernetics of observing systems. This is in agreement with another formulation that has been given by Gordon Pask.[4] He, too, distinguishes two orders of analysis. First, there is one in which the observer enters the system by stipulating the system's purpose. We may call this a "first-order stipulation." In a "second-order stipulation," the observer enters the system by stipulating his own purpose.

Philosophical Aspects of Cybernetics

From this it appears to be clear that social cybernetics must be a second-order cybernetics — a cybernetics of cybernetics — so that the observer who enters the system will be allowed to stipulate his own purpose: he is autonomous. If we fail to do so, somebody else will determine a purpose for us. Moreover, if we fail to do so, we shall provide excuses for those who want to transfer the responsibility for their own actions to somebody else: "I am not responsible for my actions; I just obey orders." Finally, if we fail to recognize each person's autonomy, we may turn into a society that attempts to honor commitments and forgets about its responsibilities.

"Cybernetics of Cybernetics," *Communication and Control in Society*, Klaus Kippendorf, ed. (New York, 1979).

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Ernst von Glasersfeld

Radical Constructivism

Even as occidental epistemology was in its infancy, some thinkers in pre-Socratic times already knew that the concept of knowledge as a more or less truthful mirroring of a basically independent ontological reality leads to an unsolvable paradox. Since reality only becomes accessible through experience, the subject undergoing an experience can never measure how much of the experience is changed, falsified, or created by the uniqueness of the experiential activity.

Although skeptics throughout the centuries have kept this insight alive, traditional philosophy has never given up the hope of getting around this paradox without having to change its concept of knowledge. Instrumentalism, proposed by thinkers whose 'absolute' knowledge did not derive from the rational separation and organization of the world of experience, but from religious dogma and belief, had little success because it offered no possibility for distinguishing between subjective and objective knowledge.

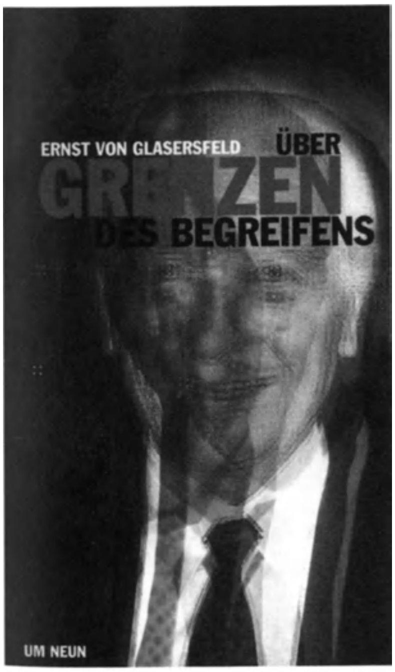
Darwinian evolution, with its basic notions of variation, negative natural selection, and viability, offered a clearly defined model that could be adopted by instrumentalism, providing it with a precise terminology and structure. Added to this, Piaget's fundamental work done in this century, which considered cognitive ontogenesis and all cognitive functions in biological adaptation a result of the self-organization of the organism, gave new impetus to a constructivist theory of knowledge.

It would have been impossible to give a comprehensive overview of the present advances toward constructivism in the framework of this essay. My colleagues in this packed series of lectures will illuminate aspects I have not mentioned at all, but, all the same, I hope that the connection will become apparent.

In view of the limits of time and space, I have to content myself with at least clarifying three fundamental points. First, that in the 2500 years of traditional philosophy, it has not found a way out of the dilemma recognized at the very beginning by the skeptics. Second, although it may seem inessential, it is not at all so to require human knowledge to reflect an ontological world independent of human beings; a knowledge that allows us to reach goals we have set for ourselves in our world of experience is fully sufficient to justify science, philosophy, and art. The third and last point is that such a knowledge — which fits, so to say, into the cavities of reality and so cannot turn it into an icon — still gives us the possibility to distinguish between subjective fancies and the objective world of communal experience.

If my elaboration has made it at least plausible to think there is a way of achieving a model of human knowledge without relying on impossible prerequisites, I have reached my goal. In any case, I want to repeat the explicit warning that I am not talking about the world of existence, but exclusively about a notion of cognitive abilities and their results.

Ernst von Glasersfeld, *Einführung in den Konstruktivismus* (Munich: Piper, 1994) pp. 38-39.



Bern, 1996

Ernst von Glaserfeld, born an Austrian citizen in Munich in 1917, developed a sign language in 1970 called "Yerkish." He and Piero Pisani developed the computer system that was used at the Yerkes Institute in Atlanta for communications experiments with a chimpanzee known as Lana. At the same time, he began teaching cognitive psychology at the University of Georgia. He has been a professor for psychology there since 1978.

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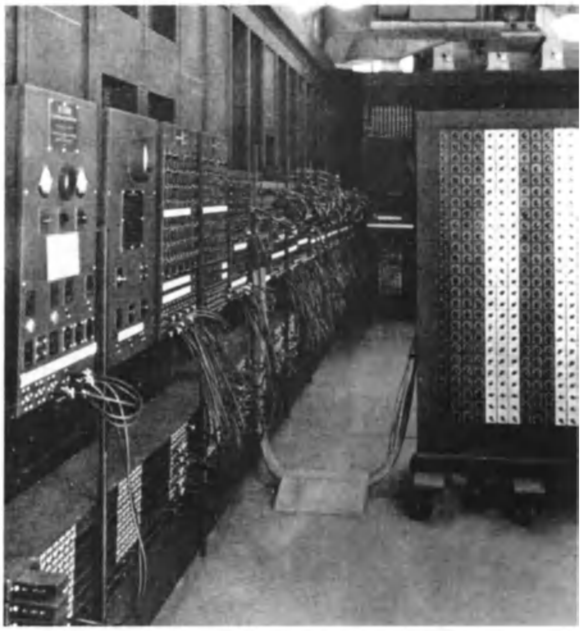
5

Győző Kovács

The Early History of Cybernetics and Hungary

Győző Kovács, born 1933 in Szekszárd. Degree from the Institute for Electrotechnology at the Technical University in Budapest. From 1957 to 1957, director of the research group for cybernetics at the UAW, later the computer science laboratory. Director of the State Computer Science Laboratory from 1967 to 1969. Director of the SZKI and the Sci from 1969 to 1987. First secretary of the John von Neumann Society for Computer Technology from 1976 to 1985, later vice president from 1985 to 1990. Became director of Számalk in 1987.



ENIAC: front left, the conductor and the signal gauges on cathode beam tubes; right, a mobile operational display

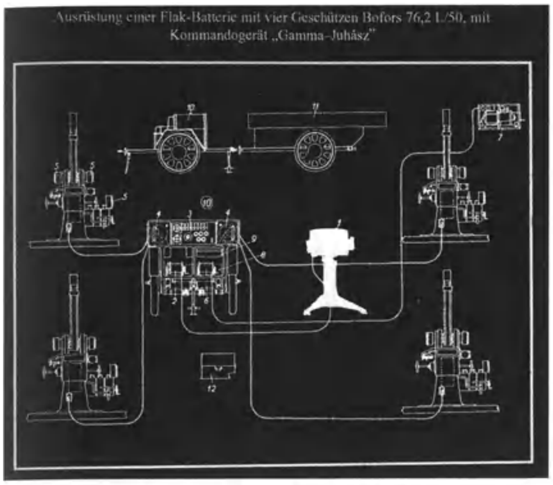
The computer — the invention that symbolizes high technology in the most developed countries — is in many aspects connected to Hungary, a country that is haunted by the phantasmagoria of backwardness or, at least, of being a backwater.

János Neumann (1903-1957), who was born in Budapest and studied there, as well as in Zurich, Berlin, and Göttingen, was one of the inventors of modern programmable computers. His name is written differently throughout the world: Johann, John, János, with or without "von," thus accepting or denying the aristocratic title bestowed upon his father, a rich Jewish banker, by Franz Joseph, the Austrian Emperor and King of Hungary. Several countries consider him their son, including the United States. Owing to his knowledge and experience in the physics and mathematics of percussion waves, he participated in the Manhattan project during World War II, together with the best scientists living at that time in America. He worked on the construction of the atom bomb with the Hungarians Leó Szilárd and Jenő Wigner, who were his schoolmates at the Lutheran secondary school in Budapest.

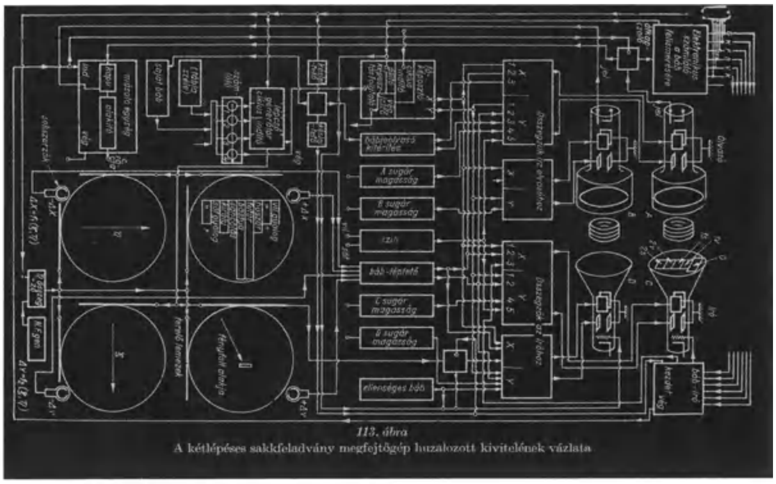
Neumann understood the significance of the computer in the field of numeric calculations necessary to modern physics. The complicated non-linear equations of hydro- and aerodynamics could not be solved in a closed form, although the solution would have been very important to the description of the movement of flowing substances — in weather forecasts, for example. Lacking an exact method, Neumann turned toward what we today call simulation techniques; these methods allow us to handle concrete problems in a quantitative way, by means of approximation. Neumann died before the discovery of the physical phenomenon of chaos, which makes these approximate meteorological calculations senseless. When, in 1944, the American mathematician Hermann H. Goldstine showed him the ENIAC (Electronic Numerical Integrator and Computer), which was already being used for making target charts in the Aberdeen Ballistic Research Institute, Neumann immediately understood the significance of the apparatus and its as-yet unexploited possibilities. After that, for more than a decade, Neumann was intensively interested in mechanical calculation and computers. The elaboration of the principle of the recorded program and his study of the first programmable computer, the EDVAC (Electronic Discrete Variable Automatic Computer) made Neumann a classic protagonist in the field of computer technology; in acknowledgement of his activities, he was made director of the American computer research program, which he led from 1945 to 1955.

István Juhász

The story of **István Juhász** (1894-1981), a brilliant inventor who sought new paths, resembles a tragedy. In 1921 Juhász was one of the co-founders and owners of the GAMMA precision mechanics factory; later he became its managing director. The factory still stands on its original site, even after a World War and forty-five years of nationalized economy. Originally it produced optical devices, motors, and precision casts, but Juhász's dream was to develop a modern anti-aircraft targeting device. With the development of aeromechanics, precise distance measurement and fire control based on quick mathematical methods became very important. Juhász's invention was a mechanical recorder operating as an analog memory, which represented the ballistic curves on the surface of a hard precision body. On the basis of the measured situation and speed of the approaching aircraft, the device was able to produce electronic signals that allowed canons to be precisely aimed. The invention proved to be very successful in the hands of the Chinese during the Japanese-Chinese war. Just before World War II, the device was exported to several countries, including the Soviet Union; however, the order could not be filled because the war broke out. At the end of the war, the Soviets practically dismantled the factory. Juhász was put on the shelf in 1947, and the factory started to produce Soviet-type equipment, which was of a lower quality. Owing to unfounded accusations, Juhász spent several years in prison;



István Juhász, Gamma anti-aircraft targeting plan



Tihamér Nemes, blueprint for a chess machine

after that he lived in seclusion in a small flat until his death in 1981. His later experiments with the analog computer, which he conducted even in his solitude, have been lost; nevertheless his work — the devices exported before 1940 — has influenced the development of cybernetics.

Beside János Neumann and István Juhász, we must also mention pioneers such as **Tihamér Nemes**, the early cybernetics scientist, the versatile **László Kozma**, and **Rezső Tarján**, who worked under difficult circumstances.

Tihamér Nemes (1895-1960), a research engineer at a telephone factory, dealt with theoretical problems. He experimented with television as early as 1930; in 1938 he applied for his first patent for a color television system. Later he constructed a moving robot, based on the study of human motion; he built logic machines and, in 1949, a chess robot. He was mostly concerned with the mechanization of human action and thinking. He belonged to that generation of early cybernetics scientists who had dealt with this field before Norbert Wiener created the concept in 1948.

László Kozma (1902-1983) was a development engineer at Bell Telephone Company in Antwerp. A leader in technical developments since 1936, he built fast computers out of elements from electromechanical telephone exchanges. Among his novel innovations, the most surprising today is a calculator that could be called over the telex network and used from a distance — was it a predecessor of the Internet? His last machines were produced during the occupation in the 1940s, made without being noticed, before the very eyes of the German army. Another of Kozma's innovations was the application of a wire tape recorder as a medium for containing information: it was a kind of primitive magnetic memory. The factory tried to get the machines to a safe place in America, but the ship carrying them was sunk by a German submarine. Kozma returned to Hungary in 1943, where he later became a professor and a member of the Academy of Sciences.

The story of the postwar pioneers is perhaps less spectacular. Of course there were exceptions. For example, a significant figure of this era was the physicist and mathematician, **Rezső Tarján**, who was the scientific head of the Cybernetic Research Group of the Hungarian Academy of Sciences, founded in 1956. Besides pursuing his employment, he wrote several well-known books on cybernetics. The Research Group was founded to keep pace with cybernetic development in other countries of the world, especially the Soviet Union — the obligatory example. In compliance with it, the Research Group's main task was to construct a machine of medium size, on the basis of Russian plans. The project proved to be successful: the machine carried out fifty operations per second, and the capacity of the magnetic memory was one kilobyte. At the same time, the group was the place where many other experts got their start. For example, **Győző Kovács**, the Hungarian expert in the history of cybernetics, started here. The Cybernetic Research Group dealt with many practical tasks, mainly in the field of economics; they cooperated with **János Kornai**, among others, who has often been mentioned as a candidate for the Nobel Prize.

In accordance with the possibilities of the era (apart from some exceptions, such as the development of the prototype of the floppy disk in the 1960s), Hungary was mainly successful in the field of computer mathematics. An outstanding example is the group in Szeged. The Hungarian cybernetic research had several headquarters, including one at the Attila József University of Sciences in Szeged, where **László Kalmár** and his students set up a laboratory. Kalmár had been dealing since 1955 with the construction of a logic machine featuring relays; this device was finished in 1958. The program could be put together with cables. Beside its main activity, the laboratory even constructed a small robot, the *Ladybug*.

Dániel Muszka, the *Szeged Ladybug*, an early robot made by László Kalmár's group

It operated on the basis of conditioned reflex, and was finished just a bit later than Grey Walter's similar devices, which were made public in the *Scientific American* between 1950 and 1952. This periodical was barely available at that time in Hungary. Kalmár's results were mainly of local interest. Nevertheless, his work on the mathematical bases of cybernetics became immediately known around the globe. In this study, Kalmár questions Alan Turing's theoretical results, using mathematical arguments to point out the limits of the Turing computer and similar, later versions. According to Turing, the type of computer we use is a universal apparatus, and in principle it would not be possible to construct a more general or more efficient one. According to Kalmár, this is not the case. His view has been the basis of interesting international debates ever since.

From the 1970s to the 1980s, we had entered a completely different world. The personal success of Hungarians participating in international development and research of cybernetics is more significant than the cybernetic successes in Hungary, as the example of Charles Simonyi, one of the leaders of Microsoft, and others prove.

Peter Weibel

John von Neumann

John von Neumann was born in Budapest, Hungary as the oldest of three brothers on 28 September 1903. His father, Max von Neumann, was a banker, a member of the Austrian-Hungarian financial aristocracy. Until the age of ten, von Neumann received a private education. He entered high school in 1914. From earliest youth on he showed remarkable abilities and great interest in scientific questions, and his nearly photographic memory developed in an unusual way during his childhood. When he took his final school exams in 1921 he was already a professional mathematician. He was not yet eighteen when he wrote his first work. He was enrolled as a student of mathematics at the University of Budapest for the following four years, but he spent most of the time in Berlin and at the ETH (Confederate Technical University) Zurich. He received his doctorate in mathematics from the University of Budapest in 1926, pretty much at the same time he finished his degree in chemistry at ETH Zurich. His nickname was "Doctor Miraculis." Von Neumann spent his free time in Zurich working on mathematical projects. He was in contact with Hermann Weyl and György Pólya. In 1921 he became a lecturer at the University of Berlin and kept this position until 1929. During this time his publications on set theory, algebra, and quantum theory made him famous in the mathematical world. In 1929 he became a lecturer at the University of Hamburg. In 1930 he was a visiting lecturer at Princeton University; he became a professor at Princeton in 1931. In 1933 he became one of the original six mathematics professors (J.W. Alexander, A. Einstein, M. Morse, O. Veblen, J. von Neumann, H. Weyl) at the newly founded Institute for Advanced Study. After his divorce from Marietta Kovesi (with whom he had a daughter, Maria, born in 1935 in Princeton), he married Klara Dan during a summer visit to Budapest.

Von Neumann's interest in questions of theoretical hydrodynamics began at the end of the 1930s. This research led to his employment in the scientific defense service and increased his interest in applied mathematics and physics. During this time he became familiar with automata. Some modifications of the mathematical-logical model for the ENIAC computer were based on his suggestions. During World War II, John von Neumann participated in the Manhattan project, the development of the nuclear bomb, and lived in Washington and Los Alamos. After the war, working with other researchers at the Institute for Advanced Study, he built the experimental computer commonly known as JONIAC, which became the prototype for similar machines throughout the entire country. *The Computer and the Brain* (1958) and the *Theory of Self-Reproducing Automatons* (1966) were groundbreaking works. Von Neumann is considered the father of the computer. During the postwar years, this all-around genius devoted himself to scientific problems in the most diverse disciplines. His interest was particularly piqued by meteorology, as it seemed to open completely new prospects for numerical calculation. For a while he was occupied with calculations in the continuously expanding field of nuclear physics. He continued to cooperate closely with the laboratories of the Atomic Energy Commission and became a member of its main advisory board. By 1954 his health had gone into decline; in the summer of 1955 the first symptoms of bone marrow cancer were diagnosed. Although he was confined to a wheelchair from January 1956 on, he continued to attend conferences and other such events. Allegedly, he was the model for Peter Sellers' war-mongering, paralyzed, wheelchair-bound scientist and presidential advisor in Stanley Kubrick's movie *Dr. Strangelove*. At the beginning of April 1956 he was taken to the Walter Reed Hospital in Washington, where he remained until his death at the age of fifty-three on 8 February 1957. His numerous works – around 156 – on set theory, algebra, theory of measurement, topology, ergoden theory, quantum theory, the problems of operator rings (today called operator algebra), continuous geometry, analysis, hydrodynamics, game theory, economy, meteorology, computer theory, automata studies, nuclear physics, and so on, can be found in his *Collected Works, vol. I-IV*, Pergamon Press, 1961-1963.

Oswald Oberhuber and Peter Weibel, eds., *Österreichs Avantgarde 1900-1938. Ein unbekannter Aspekt* (Vienna: Galerie nächst St. Stephan 1976) pp. 172-173

$$\rho \sim \frac{1}{\sqrt{2\pi N}}\sqrt{a}\; e^{-\theta N}, \tag{18}$$

wo

$$a = \frac{\xi(1-\xi)\eta(1-\eta)}{(\zeta+\xi-1)(\zeta+\eta-1)(1-\zeta)(2-\xi-\eta-\zeta)}$$

$$\begin{aligned}\theta = {} & (\zeta + \xi - 1) \ln (\zeta + \xi - 1) + (\zeta + \eta - 1) \ln (\zeta + \eta - 1) + \\ & + (1 - \zeta) \ln (1 - \zeta) + (2 - \xi - \eta - \zeta) \ln (2 - \xi - \eta - \zeta) - \\ & - \xi \ln \xi - (1 - \xi) \ln (1 - \xi) - \eta \ln \eta - (1 - \eta) \ln (1 - \eta).\end{aligned}$$

Daraus $\frac{\partial\theta}{\partial\zeta} = \ln \frac{(\zeta + \xi - 1)(\zeta + \eta - 1)}{(1 - \zeta)(2 - \xi - \eta - \zeta)}$,

$$\frac{\partial^2\theta}{\partial\zeta^2} = \frac{1}{\zeta + \xi - 1} + \frac{1}{\zeta + \eta - 1} + \frac{1}{1 - \zeta} + \frac{1}{2 - \xi - \eta - \zeta}$$

Also $\theta = 0$, $\frac{\partial\theta}{\partial\zeta} = 0$ für $\zeta = 1 - \xi\eta$, und $\frac{\partial^2\theta}{\partial\zeta^2} > 0$ für alle ζ (im gesamten Variationsintervall gemäß (17)). Daher $\theta > 0$ für alle $\zeta \neq 1 - \xi\eta$ (im Intervall (17)). In Anbetracht von (18) impliziert das, daß für alle ζ, die signifikant $\neq 1 - \xi\eta$ sind, ρ sehr schnell gegen 0 geht, wenn N groß wird. Es genügt daher, (18) für $\zeta \sim 1 - \xi\eta$ zu berechnen. Nun ist $a = 1/(\xi(1 - \xi)\eta(1 - \eta))$, $\partial^2\theta/\partial\zeta^2 = 1/[\xi(1 - \xi)\eta(1 - \eta)]$ für $\zeta = 1 - \xi\eta$. Also

John von Neumann, "Wahrscheinlichkeitslogik und der Aufbau zuverlässiger Organismen aus unzuverlässigen Bestandteilen" [Probabilistic logics and the synthesis of reliable organisms from unreliable components] C.E. Shannon, J. McCarthy, eds., *Studien zur Theorie der Automaten*, expanded edition and translation by F. Kaltenbeck and P. Weibel (Munich: Rogner & Bernhard, 1974) p. 98. (cf.: C.E. Shannon, J. McCarthy, *Automata Studies* [Princeton: Princeton UP, 2001] pp. 43-99).

Tihamér Nemes

Cybernetic Machines
Independent Automata – Animal Models

Tihamér Nemes, born 1895. Worked as an engineer. His scientific works primarily served the development of electronics and cybernetics. In 1930 he invented the warm pump, which was able to mechanically raise the temperature of natural warmth. In the same year, he applied for his first patent, for an ether organ. In 1932 he published the results of his experiments, which proved that a stroboscopic disc not only showed the number of swings it made, but also their Fourier constant. As early as 1935, he published an equation for calculating permanent magnets, and invented a typewriter that reacted to the human voice, automatically typing what it heard. His new frequency analysis device, a significant advance in light electronics, was completed and patented in 1942. In 1949 he wrote a two-step program for mechanical solutions to chess problems, and at the same time, presented a finished plan for a chess machine. He also worked on a logical device, which used rows of dots to show and automatically recognize the connection between cause and effect, as well as good and bad. His work was also important for the development of television. Nemes died in 1960.

1967

Throughout history, movable human- or animal-shaped dolls have been made largely with the aim of simple imitation. Following the invention of the clockwork there arose a fashion of toys imitating human or animal motion, such as the "floating swan," which turned its head to the right and left, etc. Such constructions are very simple, rattling through the same single procedure they always do; from the standpoint of control theory, they are like today's automatic tools, which are made simply to carry out one particular operation. A very substantial advance was made by the advent of toys whose programs could be changed, such as the "writing doll of Droz," which was able to write any kind of text because it had a double control mechanism. At the lower level, there was a separate control for the individual letters, and at the higher level, there was a switch, which would select the letters. These apparently idle amusements gave Jacquard the idea for his important invention, the card operated loom (1801). To this day, the punch card remains the particular element of a machine that can be described as an "instantaneously produced control unit." It is among one of the most important elements of barrel organs, player pianos, typesetting machines, statistical machines, and even some electronic computers.

The purpose of modern animal models is to use electronic means to imitate the simpler processes of the brain and nervous system, in order to investigate how far our hypotheses and simplifications of the structure and functioning of the nervous system hold good.

Although negative feedback plays an important role in the simpler functions of life, it is not as if it were a characteristic property that separates living beings from machines. Negative feedback was applied in technology long before its connection with the functioning of the nervous system became known — indeed, before the term 'negative feedback' was even invented. Its first technological application was probably J. Watt's steam engine regulator, which was patented in 1784. In 1893 Stodola described the isodrome regulator, whose zero point remains steady regardless of load.

The centrifugal force regulator operates as follows: if a steam engine runs faster than the speed proscribed, centrifugal force forces the balls of the regulator move farther apart; a lever actuated by the balls closes a valve on the steam pipe leading to the piston, thus causing negative feedback. The term 'feedback' comes from radio technology. Sensor-to-motor feedback plays a role in phototaxis, for example (the attraction of moths to light), the way that frogs or chameleons fix an eye on moving prey, or, in a more complex case, when a monkey reaches for and grabs a piece of fruit. In industrial and military technology, electro-mechanical servo regulators have attained a very high degree of perfection; for instance, a radar-controlled anti-aircraft battery hitting an airplane is essentially analogous to the example of the monkey above.

However, animal models are suitable for studying not only negative feedback, but also processes of choice and instinctive behavior. A mechanical analogy could be an automatic telephone exchange, where the call finder and the sequence switch effect precisely the processes of choice in question.

a) The Lux Unicellular Animal[1]


F. Lux

This device is a model of a unicellular animal: it consists of a short rubber cylinder with two slots (fig. 1). The inventor imagined it anchored in a slowly flowing brook, floating half-submerged in the water. The water in the cell is the "food" it digests. If there is too much water in it ("overfeeding"), then the rubber skin distends and the lever, indicated by the broken line on the left, closes the lower contact at a, and the small flap restricts the slot called the "mouth." If there is too little water ("underfeeding"), the slot opens wider as the contact a closes. This unicellular animal can even "learn" and "remember" according to a Pavlovian reflex process: if a big wave dangerously distends the rubber cover, then contact b also closes and the mouth is shut by magnet *c* (unconditioned reflex). The magnetization of *c* is preserved for a considerable time period. However, if, over the course of this period, the photoelectric cell (whose circuit is not shown in full in the figure) perceives a big wave as the water glitters, it shuts the mouth in advance using contact *d* (conditioned reflex). This early model is mentioned simply to show that the modern animal models below are not the first of their kind: their main innovation is the use of amplification.

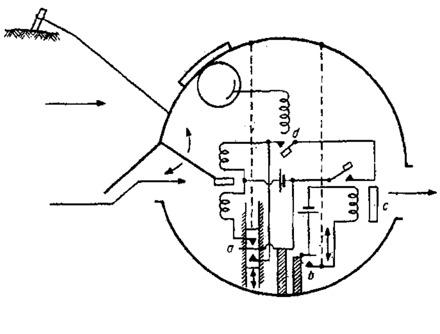


Fig. 1: Lux unicellular animal

1. F. Lux, *Gehirn und Seele* (Brain and soul), 1920.

b) Philips Dog

Moving along in chronological order, the next animal model for phototaxis was the *Philips Dog* between 1920 and 1930. This "watchdog" had two photoelectric cells for eyes: when one of these was exposed to light, it switched on one of two motors, which turned the dog toward the light until both cells received equal doses of light. Both motors then allowed the dog to move straight toward the light. When light intensity reached a certain limit, the motors were switched off, and a further relay switched on a howling siren. On ocean liners, a system operating on a similar principle but with more advanced technology steers the ship by keeping the compass needle pointed in a pre-selected direction. Similar equipment, used in military rockets, also keeps meteorological rockets pointed toward the sun. Such systems are used to maintain the direction of astronomical telescopes. The sound torpedo should also be mentioned in this context. The Germans used it for a time with success against Allied ships in World War II. Noise made by a ship's propeller was picked up by two microphones located on the torpedo, which, moving along a curve of pursuit, always hit the ship square in the stern, regardless of evasive maneuverings. As a countermeasure, Allied ships towed a noise generator, whose sound attracted the torpedoes, foiling the German strategy. Clearly, these devices were all control systems that employed negative feedback, so instead of going into more detail here, the reader should refer to literature on control and regulation technology.

2. W. Grey Walter, "An Imitation of Life" (Scientific American, May 1950) 43.
3. W. Grey Walter, "A Machine that Learns" (Scientific American, 185: 1951) 60.
4. Ivan Petrovich Pavlov, *Előadások a nagyagyféltekék működéséről* (Budapest: Akadémiá Kiadó, 1953); Asratjan, *Pavlov tanítása a magasabbrendű idegtevékenységről* (Budapest: M. Sz. Társ, 1951).

c) Machina Speculatrix[2]

This small device served to demonstrate positive and negative phototaxis. It contained just two amplifier tubes, a photoelectric cell, a contact, and two batteries. The two back wheels of this small, three-wheeled car run free; the first wheel is driven by motor M (fig. 2); the steering axis is turned by motor L, always in the same way. The operation of the machine is easily understood by referring to the circuitry shown in fig. 3 and to the table below. The numeral 1 represents the on state, and 0 is the off state; r_1 and r_2 denote relays; L and M are the motors. In position 1/2, the incandescent lamp acts as a series resistor.

W. Grey Walter, *Machina speculatrix* finds its own way home.

	r1	r2	L	M
Dark	1	0	1	1/2
Light	1	1	0	1
Blinding	1	0	1/2	1
Contact	1	1	1	1

The two small tortoise-shaped units, respectively called *Elmer* (Electro-Mechanical Robot) and *Elsie* (External Light Sensitive, Internal-External Stab), move in circles so that their fixed photocells sweep in a 360°arc. As soon as a photocell senses a light source, the steering gear automatically adjusts so that the device moves toward the light. If the light is too strong ("blinding"), it turns its back to the source and moves away from it. When the device hits an obstacle, the bell-shaped cover of the machine closes a contact (T), which for a time connects the two tubes of the amplifier, creating a flip-flop circuit. During this time the machine does not react to light, but turns around and makes searching runs. In darkness, the triode conducts; a weak light reduces its current and the pentode current grows stronger in consequence. Under strong light, the triode is shut down. If contact T is closed in the dark, a strong positive voltage pulse charges the grid of the triode, and the pentode will shut down for a time.

If there are two light sources, the "tortoises" will meander back and forth between them. If their batteries are nearly exhausted, they will even move toward any source of strong light, and this allows them to return to their "feeding" station. If a lamp is mounted on the tortoise and a mirror is placed in front of it, it will first approach the mirror and then go away from it; two tortoises each furnished with a lamp will perform a complicated ballet around one another. The remarkable thing about these devices is that they were perhaps the first to be endowed with the ability to "search," and thus execute a fairly good imitation of the process as carried out by beings on higher levels of intelligence.

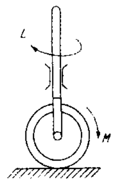


Fig. 2

d) Machina Docilis[3]

A model representation of Pavlovian reflex,[4] this machine imitates the most important phenomena involved in the development of reflexes. The term "reflex" means the response of an organism to some stimulus from its external or internal environment. Innate reflexes are called "unconditioned." Such innate reflexes and chains of reflexes permit a chick just out of the egg to run about and look for food (although somewhat indiscriminately at first, because it will peck at anything, such as the letters of a newspaper lying on the ground). On the other hand, the reflexes acquired by an individual in the course of his or her life are called conditioned reflexes. The chick soon learns to distinguish edible seeds from inedible spots and stains. This means that two unconditioned reflexes can be coupled to create a conditioned reflex by simultaneously applying the stimuli that produce them. If, for

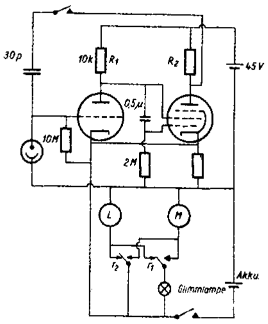


Fig. 3

instance, a white sheet is shown to a dog while it is eating, and this experiment is repeated several times, then after a number of repetitions, it is enough to simply show the dog the white sheet, and it will at once begin to secrete saliva. Displaying the sheet is a type of indifferent (neutral) stimulus that would normally produces a reflex involving only observation and orientation. This is a simple unconditioned reflex, and it is merely on account of the role it plays in forming a conditioned reflex that it is given a separate name (indifferent stimulus); orientation is the first phase of a conditioned reflex. On the other hand, another reflex that also arises unconditionally (but which, as a result of conditioning, can also be triggered by the first phase) is called the specific reflex. It is the second and last phase of a conditioned reflex. (In the above example, saliva secretion is an unconditioned reflex if it is triggered by the perception of food.) Generally speaking, in experimental work, it is preferred that stimuli entailing reflexes of observation be indifferent stimuli; on the other hand, specific reactions should be able to produce some striking, well-defined bodily function. Pavlov's choice of saliva secretion for a specific reflex was very fortunate because the intensity of this reflex can also be easily measured by the quantity of saliva secreted.

The conditioning process that takes place when indifferent and specific reflexes are coupled observes the following general rules.

1. Any indifferent stimulus can be chosen as the first phase of a conditioned reflex.

2. The stimulus producing the orientation reflex (indifferent stimulus N) must be introduced simultaneously with (or slightly earlier than) the stimulus producing the specific reflex (specific stimulus S). If N is introduced after S, no conditioned reflex will develop — no matter how many times the experiment is repeated.

3. A trace or memory reflex occurs if a certain span of time goes by after introducing N, before introducing S (this period should always be of the same length).

4. The joint repetition of N and S strengthens the conditioned reflex.

5. A new conditioned reflex can be built upon an already existing one; it is called a secondary conditioned reflex.

6. Unconditioned (innate) inhibitions: there are certain stimuli that hinder the development of conditioned reflexes. Such inhibitory stimuli include: (a) external inhibitions, which are strong, short, indifferent stimuli other than the one in the first phase of the conditioned reflex or stimuli causing protracted pain; (b) saturation inhibition, which develops when the indifferent stimulus introduced to the conditioned reflex is overly strong (e.g., light of unbearable intensity). The development of the conditioned reflex is most successful when all distracting influences are eliminated during the process of conditioning. An S that is strikingly different from the usual stimuli of the accustomed surroundings brings the fastest results: in the case of one of Pavlov's dogs, a single experiment with a bell was sufficient to establish the conditioned reflex.

7. Conditioned (acquired) inhibitions:

(a) A quenching inhibition arises when N is introduced, but not followed by S. By repeating this experiment several times, an already established conditioned reflex can be completely quenched. A few hours later, this block ceases to function, and the conditioned reflex reasserts itself. If, however, the quenching process is repeated often enough over a long period of time (days, weeks, even months), the conditioned reflex can be completely eradicated.

(b) Differentiating inhibition: any of the elements (simultaneous or not) of a composite indifferent irritation can be quenched: for instance, if saliva secretion is triggered by blowing a whistle, then the dog will at first react to whistles of any pitch, but if quenching inhibitions cause some pitch ranges to become unacceptable, the stimulus resulting in a reaction can be narrowed down to a whistle sound with a sharply limited pitch. In the same way, combinations of simultaneous or non-simultaneous stimuli of the most varied kinds can be substituted for N.

(c) Retarding inhibition: if it is our purpose to bring about a specific reaction only after a certain duration of the indifferent stimulus, we might proceed as follows: immediately after the onset of the stimulus the dog is given food. On the following occasions, the food is gradually given later and later, with the result that saliva secretion begins only towards the end of the period of stimulation.

(d) Conditioned inhibition in the strict sense: suppose that a reaction involving saliva secretion has been established, first by the sound of a bell and then by a rattling sound. Now, if a light stimulus is introduced at the same time as the bell signal, but no food is given, and if this procedure is repeated often enough, then the conditioned reflex of this pair of stimuli (bell and light) will be quenched — and moreover, the rattling sound plus the light also fail to elicit any reaction.

The *machina docilis* (or *Cora*: Conditional Reflex Automaton), which looks the same as the machina speculatrix, can do the following: if a whistle is blown whenever the machine begins to move toward the lamp after a successful search maneuver, then, after a certain number of repetitions, the machine will move in this direction even if the lamp is not burning. Thus, teach the machine learn to be guided by whistle signals in a variety of directions. After a certain time, the machine's ability disappears — it forgets what it has learned. If the whistle is blown when the machine hits an obstacle, and this is repeated several times, then the machine will retreat and pass it by as soon as it "hears" the whistle, without touching the obstacle. The process of forgetting is the same as in the previous case. Fig. 4 shows a hypothetical neural network capable of performing the above functions (in electric fish, there are organs quite similar to capacitors: they consist of thin muscle layers alternating with jelly-like insulating layers). S is the specific stimulus (in the present case, incidental light or contact with an obstacle), whereas N is the neutral stimulus (here, the sound of the whistle). The three conjunction-coupled neurones transmit a stimulus to neurone 4 only if S and N occur simultaneously (more precisely, if the signal differentiated by capacitor 1 — the sharp pulse from the signal front — and the signal, drawn out by parallel capacitor 2, overlap in time). Neurone 4 integrates the pulses arriving from 3; the disjunctive coupled cell 5 receives a pulse when this integral exceeds a certain threshold, and thus a self-sustaining pulse sequence is initiated in neural circuit 6 (positive feed-back), which permanently stimulates one of the synapses of conjunction-coupled cell 7. In such a state it is enough to simply introduce stimulus N in order to initiate both the muscle reactions of F (search movements) and specific reflex E. After some time, the pulse sequence decays as a consequence of damping circuit 6. Storage capacitor 2 serves to handle the case when N sets in earlier than S; the reverse succession (S earlier than N) is rendered ineffective by the signal compressor 1. Fig. 5 illustrates the electronic realization of this hypothetical neural circuit. The output voltage of photoelectric cell S, which controls the grid of triode 1 (amplifier), acts on the control grid of pentode 3 (simplified in the diagram), whose suppressor grid is indirectly controlled by microphone N. Owing to negative feedback, the damping circuit of the triode after N can be very sharply tuned, e.g., to 3000 Hz. One of the parallel storage capacitors is connected to the grid of triode 2; the other is indirectly connected to the grid of pentode 3. Pentode 3 delivers an anode current only if both its control and suppresser grid receive a positive voltage. When this has happened several times, capacitor 4 becomes sufficiently charged so that it discharges through glow-discharge lamp 5. This gives rise to a positive voltage pulse with very subdued damping, which trips on oscillator circuit 6; this circuit oscillates for a long time and delivers a positive charge to pentode 7's suppresser grid. This pentode delivers an anode current (which drives motor E) only if its control grid also receives a positive charge from triode 2.

Now it may be seen that Cora's functioning does not quite accurately imitate the formation of the conditioned reflex; indeed, the inventor himself simply called it a first approximation. The table below serves to compare the processes taking place in Cora and in a living animal. If proposition s means that "stimulus S is introduced," and n means that "stimulus N is introduced," then:

	Cora	living animal
ns =	formation of conditioned reflex begins	formation of conditioned reflex begins
ns =	forgetting begins	quenching inhibition begins
ns =	forgetting begins	a long process of forgetting begins
ns =	forgetting begins	a long process of forgetting begins

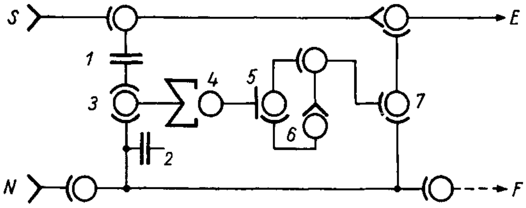


Fig. 4

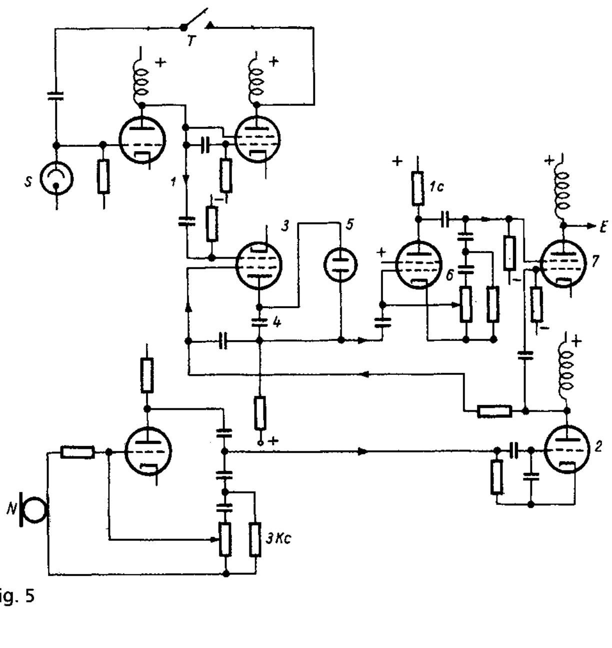


Fig. 5

In order to further develop the machina docilis, it would be necessary to provide it with circuitry that would simulate the quenching inhibition — one of the principal agents in the development of composite reflexes. A model designed by András J. Ángyán[5] and constructed in 1958 by László Varjú was equipped to react to external inhibitions as well.

The above comparison shows that ns plays an important part in the living animal. It is impossible not to recognize the resemblance to the behavior of man applying an *enumeratio simplex*: if, even once, the effect does not follow the cause, we begin to doubt the connection between them. It is merely because we count on the possibility of extraneous interferences that we do not reject the connection at once.

Cora was designed to demonstrate the development of a single conditioned reflex only. In the living animal, of course, a large number of such reflexes can develop. It should be possible to combine any neutral reflex with any specific reflex. A beautiful anatomical realization of this is the net of Purkinje cells in the cerebellum, where the synapses between axons a and the dendrites of the nerve cells are formed. Its most primitive electric analogy is the plug

5. A. J. Ángyán, *"Machina Reproducatrix," Mechanization of Thought Processes*. Symposium No. 10 of the National Physical Laboratory Teddington, A.M. Uttley, ed. (London: 1959) pp. 933-943; H. Zemanek, H. Kretz, A. J. Ángyán, "A Model for Neurophysiological Functions," International Conference on Information Processing (Paris: UNESCO, 1959; Oldenbourg/ Munich: 1960). But even this model did not completely correspond to the results of the experiments. H. Zemanek and H. Kretz developed an extensive system, which can be regarded as a complete representation of the conditioned reflex. See H. Zemanek, "Lernende Automaten" (MTW-Z., Regelungstechnik und Automation 8: 1961) pp. 49-54; also H. Kretz, "Modelldarstellung biologischer Verhaltensweisen," *Kybernetik. Brücke zwischen den Wissenschaften*, H. Frank, ed. (Frankfurt a. M.: Umschau-Verlag, 1964) pp. 113-122; H. Zemanek, "Modelle für den bedingten Reflex," *Taschenbuch der Nachrichtenverarbeitung*, K. Steinbuch, ed. (Berlin/Göttingen/ Heidelberg: Springer-Verlag, 1962) p. 1433.

6. E. Eichler, "Ein umweltabhängiger Automat," Radiotechnik (5/6: 1955) 173.
7. For a similar theory, see T. Nemes, "Logical Machine for Genetically Recognizing Class and Causal Relations," Acta techn. Acad. Sci. Hung. (VII, 1-2: 1953).

board (fig. 6), where any wire a can be connected to any wire b. However, a more economic network can be conceived (fig. 7). If leads a correspond to the paths of the neutral reflexes, and leads b to those of the specific reflexes, then the blocks inserted into connecting leads c represent a complete *machina docilis* circuit (except for some slight adaptations). A further requirement is a special switch that switches rows. It switches on the n-th lead c after the (n - 1)-th has been dealt with. The crosses indicate the points at which leads a and c (and b and c, respectively) are connected. These connections develop when both leads are supplied with voltage at the same time. The docile cross points indicated by crosses must, of course, be definitely established by the first simultaneous occurrence of charges, and the joints thus formed must not be undone by subsequent events. Thus instead of nm learning points (x) and nm logic circuits (n + m) k, only learning points and k logic circuits c are needed for an animal model with n leads a, m leads b, and k leads c. In animals, neural circuitry of similar constitution might exist on account of the biological "principle of economy." Presumably, it is necessary to prepare in advance only as many circuits corresponding to c as will be sufficient for the life of the animal.

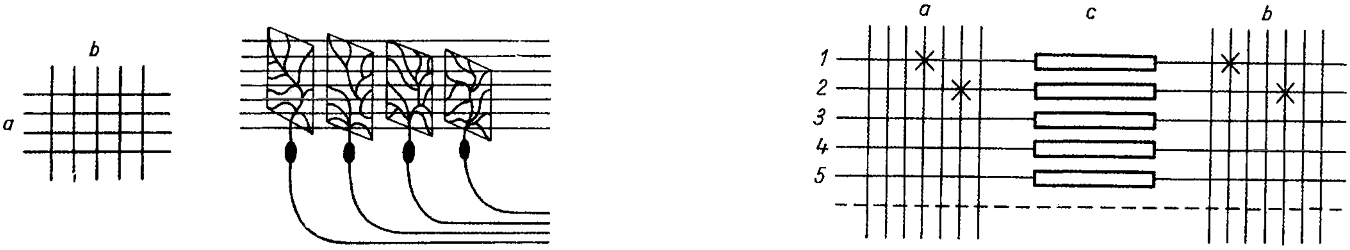


Fig. 6 and Fig. 7

It should further be pointed out that the hypothetical integrating cell, denoted by 4 in fig. 4, can perhaps be avoided on the assumption that the manifold simultaneous repetition of S and N serves first of all to eliminate the many false connections $S_i n$, due to the numerous disturbing stimuli (S_i). This is confirmed by the fact that, depending on the experimental conditions, the number of repetitions necessary to establish a conditioned reflex is highly variable.

e) The Vienna Tortoise[6]

This device was the subject of a thesis at the Vienna School of Technology. It is a variant of the preceding one. Only the realization of the logic modeling the Pavlovian conditioned reflex is different, being based on a sounder theoretical foundation.[7] To save vacuum tubes, hot-wire resistors are used to form time averages; such resistors change their resistance rather slowly even under a rapidly varying load. When it receives a sound signal, the machine, like the *machina docilis*, comes to a standstill and performs a retreating and then a bypassing maneuver, as though it had hit the obstacle. In fig. 8, the currents controlled by the contact and the sound signal are both led to hot coil W_1; the sound current is led to W_2; consequently, resistor 2 shunts the relay and works against hot coil 1.

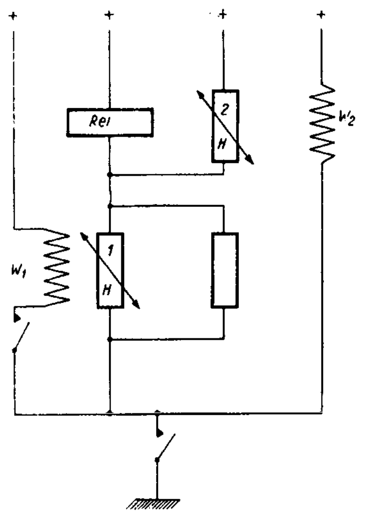


Fig. 8

f) The Szeged Ladybird[8]

The *Coccinella*, constructed at the Institute of Pedagogy and Psychology of Szeged University, Hungary, is a *machina docilis* in the shape of a ladybug 60 cm long and 25 cm high. Two of its photoelectric cells are connected like those of the *Philips Dog* so that once the machine has caught a glimpse of a light, it interrupts its search and moves toward the light, until a third photoelectric cell switches the drive motor off when the light source is in the axis of the machine. On tapping or pressing the spots of the *Ladybird*, the machine stops and emits a soft murmuring sound. This sound ceases when the back of the machine is stroked, and the machine begins to move again. The sound of a whistle at a certain pitch makes some lamps mounted on the machine light up. Several such conditioned reflexes can be stored, because the circuit that reproduces the development of the conditioned reflex is exceedingly simple (one tube only!). There are only seven vacuum tubes, three crystal diodes, three photoelectric cells, one microphone, and two motors in the machine. Instead of a battery of its own (the early models carried small batteries), this machine trails a flex connected to the mains.

The quoted article also mentions Nikolau's *Reflex Dog*, Albert Ducrocq's artificial animal family, *Miso*, and the animal models constructed in the Soviet Union.

g) Squee, the Artificial Squirrel[9]

An animal model named *Squee* imitates some simple types of instinctive behavior. According to earlier definitions, instinct is, in living beings, provided with a nervous system, as well as a tendency to adopt courses of action under certain conditions, which serve the preservation of the individual or of the species. According to the modern definition, instinct is merely a chain of reflexes. The neural construction realizing instinct is a latticework of several unconditioned and conditioned reflexes, the latter based on the former.

Squee is a box moving on two wheels and a sliding shoe, with two photoelectric cells turning in the horizontal plane mounted on top of the box. If a white ball is thrown on the floor, then the machine approaches it, lifts it up with a shovel provided for the purpose, and carries it to its nest in a corner of the room (thus imitating the collection of nuts). Its nest is a metal plate on the floor; whenever *Squee* touches this plate, it drops the ball and returns to look for further balls. An AC lamp illuminates the nest; a DC lamp lights the rest of the dark floor (and, consequently, the ball to be caught). The two photoelectric cells direct the model exactly to the balls; the ball rolls into the open shovel where it closes a contact, which in turn closes the shovel. Now the photoelectric cells, switched on to an AC amplifier, direct Squee to its nest. The circuitry of this animal includes no innovations in principle, and therefore we shall omit its description.

h) The Mouse in the Maze[10]

This is a small car that can be placed in a labyrinth that can be randomly composed of adjustable aluminum plates set on a base of twenty-five squares. The car carries a rod magnet; on its front side, it has copper whiskers, with which it feels obstacles. This *Mouse* can find its way out of the labyrinth in a few minutes. The control mechanism is built into the base plate of the labyrinth. The author did not publish the circuitry of the machine. There are forty relays for programming; a further fifty relays serve as a memory bank. The magnet of the *Mouse* signals its whereabouts by tipping over fixed contacts that act as place markers. If the Mouse collides with a wall, the control mechanism turns it ninety degrees and repeats this operation after every collision. The *Mouse* finds the way out by systematic search (checking one possibility after another). (Labyrinths have a popular solution, long known: always keep to the right [or the left] at each obstacle. This allows one to proceed along one of the walls of the labyrinth, taking in every entry and ramification; the correct one will necessarily occur. This simple principle fails, however, in the case of labyrinths where, as in fig. 9, there is a part A that is not connected with the rest of the walls.) Once the *Mouse* has found its way out, it can find it again in about fifteen seconds, without any more searching or hesitation.

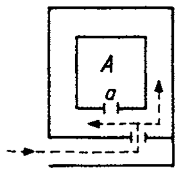


Fig. 9

This model demonstrates a very important anthropomorphic property, an indispensable requirement of intelligent life — namely, the ability to instantaneously learn a process that has already led to a favorable outcome. This fundamental process was discussed from another point of view in connection with Pavlovian reflexes and the learning machine. The toy mouse, run by an ordinary clockwork, which turns away from the edge of the table and runs in another direction is a good mechanical model of the unconditioned reflex.

i) The Homeostat[11]

According to its inventor, the *Homeostat* roughly demonstrates the principles behind the complicated functioning of an entire brain. It includes, among others things, four pointer instruments. Each pointer is free to swing in an electrolyte tank arranged as a potentiometer (fig. 10). The pointers receive electric charges proportional to their

8. D. Muszka, "Kibernetikai álltmodellek," Természettudományi Közlöny, July 1950. The apparatus was demonstrated by its designer at the Budapest Industrial Fair in 1961 (see the photograph of the *Ladybird* in this book).
9. Jensen, Koff, Szabó, "Light Sensitive Electronic Beast," Rad. Electronics (December 1951) 46.
10. C. E. Shannon, "Problem-solving Electric Mouse Aids in Improved Telephone Research," Elec. Eng. (July 1952) 671.
11. W. R. Ashby, "Design for a Brain," Elec. Eng. (20, Dec. 1948) 379-387.

12. Fisher-Yates, *Statistical Tables*, 1943.

position in the tanks at that instant, and each transmits these charges to the grid of a triode. Every instrument coil consists of four insulated parts: one receives a current from its own triode, the remaining three from the foreign triodes. If only one triode is on, then the pointer swings until it finds the particular grid voltage that produces zero anode current, because the instruments have no damping springs. However, since the coil is at rest and the magnet moves, there is a (geomagnetic) directive force that slightly changes the value of the anode current, at which the instrument comes to a rest. So far this is just a simple regulator. Now if the four instruments are coupled in the way described above, then each of them interacts with the remaining ones, and the pointers either all come to a rest after a few oscillations — each at a certain point of equilibrium — or, swinging with increasing amplitude, they beat against the sides of the tanks. If now the currents of some coils are commuted or the amplitudes are changed by manually operated rheostats, then a setting can be found where the pointers quiet down and come to rest. If the pointers are deflected by hand from this point of equilibrium, they return to it again. Even at this point, the system is merely a multiple-feedback regulator whose equations are well-known, and it is nothing new, in spite of being considerably complicated.

However, as soon as the design is changed so that it can perform by itself the operations of selection, which were done manually up to then, one obtains a construction comparable to the instinct equipment of animals. In order to attain this, it is enough that, in the case of a heavy enough current, relay F should move the magnet of a lever, which changes the values of the rheostats and the setting of the commutators in boxes K. If the amplitudes further increase when this is done, relay F drives the lever one step further and this procedure is repeated until equilibrium is attained. Since each switch has 25 positions, there are 390,625 possible combinations. This switching equipment is wired so that the individual steps involved in switching change the values of the parameters in completely random succession, rather than systematically.[12] (By the way, this random succession is not entirely justified, as in some cases the solution could be found more quickly by switching in the natural order of succession.)

The new thing about the *Homeostat*, which has hardly ever been realized in machines before, is that it is capable of systematic search — automatic experimentation, which is a function of higher order rather than of plain negative feedback.

In the animal world, functions abound in which negative feedback is temporarily replaced by search. A dog, unable to get past a fence to reach its food, will run along the fence until it finds a breach. Consequently, it first moves away from its goal, something that would be incompatible with strict negative feedback. The Tenerife experiments on chimpanzees have shown that some of the animals managed to get hold of a cluster of bananas with a stick, even when they had to push it away first in order to release it from a hidden catch.

The *Homeostat* will find solutions in a variety of situations: for example, if the current of one (or several) of the coils is neutralized from the outside, the machine immediately begins to search for a new position of equilibrium. If the polarity of one of the output or input leads, or the polarity of a tank is changed, or if an obstacle is placed into a tank, this does not prevent the machine from looking for a switching combination that will again result in equilibrium. Of course, this machine is unable to produce a change that was not built into it in advance; it can only choose among the possibilities put at its disposal by its designer.

The first application of the "search" principle in technological practice was perhaps the "call finder machine" in telephone exchanges. In cybernetic machines, it first appeared in the *machina speculatrix*, the labyrinth solution machine, and the chess machine.

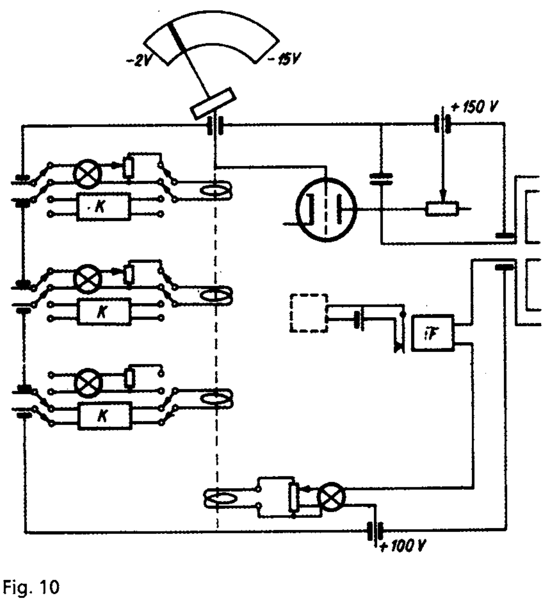


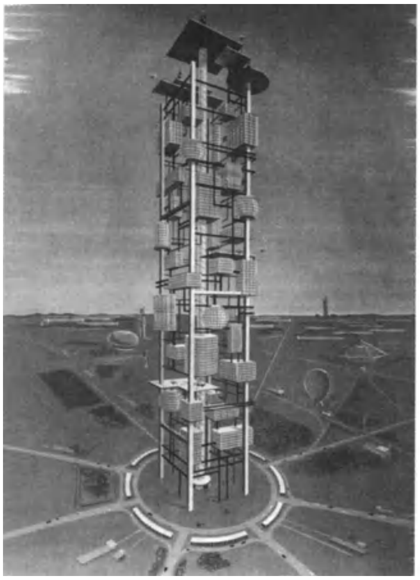
Fig. 10

Tihamer Nemes, *Cybernetic Machines* (New York: Gordon and Breach, 1970)

Nicolas Schöffer

The Cybernetic City

1. The Program for the Working City: Verticality



Nicolas Schöffer, *Vertical university center* (working city)
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Nicolas Schöffer, *Center for scientific research* (working city)
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2. The Program for the Residential City: Horizontality

While the one-third of life that is dedicated to work has a vertical character, the third dedicated to sleep (as well as the third for leisure) have a horizontal character, as we work in a vertical, standing, or sitting position and sleep in a horizontal position. The architectural frame for these two areas of activity has to correspond to both of these functions and connect integrally to them. The visual impression of verticality incites us to rise, so that we find ourselves in a position parallel to our surroundings. The horizontal stimulates relaxation and de-concentration. There is no doubt: skyscrapers cannot be a place of sleep because they do not promote peaceful and inactive dreams.

This is why I imagine these cities as relatively close to the ground, yet standing on high pillars at a certain height of 10 to 30 meters above the ground.

These cities extend themselves in more or less long strips over the landscape, and the residential buildings have no more than two floors. Each flat consists of standardized, ready-made elements, and each entity (each strip) can contain 100 to 500 adjacent flats.

Nicolas Schöffer, *Living and sleeping city* (horizontal city)
© VBK, Vienna, 2005

Compared to the number of inhabitants such strips seem to occupy a large area. But if we take into account that they are resting on high pillars, elevated from the surface, a large area will remain unused, and, from the perspective of urban planning, offers some possibilities for stretching out that were never before given.

The Five Topologies

A dwelling protects from bad weather and from other people, dwellings are collectives protecting from other dwelling collectives. In architecture, a topology of fear dominates, a topology of a closed circuit, firmly locked for a longer or shorter time. The new topology I am suggesting is an open topology, a topology of trust, even – we should not be inhibited to say – a topology of love in the noblest sense of the word.

The time when there were places of refuge is past, in their place are open compartments. The time of complexes of refuge has expired, constructions whose rhythms correspond to time and space replace them.

For this, we need time, light, sound, and space; they are the basis of the five topologies:

1. Time – the topology of rhythms,
2. Light – the topology of light,
3. Sound – the audible topology,
4. Climate – the topology of artificial and natural climatic flows,
5. Space – the topology of space.

From now on the organization of all details of the area have to be worked out in this sequence so that the piece of land fits harmoniously into the sector, the sector into the complex and the complex in the row of complexes. Thereby we have to see that each piece of land and each complex has its own system of information and supplies, and each headquarter is connected to the others to form an organic network of centers which are in constant interaction.

Nicolas Schöffer, *Multiple prism with color light projections, lux 9, and human body*
© VBK, Vienna, 2005

Nicolas Schöffer, *Center for sexual recreation*
© VBK, Vienna, 2005

1. The Topology of Rhythms (of Time)

The fundamental problem for every organization and disorganization is the use of time. Before we start construction or work out a plan for construction, we have to determine zones with different time densities and work out a schedule whose appointments comply with each other to form a construction – we could say a sculpture – of time or different times. We have to imagine a high density of possible events in certain functional or leisure cores, an average density in some other functional or leisure cores, while the residential zones are determined by a loose rhythm. The planning of the actual temporal topology has precedence over any other step in the planning. The topology of rhythm is a temporal planning consisting of the arrangement of zones characterized by a different density of events side by side and on top of each other. This is a chrono-dynamic force applied to and built into architectural complexes which, in the words of Lupasco, represents "the rhythmic realization of the potential dynamic force of time."

2. The Topology of Light

After time, the second means of great significance is light. Areas illuminated at night can have an aesthetic as well as a functional character. The light sign, used to demarcate a certain sector, designed as a sculpture, is, firstly, of an aesthetic character. If it moves due to cybernetic programming it represents a permanent illumination. In the center of leisure activities those nightly aesthetic illuminations can also function temporarily with an audio-visual light dynamic.

The horizontally and vertically oriented traffic needs artificial lighting that is either temporary or permanent. There will also be periodical lighting fit between the temporary and the permanent lighting. This is a flow of information and means of collective regulation mediated through light and always directed by the cybernetic center. Those signals can also be used in the shadowy zones during the day.

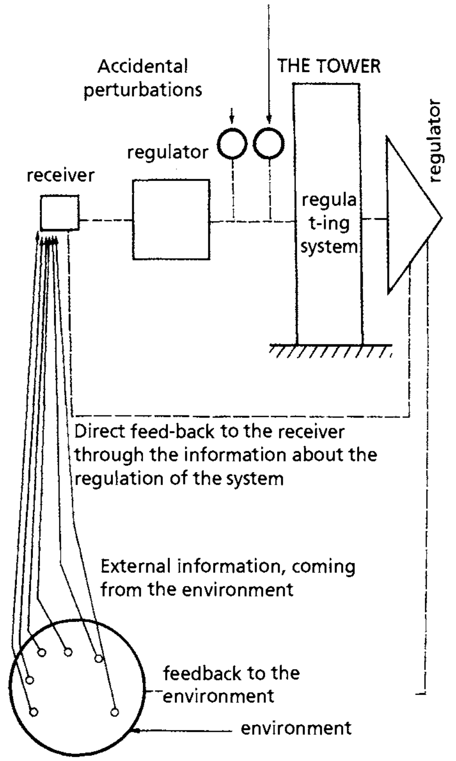
We can thus include in our plan periodical lights, programd by cybernetic centers, that occur at a certain moment to activate or shut down life in the city.

3. The Audible Topology

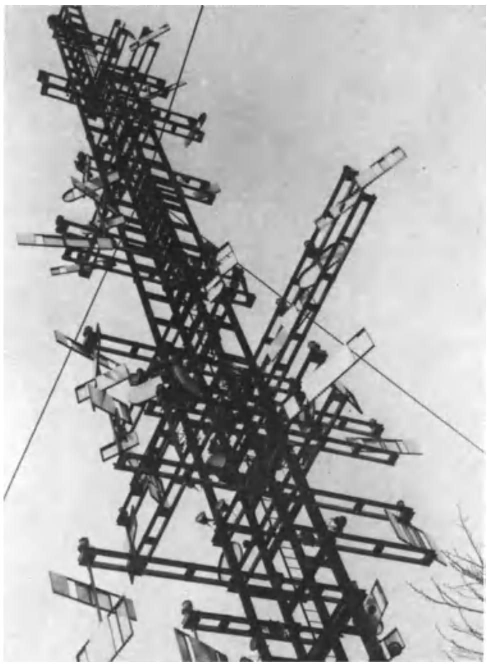
We have to distinguish two sound media: natural and artificial tones. The natural tones on the one hand are all natural noises that are not disturbing elements in the technical organization of sound that on the contrary contribute to a favorable indeterminacy (animal sounds, wind, the rustle of leaves, etc.). On the other hand are sounds originating from a human or technical source. The latter have more or less to be restrained or neutralized, or to be confined to a site where that kind of sound is not disturbing – or in the end – they have to be reduced by various technical means.

The artificial sounds, however, represent the true material for the architect who has to create noiseless areas with natural or artificial means. In the case of the latter he can use supersonics or some kind of muffler. He has to plan zones with different degrees of noise where the centralized cybernetic regulation is able to achieve a vitalizing or relaxing volume of sound, zones that represent a truly audiovisual bath. And eventually he has to plan loud and noisy zones, especially in the cities of leisure.

in: *La ville cybernètique*, Paris: Tchou Èditeur 1969



Theoretical plan of the cybernetic light tower



Nicolas Schöffer
The Cybernetic Tower in Liège, 1961
© VBK, Vienna, 2005

5

Győző Kovács

László Kozma

László Kozma, born in 1902, electric engineer. He got his diploma at the University of Brünn and was later employed by Bell Telephone Antwerp, where he became the directing technician in the Department of Development. He built several machines, which were protected by American and English patents; the first computer in 1936. 1945-49 technical director of the firm Standard in Budapest. He got the order to rebuild the telephone network in Hungary. He taught at the Technical University Budapest. In 1958 he constructed the first Hungarian computer, which functioned through a digital binary signal receiver. In 1964 he constructed a special linguistic computer with a receiving system for special signals for the Hungarian Academy of Sciences. In 1964 he was elected special adviser of the Academy of Sciences. He died in 1983.

Many people came to accompany the Kossuth Prize winner on his last journey on November 29, 1983. Some had known him as an excellent engineer, others as a university lecturer in circuitry, but, sadly, only few had known him as a pioneer of computer technology.

Kozma was a telephone exchange design engineer. In Belgium (Antwerp) he worked for the American firm "Bell Telephone" and first came into contact with computers in 1938.

In the following quotations taken from an interview recorded with Judit Esti from Hungarian radio in autumn 1983, and in his article *My Technical Work in the Stone Age of Electronic Computers*, we will hear what Kozma himself has to say:

I came to Antwerp in 1930 where I worked in telephone exchange research. They were very satisfied with me and by 1938 I had already obtained twenty-seven patents. One day my boss, an Englishman, sent for me and informed me that we needed to build computers because they were very important. Thus, we would not only produce telephones in future but also other things that would make a profit because telephone exchange orders were declining. I was thus to build a computer, albeit only using the available telephone exchange components. In 1938, the idea of the necessity of an electronic computer was already in the air. At that time I had no idea exactly what this demand was based on. Today I know that preparations for war were in full swing and that electronic computers were needed to control and guide weapons (missiles). And so I commenced my work without knowing who else in the world was working on electronic computers. I began with the small eleven fixed-point computer that is described in my major patent. Together with my colleagues I built a cupboard-sized box full of relays and moving parts. The computer was very slow because it calculated in the decimal system. There was certainly no binary system at that time. In the decimal system, I imitated the manual method, which was relatively easy. This first computer did not have any memory. It could add, subtract, and multiply. It could not divide very well. It performed an addition in one second, a subtraction in one and half seconds, and a multiplication in five to six or seven seconds, depending on the multiplicand. If I divided a number by a four-digit primary number, the computer took hours to spew out the result in Morse symbols on a six-metre long strip of paper. After we had completed the first computer, I immediately started building another one. This one was faster. It could add and subtract in half a second and took about one second per digit for multiplication, while a division took roughly one second per quotient. In 1940 the Germans came. My head engineer fled to the south of France, albeit not before shipping the second computer to America. After the war I learned that the ship transporting the computer had disappeared and had probably been sunk by a German submarine. So this was the sad fate of the second computer which is probably still lying somewhere at the bottom of the Atlantic. Meanwhile, we had built a new computer in Antwerp. This third computer was finished in 1941. During the German occupation, there was a German officer at the works. We agreed that if he came into the laboratory and asked what we were working on, we would say we were drawing up statistics on telephone exchanges. We would not tell him that we were working on computers. Luckily, the German never came into the laboratory. While listening to London radio it began to dawn on me that computers could be of great military significance. The works manager must have had the same idea because he had all work connected with the computer stopped at the end of 1941, and I was transferred back to the electric circuit development department.

Just for the record, I should mention that I visited the works in Antwerp once more in 1946, where computer number 3 had already been taken apart and a new one had been put together, replacing the relays with bi-stable, gas-filled cold cathode tubes.

László Kozma had the opportunity to build a digital computer with impulse receivers once again in Budapest in 1955. The MESZ-1 (Electronic Computer of the Technical University) was completed in 1958. It was primarily planned for educational purposes but proved to be of great assistance for the university's research programs. The computer was in operation for almost ten years and is now one of the main showpieces of the Technical Museum in Budapest.

in: *Mikroszámítógép Magazin*, Budapest 1994.

Attila Kovács

5

Cybernetic-Electronic Constructions with Artificial Sense Organs

art is artificial.
the artist has become a maker of proportions.
in the automated urban civilization handicraft is an anachronism.
this civilization can realize its artificial art only with the help of science and technology.
just like science and technology are evolving into a planetary unity, art should evolve into this unity.
this evolution is realized by further and further advancing, programming human beings.

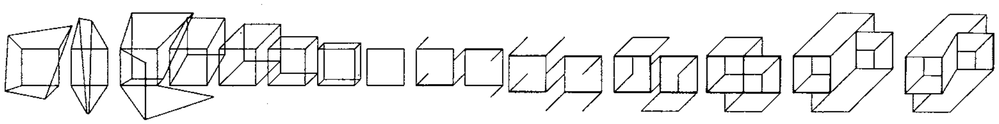
the cyber-electronic plasticity is the programmed multimedia effort to synthesize permanent change. it leaves the state of the fixed aesthetic object exactly like the state fixed in the repetition of kinetics.
it would like to unfold in the purely technological medium. it uses all perceptible and artificial types of impulses whose function can be changed into an aesthetic quality and whose applications are expandable.
the naturally beautiful and the non-technological is no longer relevant (in terms of forming a repertoire), i.e., the qualities of colors, forms, sounds, noises, light, rhythms, smells, and so on, become pure (produced) values of sensation. this is to say that those qualities are artificial manipulable impulses that influence our sensitivity.
the different qualities of color, form, light, rhythm, temperature, electronic sounds, or sound masses, velocities, and so on are subject to a lively sequence, permanent change. with the help of electronics for the first time, a change (beyond discrete visualization), is continually realized.
the variety of impulses achieved through the manipulation, will, in the process, make possible the emergence of various structural formations, thus a texture with multiple simultaneous layers whereby a simultaneous process in space arises.
the sculpture is therefore an active, organic entity regulated by the computer. it was developed from the most simple to an ever higher degree of complexity.
the formal structure of the sculpture should refer to architecture.
because of this, the sculpture is a cell-like construction.
the electronic cells form a square system of construction elements that make the tectonic structure possible – the choice/use of a spatial square grid allows for a number of arrangements. due to the variability of the arrangement, two- or three-dimensional sculptures of any size and form can be built, corresponding to the given architectural (or other) environment. each element is able to induce or receive different changing, or changeable impulses.
the sculpture has sense-organs, set up in its surroundings (light meter, color meter, color sequence meter, thermometer, barometer, microphone, chronometer, steam meter, freight pressure meter and scent meter, photocells, etc.), which help the sculpture to stay in contact allowing action and reaction with the registered environment. the qualities of the impulses and their production are determined by three causes:

Attila Kovács
born 1938 in Budapest. Studied at the School of Applied Arts, Budapest; Academy of Applied Arts, Stuttgart. Lives in Cologne and Budapest.

1976 *Albers-Kovács*, Museum Ludwig, Cologne
1983 Sprengel Museum, Hannover
1987 Wilhelm Hack Museum, Ludwigshafen
1991 Kassák Múzeum, Budapest
1995 Műcsarnok, Budapest
Galerie Wack, Kaiserslautern
Chapel Art Center, Cologne
2002 Diözesanmuseum, Cologne

Group shows
1969 *Operationen*, Museum Fridericianum, Kassel
1977 documenta VI, Kassel
1986 *Trends in Geometric Abstract Art*, Tel Aviv Museum of Art, Tel Aviv
1998 *Der unendliche Raum dehnt sich aus*, Staatliche Kunsthalle, Baden-Baden
1999 Ungarn heute, Galerie der Künstler, Munich

References:
Attila Kovács, *Szintetikus programok* (Budapest: Új Művészet, 1992/3).

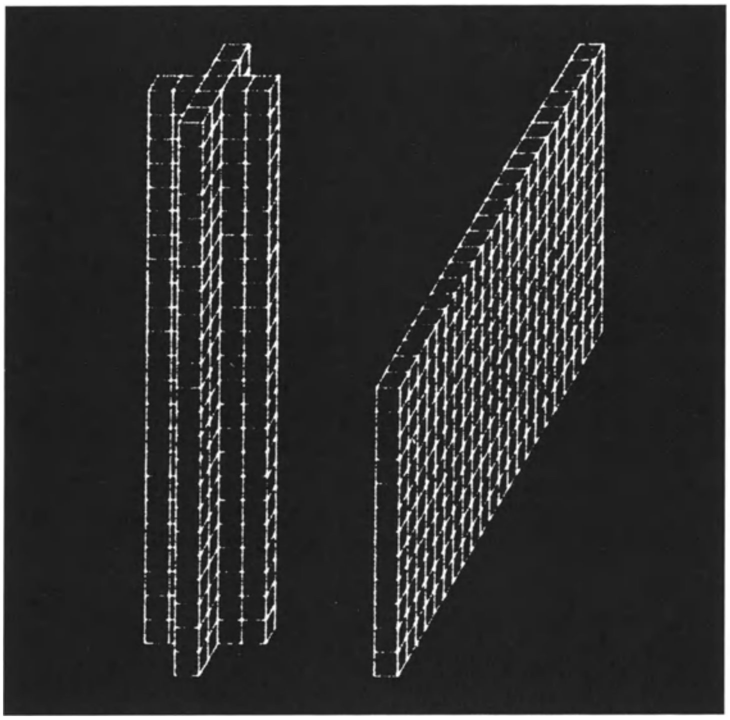


Attila Kovács
structural development hommage à albers, 1968
Indian ink on paper
21 × 130 cm
© VBK, Vienna, 2005

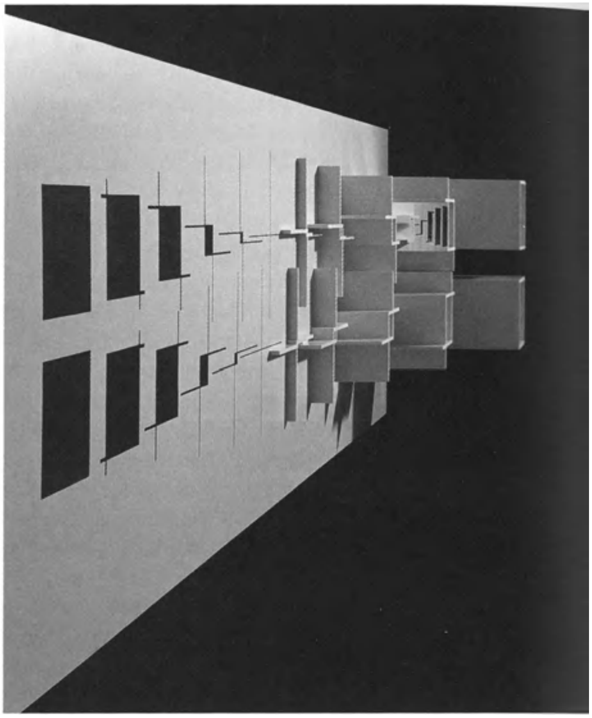
1. up to 1/3 by an inflexibly programmed inner dynamic
2. up to 1/3 by the reaction to the qualities of the environment registered through the sense-organs
3. up to 1/3 by an individual or collective intervention as a reaction of the audience to the activity of the sculpture.
the control-panels allow the possibility of an aesthetic communication or the activation of creativity in the form of an operation, a game, a short fixation.

those three causes determine the process in three different ways:
1. separately one after the other
2. simultaneously influencing each other
3. through a simultaneous, but separate impact

the realization of the concept needs theoretical clarification
1. of the laws concerning the information qualities of the impulses – especially clarifying whether the information sent out by the visual, the audible, etc. – is identical in order to achieve coordination. the prototype should show how and when a structure is determined or stochastic, when, and confronted with which qualities the structure



Attila Kovács, *Sketch*, 1969-70
Electronic-cybernetic sculpture and wall
© VBK, Vienna, 2005



Attila Kovács, *Substrat k-h-4*, 1967-69
White polystyrole, black etching ink, 39.5 × 133 × 22 cm
© VBK, Vienna, 2005

remains closed, stable, relatively open, unstable or shows any other kind of behavior.
2. of the qualities of the given environment (i.e., architectural or landscape).

this complex construction principle of cybernetic-electronic art can only be realized by a team which is led by the proportion-maker and consists of the electronic engineer, the musician, the constructor, the futurologist, the programmer, the lighting expert, the statistician, the calculator, and so on. Only teamwork holds the possibility of a synthesis and is able to realize urban art by reassigning the functions of technological products.
for me, urbanity means – at least in a futuro-logical sense:

MEDIUM OF ART: AESTHETICIZED ENVIRONMENT!
ARTIFICIALITY SHALL PREVAIL OVER CRAFTSMANSHIP!

on the basis of the first results and the elaborated new language, the development of mammoth projects for the mega-cities of the future should begin, they must have a considerably higher capacity and larger repertoire and serve as aesthetic centers of mass communication. of course they would only make sense under future spiritual and material conditions.
the constructions built of cybernetic-electronic elements are harbingers of this future planetary-aesthetic culture of computer-civilization.

1969/70

Heinz Zemanek

Information Theory and Technology in Austria after 1945

Information theory and technology are rooted in two things: telecommunications technology and computer technology. The merging of both in electronics led to developments wilder than in any other field in which Austria played a major role.

Information is a strange entity that escapes definition. When urged to define it, I give ten definitions, so that none of them will be taken too seriously. Information is the content of language and computation, a particular something that allows for control and regulation, and it is what people respond to in arts and entertainment. Think it over a little, and you will agree that not defining the term is better than defining it.

Heinz Zemanek, born 1920 in Vienna. Studied communications technology. Ph.D. and Habilitation at the Technische Hochschule in Vienna. Assistant professor from 1947 to 1961. During this time he built the *Mailüfterl*, a transistorized computer. Director of the IBM Laboratories in Vienna from 1961 until 1976. Independent researcher until 1985. Published over a dozen books and over 450 papers. President of the IFIP (World Computer Society) from 1971 to 1974. Lives in Vienna.

1. Before 1945

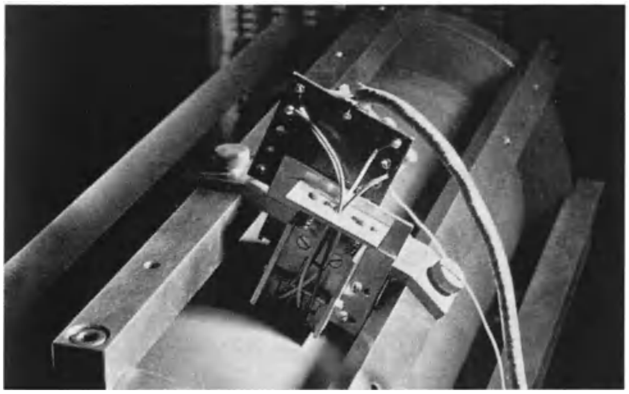
In many respects, the year 1945 marked a caesura for Austria, as well as for telecommunication and computer engineering, which we will deal with here. The state of telecommunications art at the beginning of World War II comprised classical transmission technologies such as teletype, telephone, radio, and television, including auxiliary fields such as fine mechanics and acoustics. Radar technology, which Germany introduced during the war — although far too late and inadequately — marks the transition. For many in the field, myself included, it was the key to modern electronics and computer technology. Calculating technology remained mechanical until World War II. To imagine what it was like, just recall the desk calculators by Schickard, Pascal, and Leibniz, as well as the abacus. So 1945 marks what is essentially a new beginning, more distinctive than in any other field of technology, except for the unfortunate atomic bomb, of course. The development from 1945 on is fascinating; if the reader wants to know more there is a great deal of literature; German readers can refer to my books.[1]

2. Telecommunications Technology

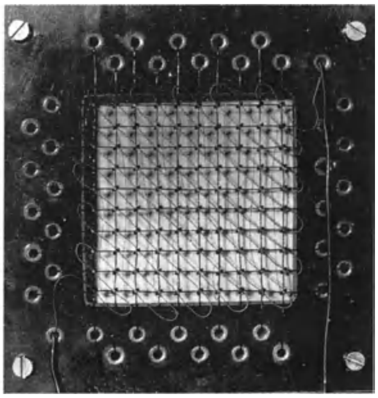
The task of telecommunications is to build bridges by making it possible for people to exchange information, to allow conversations to take place far beyond the reach of the human ear, and to transmit letters instantly instead of entrusting them to a coach or a ship. We can find all the devices and processes that were originally conceived for telecommunications technology in computer technology, from line and amplifier to coding and screen.

3. Computing Technology

The invention of the mechanical desk calculator, which contained such telecommunications parts as relays, tubes, and transistors, promised an acceleration of the computing processes. It required more than just great inventions, however; the will to invent them was even more important. Seen in this way, the computer was not so much an invention, but a realization of comprehensible concepts, which, however, immediately turned into an adventure. Alone the idea of involving thousands of tubes in a single process seemed a hopeless one to most engineers. Success demanded special courage and committed work.

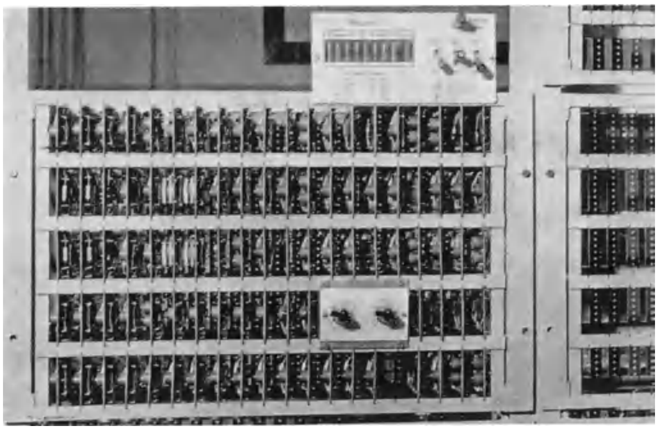


The drum storage bank. One of the two hundred mounted reading and writing heads. A drum with a circumference of 17 cm and a length of 40 cm, rotates at a speed of 3000 rotations per minute. The storage bank has a capacity of ten thousand eleven-place numbers. Average search time: 0.02 seconds.



The fast storage bank. Test model with one hundred rings. Ferrite rings with a circumference of 2 mm can be magnetized and store the numbers. Two thousand rings have a capacity of about forty words. Search time: four millionths of a second.

1. H. Zemanek, *Weltmacht Computer – Weltreich der Information* (Munich: Bechtle Verlag, 1991); H. Zemanek, *Das geistige Umfeld der Informationstechnik*, Edition S.E.L. Stiftung (Berlin: Springer Verlag, 1992); P. Goldscheider, H. Zemanek, *Computer – Werkzeug der Information*, companion book for ten television shows broadcast on ORF/ZDF (Berlin: Springer Verlag, 1971); *Jubiläumsheft 25 Jahre Elektronische Rechenanlagen*, H.-R. Schuchmann, H. Zemanek, eds., no. 6 (Munich: R. Oldenbourg, 1983).



Decade adder. Every one hundred plates can be unified by an insert. Each of the 25 inserts represents a functioning unit. This prototype contains 250 transistors, 500 diodes, and 650 resistors.

It was not enough to create an electronic structure for the desk calculator. The speed of the calculator required automatic computing, immense memory capacity, and a way to control the programming. Here, telecommunications technology was able to offer enough ways to approach the problems, and at the same time, totally new perspectives were opened. In this sense, computer pioneers were bold adventurers in science and technology.

An essential feature of the computer is its consistent logic, based on switching algebra. It starts with the logic of the adding device, realized with cogs and pins in the desk calculator, and with relays, tubes, or chips in the computer. In the same way that the binary cog of the cogwheel in the desk calculator is organized in the decimal system, it is also possible to organize the adding device — logically grounded in base 2 for binary calculation — on base 10 and every other base. It is true that the computer reduces all processes to processes of ones and zeros, but that does not mean it can calculate only with zero and one (this is like saying that man can think only with single nerve impulses). For its first programmed task, the *Mailüfterl*[2] (a pioneering Austrian computer) calculated the prime number 5,073,548,261 in May 1958. That it did this using only zero and one is no more important than whether a desk calculator is made of iron, bronze, or a chip. Correctly programmed, the computer can calculate any calculable number, provided memory banks and processing time are sufficient. Incalculable numbers also exist in principle, and there are numbers that create practical problems as well. Meanwhile, such large prime numbers have been calculated that it is not possible to explain to the layman how this can be done with an engine of twelve decimals. I myself belong to this class of laymen: nobody today is more than a localized specialist.

In terms of electronics, it was quite simple to proceed from the whole numbers used by the desk calculator to decimal fractions, the floating comma, and letters and characters of any kind: binary coding is fantastically flexible. And so one day, numerical programmers found themselves confronted with the problem of storing natural language texts whose inner logic is quite different from that of numbers arranged by size. Looking at it logically, natural language text arrived on the scene by accident, first as something of an address label. Overnight it became possible to input, save, and print out texts by Goethe or Wittgenstein, without having even contemplated the logical processes involved. (As early as the 1960s, we input the *Tractatus* into the *Mailüfterl* in order to try what turned out to be a rather unsuccessful vocabulary experiment.)

At about the same time that the computer stopped being an exotic white elephant and became a commonplace object, telecommunications began to use computer technology, most obviously for direct dial telephones. More and more, computers became telecommunication devices. A fusion began, which called for a common name for computer and telecommunications technology, and so the term information technology came into use. Over the past century, the two fields have gradually come to be a united one that has either conquered or infiltrated all other fields — at least the technological ones. Although the car only has a board computer now, as time goes on it will become a computer on wheels, just as the airplane is becoming a computer with wings. This does not happen of its own accord, without problems or even accidents, but it gives technology a unity it did not previously have.

4. Technical University Vienna

Of course I did not predict this development in full. However, I recognized the importance of the computer as an information technology device at a time when almost everyone saw only the calculating machine. That had two consequences. First, in the *Mailüfterl*, we had a computer that was expected to do urgent calculation tasks, but where information technology applications could take precedence. And secondly, under these auspices, the *Mailüfterl* team became one of the first software engineering teams oriented toward engineering, not mathematics (software engineering is an invention of mathematicians!).

From a different perspective, this lack of pressure, however, made the *Mailüfterl* a special case, maybe even a globally unique one: there was no strong financial or budgetary power behind it. Actually there was no power behind it. The *Mailüfterl* was a university assistant's personal enterprise, tolerated by institute and ministry, but funding it was exclusively my problem (except for the initial amount of 30,000 Austrian schillings — at the time, worth about US$1000 — from the Dr. Theodor Körner Foundation). That I was able to solve this problem is an Austrian miracle.

Admittedly, a wide spectrum of preparations was required in order to build a computer (we will discuss

2. H. Zemanek, "Mailüfterl – Eine Retrospektive," *Jubiläumsheft 25 Jahre Elektronische Rechenanlagen*, H.-R. Schuchmann, H. Zemanek, eds., no. 6 (Munich: R. Oldenbourg, 1983) pp. 91-99.

information theory, switching algebra, and PCM soon), in addition to very modern, if not ultramodern, daring technology. In 1954, it was not as easy a thing to get to the transistor, to semi-conductor technology, as it may seem today. Even in 1957, I returned from Howard Aiken's computer conference at Harvard University with rather mixed feelings, so many objections were made against the transistor. But my instinct was correct, and proving the transistor's reliability was our service for the Philips company, which had generously donated to the experiment. Only four out of three thousand transistors collapsed, and all four were on the list of 'offended' transistors, which had been touched erroneously by a soldering iron (Philips probably also received confirmation from elsewhere, but at any rate...)

Information Theory

The name Information Theory[3] is misleading and even wrong, for Shannon originally titled his paper *Theory of Communication*, and even that went too far, because the paper dealt with the statistics of signal sources and the transmission of signals with noise interference. His primary conclusion was that any transmission channel has a limit — the channel capacity — that cannot be exceeded by even the most sophisticated coding method. People, too, have a limited channel capacity. It is indeed possible for us, mechanically speaking, to play stochastic sequences of tones much faster, but playing them correctly can only be done as fast as we can read and transform them into finger movements: that is what limits our capacity.

Pure transmission technical capacity can be contrasted with a processing technical capacity (just remember how quickly people or computers can translate spoken languages, or of the capability of both as regards other literary or linguistic tasks). However, there is no theory for this, and certainly there is no general theory of information. Information theory does not exceed the statistical parameters of signal transmission, which laymen — because of the misleading name — take for a real information theory.

Switching Algebra

Another basic mental device for computer technology is switching algebra,[4] a means to formally describe digital circuitry and reduce its complexity.

It was an Austrian, Paul Ehrenfest (later famous as a physicist), who, in a review of a 1910 book on formal logics[5] early on established the equivalence of formal logic and switching algebra. Unfortunately, it was published in Russian in a little-known St. Petersburg journal, so that this knowledge first had an effect much later, after other sources had made it public. Switching engineers first invented switching algebra through their pragmatic study of contact network behavior.

Among the creators of this kind of switching algebra, one finds very important Austrian authors such as Johanna Piesch, A. Duschek, and O. Plechl. I have also contributed: my habilitation thesis concerns the logic of probability, an expansion of John von Neumann's idea on the transmission of information in bundles of nerves when, as is indeed the case, the logical function is unreliable. How do our unreliable neurons achieve their reliable operation? They vote democratically, von Neumann says: whatever the majority votes, whether yes or no, is paramount. But von Neumann's model requires far too many lines in the bundle, tens of thousands of them. My idea to include feedback — a widely occurring structure in biological control — reduces their number to hundreds, and that is realistic. But it has no significance for technology.

Switching algebra functions can become quite complicated and easily invite errors. For this reason, devices for the presentation and control of logical functions have long since been built. My history of switching algebra describes both very old and new devices. We built several in Vienna, such as the *LRR1*, the Logic Relay Machine No. 1,[6] treated logical functions of up to seven variables. Later we constructed a laboratory practice box for just four variables, but it had a constant optical display and permitted the original function and the calculated simplification to be seen side by side. In practice, one would need functions for ten to twenty variables, but only a computer can get this under control. One of my team members, Viktor Kudielka, designed a method to solve this problem in his dissertation and also wrote programs for the *Mailüfterl*.

Pulse-Code-Modulation (PCM) and Vocoder

PCM and Vocoder belong to the pre- and post-technologies of computer technology. Even if these transmission processes are not generally known today, they are nonetheless often used. PCM (the momentary amplitude is transferred and transmitted by a binary code) is not only very common in electronic telephone switchboards, but is the basis for almost every method of digitizing continuous signals — sounds as well as images. I encountered this outside of literature during my studies in France in 1949 and later began making PCM and Vocoders with my students. Four of them built a PCM-system, and this enterprise introduced teamwork to our institute at the same time. These kinds of experiences were absolutely necessary for subsequent computer

3. H. Zemanek, *Elementare Informationstheorie* (Vienna: R. Oldenbourg, 1959).
4. H. Zemanek, "Schaltalgebra," Nachrichtentechnische Fachberichte, vol. 3, 1956.
5. P. Ehrenfest, "Review L. Couturat, L'algèbre de la logique," Zhurnal russkogo fisiko-khimicheskogo obshchestva (42: 1910) 382-387; H. Zemanek, "Ein österreichischer Physiker definiert 1910 die Schaltalgebra," Elektrotechnik und Informationstechnik (110: 1993) 2-15.
6. J. Weipoltshammer, "Die logistische Relais-Rechenmaschine LRR1," diploma work, Technical University, Vienna, 1954; H. Zemanek, "Logistische Rechenmaschinen unter besonderer Berücksichtigung der LRR1 des Instituts für Niederfrequenztechnik der TH Wien," Nachrichtentechnische Fachberichte (4: 1956) 56-59.

7. Chr. Schwiedernoch, "Entwicklung eines Vocoders," Dissertation, TH Wien 1955; E. Rothauser, "Ein Impulsverfahren zur Sprachübertragung nach dem Vocoder-Prinzip," Dissertation, TH Wien 1960; J. Holzer, G. Mißriegler, E. Niedermayer, H. Putschi, H. Zemanek, "Ein Versuchsmodell für die Impuls-Zählmodulation," ÖTF (8, 9/10: 1954) 125-132.

8. H. Zemanek, "Die Universal-Relaisrechenmaschine (URR1) des Institutes für Niederfrequenztechnik an der Technischen Hochschule Wien," Elektrotechnik und Maschinenbau (72: 1: 1955) 6-12.

development, but they first had to assert themselves to counteract the traditional style of the Technical University.

I was only familiar with the Vocoder from journals, but I understood immediately that it had to be digitized. Two PhD students — first, Christoph Schwiedernoch and later, Ernst Rothauser[7] — started on a path that ended in an IBM product made in Austria: the IBM 7772 telephone data answering system, part of the IBM/360 family.

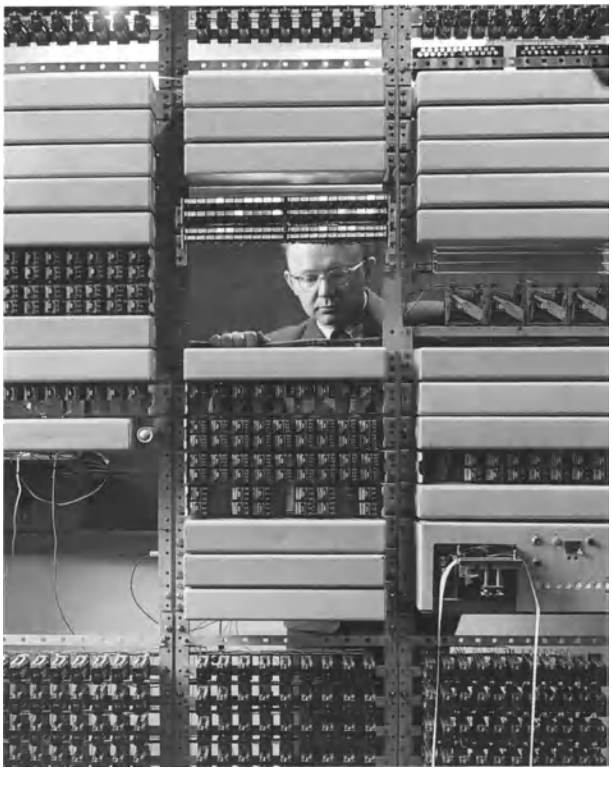
Computer Development in Austria

A description of developments in Austria can accurately focus on the *Mailüfterl*, for it was not only a pioneering Austrian machine, but was the only larger computer ever invented in Austria. Its uniqueness lies less in technical details (although a number of them were quite original and were awarded patents) and more in the particular circumstances in which this machine came into existence. Again and again, the newspapers called it the first transistorized computer or the first European computer. These are journalistic exaggerations. Probably it was the first fully transistorized computer to be developed in continental Europe. It was built with full transistor technology: not a single tube, no vacuum or gas element, and even the power supply was entirely transistorized. So there is something true among all the journalistic exaggerations. To describe the development in detail would lead too far and is, moreover, unnecessary. Everything can be easily found in the literature.[2]

URR1

It made sense to first build a relay machine,[8] because it was relatively easy to get the relays. The model gave me insights into planning and allowed me to see what needed to be done in order to develop a powerful machine.

The **URR1, 1954. Model of a relay machine**

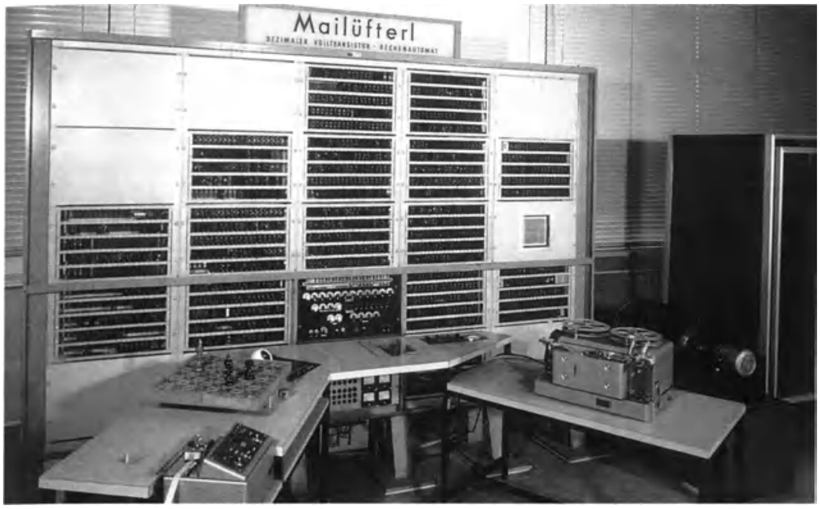


URR1 had only fifteen data storage addresses for a word width of 18 bits, i.e. there were 18 relay adders side by side, which carried the transmission. Multiplication, division and square root, which required shifting, were organized by a rotating multiple switch. A simple and transparent structure, but it gave me lots of insights that are difficult to obtain today — who still has a chance to solder together an entire computer?

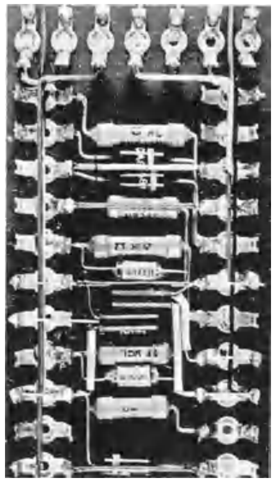
The Mailüfterl

Every time I start describing the *Mailüfterl*, something different comes out. Here, I want to emphasize its connection to Austrian industry and international development. The main problem was the transistors: at that time, eight years after their invention, they were still a rarity. Mr. Rinia, the head of Philips in Eindhoven, had extraordinary confidence in an insignificant, unknown assistant professor and gave us (all in all) 3000 transistors and 5000 diodes. But from the steel rack to the thirty kilometers' length of wire we needed — all worth several hundreds of thousands of Austrian schillings — it was all donated by more than thirty-five companies. Originally, a plaque containing all their names was affixed to the Mailüfterl, but this plate was removed when it became IBM property and has unfortunately disappeared. The generous support meant we had an obligation to get the maximum out of the gifts we received. The name *Mailüfterl*, a Viennese diminutive for a May breeze, stems from a comparison to MIT's *Whirlwind* tube computer: much slower than the famous American machine. Well, the *Mailüfterl* did not turn out to be that slow: we pushed the hearing-aid transistors to an extreme speed. We used their inertia for storing information: a triggered transistor recovers from the shock of an incoming impulse only after some time (some millionths of a second), and our switching circuitry (by K. Walk and V. Kudielka) allowed the transistors to hold the information (0 or 1) as long as necessary before sending it on. We received a patent for this acceleration trick.

Several companies gave us ring-shaped magnetic cores for storage and switching— today these have been entirely replaced by the chip — and they were selected cores, although unfortunately selected by others. We received the less effective tail end of the line, the somewhat weaker rings. To compensate, we had to think of something new, which led to the second patented invention (K. Bandat). We used multiple wiring so that the current power multiplied, and in reading the rings, we did not, like the others, go back from one to zero, but from zero to one. This yielded a negative reading, which can easily be corrected by a negation circuit, but the signal-to-noise ratio was improved somewhat.



The *Mailüfterl*, the pioneering Austrian computer, 1958



Small Plates. The *Mailüfterl* consisted of 2000 plates of this type. This shows resistors, condensers, diodes, and transistors.

Altogether, the *Mailüfterl* was indeed a marriage of ideas and parts, borrowed concepts and sponsoring companies in Austria and abroad, and this marriage was a bigger achievement than the new inventions, considerable though they were, and as proud as we were of our technical ideas.

Formal Definition

I had always seen the computer as a technical information tool, and I looked for corresponding applications. It was evident that the *Mailüfterl* also had to calculate, and we hoped for help from the outside on this — we hoped for another marriage, if I may continue to use this metaphor. The two courtships, it is true, were not successful enough. I would have preferred FORTRAN because it was generally used outside the universities, but IBM did not react to our inquiry. Our colleagues in Munich, on the other hand, assured us that it would not be too difficult to take over their ALGOL compiler. Luckily for us, actually, it did not turn out to be that simple. We had to elaborate our solution to a great extent on our own, and the team — reinforced by P. Lucas's knowledge of programming — had to dig deep into formula translation and its processes, which prepared the transition to both software engineering and formal definition.

Switching algebra is a means to formally describe circuitry. Obviously, programming needs to be formally described in the same manner; it should be stipulated what is meant by a programming language text, particularly because size and the speed of execution do not permit observation of what actually happens. One must trust in the program, and for this it is necessary that the program be correct and lead automatically to the goal.

We were well prepared when the chance came up to be entrusted with the formal definition of the new IBM language, intended to replace FORTRAN and ALGOL (and COBOL as well). It was first called New Programming Language (NPL) and, finally, PL/1. An additional opportunity arose to organize the very first IFIP Working Conference.[9] The IFIP Technical Committee 2 (which I chaired at the time) gave rise to a plan for a conference on language definition, and I promptly accepted its organization — an Austrian initiative of global importance, with global consequences.

The time between 1964 and 1968 was more than filled with the development of a definition language and the definition of the syntax and semantics of PL/I.[10] The definition language was named Vienna Definition Language (VDL) and attracted global attention. After completion of the Vienna project (and transformation of the Vienna Laboratory into a practical programming workshop), it was continued elsewhere.

Here, Austrian achievements during the First Republic come to bear on the subject: Wittgenstein's *Tractatus*, and his later *Philosophical Investigations*. The *Tractatus* is the attempt to construct a formal description of the world or at least of the scientific universe (Wittgenstein had never intended to carry through with this description, and without a computer, it would have been absolutely hopeless). That this attempt and the one at the 'language game' (Wittgenstein I and Wittgenstein II) turned Austrian Ludwig Wittgenstein into a 'computer philosopher,' without his ever taking visible interest in the computer, is a unique case in the history of philosophy that deserves intense interest.

The Vienna Laboratory also created a forerunner for a word processing system, which we needed for to document the definition process. Since such a system did not yet exist, we had to develop it ourselves.[11]

9. T.B. Steel Jr., "Formal Language Description Languages," Proceedings IFIP, (First) Working Conference (Baden bei Wien 1964; North Holland, Amsterdam 1966).
10. P. Lucas, K. Walk, "On the Formal Description of PL/I," Annual Review of Automatic Programming (6, part 3: 1969) 105-152.
11. F. Schwarzenberger, H. Zemanek, "Editing Algorithms for Texts over Formal Grammars," Proceedings of the International Computer Typesetting Conference, University of Sussex 1967 (London: The Institute of Printing, 1967) pp. 126-131.

12. H. Zemanek, "Abstract Architecture. General Concepts for Systems Design," *Abstract Software Specifications*, D. Björner, ed. (Copenhagen 1979); and *Lecture Notes in Computer Science*, D. Björner, ed., vol. 86 (Berlin: Springer Verlag, 1980) pp. 1-42; H. Zemanek, "Gedanken zum Systementwurf," *Zeugen des Wissens. 100 Jahre Automobil – Daimler Benz*, H. Maier-Leibnitz, ed. (Mainz: Hase & Koehle Verlag, 1986) pp. 99-125.

13. E.W. Spaulding, *The Quiet Invaders – The Story of the Austrian Impact upon America* (Vienna: Österreichischer Bundesverlag, 1968); F. Gray, "Pulse Code Modulation," US Patent Nr. 2 632 058 (17 March 1953); M. Rothen, "La télégraphie et quelques autres applications de l'électricité & l'exposition universelle de 1878," Journal télégraphique (2: 1878) 247-254.

Abstract Architecture

After *Mailüfterl* and Formal Definition, my last big enterprise was as an IBM Fellow. The laboratory had been transformed, and I had been named a fellow, which was a great honor. One is permitted to work for five years, go wherever one wants, and travel wherever one wants (the bitter pill was my transfer to Böblingen, near Stuttgart, but then my fellowship in Vienna was prolonged until retirement, a worthwhile compensation for two and a half years in exile). The Formal Definition work had shown my crew that a definition method by no means guarantees the quality of what has been defined. What was left to consider was how a design becomes a good design.

To this day, I struggle with this question. Although I have written at least two publications[12] that demonstrate the basic ideas (actually derived from Vitruvius), the book I have in mind means lots of further work for me.

5. Developments in Austria

The *Mailüfterl* computer was the only one built in Austria, but many, of course, were in use, and an overview of at least the early history might be very useful. But here I must concentrate on selected, very short accounts. At the University of Technology, mathematicians were interested in computers, and Professor Inzinger initiated a group that dealt with the mathematical side of application (after the death of Professor Inzinger, Professor Bukovics continued). They even started a news journal and, later, a genuine journal, *Computing*. As far as chips are concerned, Professor Selberherr, whose contributions are internationally recognized and applied, must be mentioned.

Information Technology in Linz, Graz, and Vienna

A center of information technology development is the University of Linz, beginning with Professor Adam, who became a founding professor of this university. His most original idea was on the professional side: he obtained a trade license as a reckoning master, attaching himself to a medieval tradition and connecting it to present information technology, with automatic control and operations research. Another important figure in Linz is Professor Schulz, who brought his past with IBM in Germany with him, and who did a lot for program design. Professor Reichl, Professor Pichler, and finally Professor Chroust (who had been my assistant at IBM for many years) deal with many aspects of systems research. Professor Buchberger, with his Research Institute for Symbolic Calculation, has created an institution that acts as a bridge between university and industry. Several projects became impressive successes.

In Graz, Professor Maurer is to be mentioned. He created an Austrian variation of the Internet, namely the BTX screen text, with a workstation known as MUPID (Multipurpose Universally Programmable Intelligent Decoder), which can be purchased, or a card can be used to turn a PC into such a workstation. The good basic idea had been to use the post to offer the single small user a great number of computer services. The fact that this enterprise did not achieve the deserved success is not due to the idea, but to the shortsightedness of others who should have done more advertising to spread this technology. The Institute for Fundamentals of Information Technology, headed by Professor Maass, and the Institute for Machine Vision and Representation, headed by Professor Leberl in an excellent manner, reinforce the Technical University of Graz's presence in the area of computer research.

Last but not least, one has to mention Professor Trappl of the University of Vienna, who heads the Institute for Medical Cybernetics and Artificial Intelligence. Very early on, Trappl recognized the importance of cybernetics for science and society. Since 1971 he has organized a biannual conference called the European Meeting for Cybernetics and Systems Research, whose proceedings inform on the actual status of research. Furthermore, Professor Trappl has aimed at and realized the interconnection between cybernetics and the arts. The Austrian Research Institute for Artificial Intelligence, headed by Professor Trappl, also investigates the possible uses of autonomous software agents in virtual environments and other areas of telematics.

Austrian Contributions Abroad

The number of Austrians sharing in achievements produced in other countries is much larger than any other proportional comparison, or so a former American diplomat discovered in the volumes of *Who's Who*, and that discovery motivated him to write a book, *The Quiet Invaders – The Austrian Impact on America*,[13] a really 'underground' book that was never properly distributed. The famous American computer pioneer Franz von Alt was of Austrian origin; he was an employee of the US Bureau for Standards and edited the well-known series, *Advances in Computing*. I will come back to Professor von Foerster in the section on cybernetics, because he was most successful in that field. The merits of Professor Morgenstern are in the area of economic theory and game theory (he and John von Neumann were the co-authors of the initial book), but he has also done a great deal in helping equip Austrian universities with computers.

The name Kurt Gödel stands for a revolution in mathematical thinking; his theorem of undecidability is of fundamental importance for programming languages and higher programming. Goedel will eventually be ranked among the highest in mathematics.

6. Cybernetics

Electronics began flirting with biology early on, in the 1930s, and there were even forerunners in the nineteenth century. Actually, electricity began with biology and Galvani. In the 1930s, its main purpose was telecommunication, and its goal was to learn from biology. The 1950s became the golden age of cooperation, and there is a familiar key word for it: cybernetics. Again, I may and must begin with myself, because I am the only one on earth who has built and further developed all three basic models with my students. They are the *Artificial Tortoise*, the *Mouse in the Maze*, and the *Homeostat*.

The artificial tortoise looks only slightly like a tortoise and was not intended to imitate one. Rather, it is a model for the conditioned reflex. The Russian physiologist I.P. Pavlov developed the algorithms for it around 1890. When a dog sees food, the production of saliva in his mouth increases. This is an unconditioned reflex. If a bell is rung at the same time (Pavlov used an electric door buzzer), the animal learns that the bell promises food; saliva production increases when the bell rings, even if no food is visible. This is a conditioned reflex that disappears when the hope for food is not fulfilled often enough. Pavlov described the phenomenon, not as a formula but in prose. British neurologist W.G. Walter recognized that this model could be made electronically and built a little covered vehicle[14] (hence the name tortoise), containing a lamp and whistle, symbolizing food and sound respectively. If the vehicle hits an obstacle, the cover closes a contact; the model rolls back and tries again, adjusting a little more to the right or left. This creates the impression of animal behavior. The first Vienna model was a copy of Walter's model and represented Austria at the first cybernetics congress in Namur in 1956.[15]

My medical partner for the next step was Hungarian neurologist and psychologist A.J. Angyan. He traveled with a more complex model of Walter's tortoise to a conference in London, the Mechanization of Thought Processes, in 1958[16] and stopped at our institute in Vienna in order to improve his somewhat poor model (at that time, cybernetics in the communist countries was still a bourgeois, decadent quasi-science, and Angyan could not obtain proper components). On his return trip, he decided in Vienna not to return to Hungary, but to apply for an American visa. During the waiting period, which lasted longer than expected (a good opportunity for us!), he not only cooperated with us as a team member in developing an expanded model for two connected conditioned reflexes[17] but also obtained a grant from the Rockland State Hospital in New York City, which permitted him to live in Vienna and contribute a little to the costs — in return, the Hospital received one of the two models built. The student assistant was Hans Kretz. Altogether, we built more than five models of the tortoise in Vienna.

The Rockland State Hospital was satisfied with the result, and, after Angyan finally got the visa for the U.S.A., he captured the interest of Warren McCulloch, who liked to support immigrants and took him under his wing. Angyan's further career was guaranteed.

Another variation, fully transistorized, was built in Vienna by a student, H. Bielowski. Interestingly enough, it turned out to be bigger, not smaller — that would be different today. This model was shown in the Austrian Pavilion at the World Expo in Montreal in 1981.

The *Mouse in the Maze*, designed by Claude Shannon,[18] creator of information theory, was built by Richard Eier, who is today a full professor for computer technology at the Technical University of Vienna. Eier created an expanded version[19] — that is, it was not only based on Shannon's biological model, but also included Ariadne's thread in virtual form. Of course this orientation device was not an invention of Ariadne: she got it from Daedalus, the engineer and builder of the maze. When the King found out, Daedalus got into difficulties: the King locked him into his own labyrinth. He tried to save himself and his son by constructing wings out of feathers and wax, in order to escape to Egypt. His son, Icarus, ignored his father's warning, flew too close to the sun, and drowned in the Mediterranean sea.

Ariadne's thread denotes two bits for escaping a square and two bits for the state of a square:

00	West	not yet entered
01	North	partial solution (at least provisionally)
10	East	dead end
11	South	danger of going in a circle; is immediately neutralized when a virtual wall is inserted, hindering the ability to continue in a circle

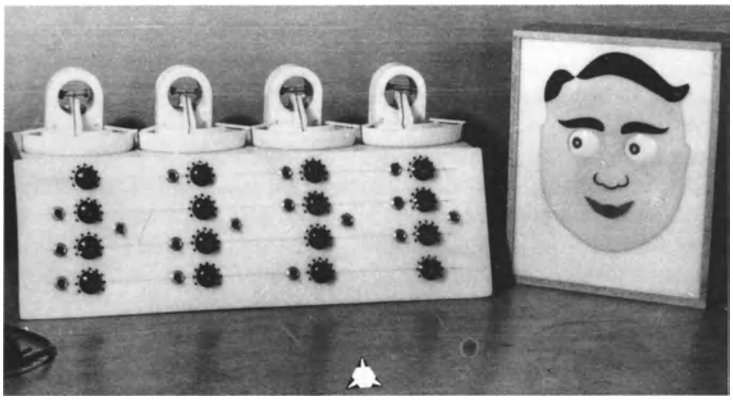
14. W. G. Walter, *The Living Brain* (London: Duckworth, 1953); H. Zemanek, "Nachrichtentechnik und Datenverarbeitung zur Makartzeit," Jahrbuch des Österreichischen Gewerbevereins (Vienna 1974) pp. 71-92; H. Zemanek, "Otto Schäffler (1838-1928)," Blätter für Technikgeschichte (41/42/43) (Vienna; Springer Verlag, 1983) 82-118; H. Zemanek, "Hollerith und Schäffler – Datenverarbeitung um 1890. Drei Nationen werden elektrisch gezählt," *Elektrotechnik im Wandel der Zeit*, H.A. Wessel, ed., Viertes VDE-Kolloquium "Geschichte der Elektrotechnik," Nuremberg 1986 (Berlin: VDE-Verlag, 1986) pp. 95-113; Otto Schäffler, Neuerungen am statistischen Zählmaschinen-Patent Nr. 463.182 (20 September 1895 with priority from 30 May 1895).
15. H. Zemanek, "La tortue de Vienne et les autres travaux cybernétiques," Actes du 1er Congres International de Cybernétique, R. Boulanger, ed., Namur 1956 (Paris: Gauthier Villars, 1959) pp. 770-780.
16. "Mechanization of Thought Processes," Symposium No. 10 held at the National Physical Laboratory 24 to 27 November 1958, vols. I and II (London: Her Majesty's Printing Office, 1959); paper by A. J. Ángyan, "Machina Reproducatrix," pp. 933-943.
17. A. J. Ángyán, H. Kretz, H. Zemanek, "A Model for Neurophys. Functions," *Fourth London Symposium on Information Theory, 1960*, Colin Cherry, ed. (London: Butterworths, 1961) pp. 270-284.
18. C.E. Shannon, "Presentation of a Maze-Solving Machine," pp. 173-180, *Cybernetics. Transactions of the Eighth Conference, 1951* (New York: Josiah Macy Jr. Foundation, 1952) pp. 240ff.
19. R. Eier, H. Zemanek, "Automatische Orientierung im Labyrinth," Elektronische Rechenanlagen (2: 1: 1960) 23-31.

20. W. R. Ashby, Design for a Brain (London: Chapman & Hall, 1952), sec. rev. ed. 1960.
21. A. Hauenschild, "Der Homöostat," work for the state examination at the Technical University in Vienna.
22. H. von Foerster, *Cybernetics, Transactions, vols. VI to X* (New York: Josiah Macy Jr. Foundation, 1949 – 1953).

A magnet on its underside moves the mouse on a rail coordinate system. When it hits a wall, the carriage senses that it has lost the mouse, returns and tries in the next direction. The correct escape route is stored.

The *Homeostat* is a model for the principle of homeostasis, a biological function first described by British-American physiologist W.B. Cannon; W.R. Ashby[20] built a model of it. The model is a multiple feedback system in which four variables influence each other. a rotating switch alters their interconnection. Four pointers start to move when switched on or when triggered by some input, and they begin a search for a point of equilibrium. The pointers pick up tension from a liquid potentiometer, and when they touch one of the two ends of the potentiometer long enough, the rotation switch takes the next step: a new search for equilibrium begins. Here is an example of the homeostatic function in your own body: when, you go outside on a winter day, your cheeks get red in order to compensate for the temperature decrease: more blood brings more heat. If this regulation turns out to be insufficient, your inner switch leads you to produce more heat — by stamping your feet, for instance.

In our case, a student, A. Hauenschild, restricted himself to a pure copy,[21] but he added two demonstration devices. One is a primitive glass screen, on which two spots of light are moved in accordance with the four variables. There is a setting where the two spots of light behave like cat and mouse (the cat tries to catch the mouse; the mouse tries to escape). At another setting, the spots behave like two boxers, attacking each other again and again. The second demonstration device is a stylized human face, where the four variables control the positions of the corners of the mouth, the eyebrows, and the eyes. This produces a play of features. Such demonstrations give a better idea of how the abstract concept of homeostasis produces dynamic effects. Ashby once came to visit us and found the two devices very useful; moreover he admired the Vienna model — but this is only thanks to our luck: my student's father was the owner of a plastics factory, so the model could be made with much better materials than the original's. For several years, Ashby worked with Heinz von Foerster at the University in Urbana (a one-hour's flight south from Chicago), and so this is a good moment to insert a word on von Foerster, who wrote only one book[22] in Austria back in 1948, but achieved a great deal in America.



Homeostat
by A. Hauenschild

When von Foerster realized that his book on the human memory was a succès d'estime, but did not create a base for an Austrian career, he went to the States, where he fell into the hands of McCulloch, the scientist mentioned above, who helped so many immigrants. McCulloch brought him to the attention of the J. Macy Foundation, where he became editor of the conference proceedings, for which von Foerster instantly proposed the name "Cybernetics." Von Foerster edited five volumes altogether. Later, he became a champion for cybernetics in the U.S.A. He succeeded Arthur Samuels at the University of Urbana, who had computerized the game of checkers and then later moved on to IBM, to have better access to computers.

Conclusion

The computer has long since transformed from exotic monster to everyday device, and mass production covers the tracks of its Austrian beginnings. But what was done during that time improved the initial preconditions so much that the significance of Austrian contributions to information processing is far out of proportion to the size of the country. It cannot be said that those who had the power to develop the economic potential of these contributions have been possessed of extraordinary foresight. Understandably, foreign companies pursue only those inventions that bring safe gains. If they had taken advantage of the knowledge in Austria, Austrian enterprises could have been achieved much more in such as a rapidly growing field. And this dry statement will close this excursion into history.

Hermann Maurer

How Things Often Repeat Themselves – or: Development Goes Winding Paths in Information Technology, Too

1. Introduction

When I first became interested in computers and information technology (IT) back around 1961, it was initially the wealth of applications that fascinated me. Looking back, this wealth was but a tiny fraction of what has developed today. And in twenty years time again, we will begin to understand that people in 1996 had not even begun to grasp the really important applications.

Through the influence of Professor Zemanek, I increasingly began to explore the theoretical principles of IT from 1964 on, which brought me back to my beloved mathematics (as things tend to repeat themselves). I am proud that I was able to achieve a certain reputation in this field in the ensuing fifteen years. My first book, *Theoretische Grundlagen der Programmiersprachen* [Theoretical principles of programming languages], turned out to be a bestseller; my third book, *Algorithmen und Datenstrukturen* [Algorithms and data structures], was translated into several languages, including a pirated version in Chinese. But the most important thing during this period of theory was my friendship with many colleagues, first and foremost Arto Salomaa in Finland and Derrick Wood in Canada. The MSW team authored more than fifty journal articles, most importantly on the theory of L-forms. During this time, I also had the opportunity to work with some of the best students I have ever known, B. J. Albert (now in Würzburg), H. Edelsbrunner (Illinois), D. Fellner (Bonn), G. Schlageter (Hagen), R. Seidl (Saarbrücken), and E. Welzl (ETH Zurich), to name but a few. But as a result of my second calling (taking me from Karlsruhe to Graz in 1977), I also began to become more interested in applications again, and that is my main story here.

2. From Videotext to HyperWave

From England in the mid-1970s, the idea emerged to make information and services accessible to the general public in computer networks. There weren't any PCs yet. So what could be more obvious than to try and use existing TV sets, retrofitted with some electronics (ie, a decoder) to act as terminals, and link them to the computer networks via modem and telephone. In 1979, I drew up a study as to whether this kind of "videotext" could be useful for Austria, too. The resulting recommendations were sobering: the simple version used in England (under the trade name Prestel) wasn't useful.

The reasons for this were that you can't use a typical remote-control keypad to make meaningful queries or entries (as these keypads lack letters, the only possibility is to use menus and just enter numbers); that the resolution of a television is low; and, above all, that it is very easy to build a fully adequate graphic computer instead of a simple decoder with just a few more electronics. If you add to this decoder a printer and external memory, what you've got is a real "personal computer" (a term that hadn't even been invented at the time!). Thus, the MUPID (the Multipurpose Universal Programmable Intelligent Decoder) was born in 1982 and developed by my collaborator Dr. R. Posch – today a world-renowned professor at Graz University of Technology – and myself. Videotext promised (almost) everything that the World Wide Web (WWW) is promising today: access to vast amounts of data, e-mail communication, discussion forums (such as the Electronische Rede- und Diskussions-Ecke (ERDE) discussion group), chat rooms, online catalog orders, and other transactions. The external memory of MUPID wasn't really necessary: MUPID was able to load software from servers and run the programs immediately (we coined the term "tele-software") and was capable of displaying high-quality video graphics.

Videotext did not catch on in a big way. The abandonment of the videotext standard throughout all European countries except Germany, Switzerland, and Austria, cumbersome mail administration, and the advent of the PC are a few of the obvious reasons; there are many more, but in truth the time was not yet ripe for simple computer networks. The strange thing is that videotext was in some respects ahead of the WWW, in terms of the guaranteed speed of transfer, data security, and so forth. But, despite all this, we must be aware of two facts. No other computer was built in (35,000) or exported from (15,000) Austria on the same scale as MUPID. Incidentally, the failure of videotext was to a great extent due to the information chaos that comes about when a large number of organizations input and maintain data in an information system independent of each other and without any inherent support from the system. So one gratifying thing is that although MUPID has long vanished, and MUPID Computer Ges.m.b.H. (MCG) was forced to close shop many years ago, the staff of MCG has founded more than ten successor firms in Styria with more than 200 employees. So the accumulation of know-how was not in vain – not at Graz University of Technology and not at Joanneum Research (JR).

Around 1988, under my direction, a growing team was concentrating on what a future networked multimedia system would have to be like in order to achieve the success that videotext had not. The project was given the code name Hyper-G. On the basis of worldwide experience, Hyper-G was ultimately conceived as a networked database system with vast support for database organization (e.g., automatic reference management, removal of outdated documents, etc.). It was specified for the first time in a dissertation by DI F. Kappe. In the years following 1992, the development was largely influenced by Kappe; at times the team had more than fifty members.

Hermann Maurer, studied mathematics at the Universities of Vienna and Calgary (Canada) from 1959 on. In 1965 Ph.D. at the University of Vienna. 1963-66 mathematician and programer at the IBM Laboratory Vienna. 1966-71 assistant and later associate professor of computer science at the University of Calgary. 1971-77 professor of data processing at the University of Karlsruhe. Since then professor at the Institute of Data Processing and Computer-based Media at the TU Graz. Since 1982 also chairman of the Research Institute of Applied Data Processing of the Austrian Computer Society. Guest professor at these universities: SMU (Dallas), Waterloo (Canada) and Brasilia (Brazil). 1984-88 adjunct professor at the University of Denver. In 1993 professor of computer science at Auckland University. Honorary professor at the Polytechnic St. Petersburg. His main fields of research are languages and their application, data structures, efficient algorithms, mass information and transaction systems, computer-based new media, hypermedia system and the effects of information technology on the society. Author of several books and about 400 articles. Director of diverse industrial and hypermedia projects, such as MUPID, COSTOC, Hyper-G or Images of Austria (Expo '92 and Expo '93). Publisher of several specialist journals. He is also the author of Science Fiction novels, recently translated into English: e.g. *The Paranet, The Paradoppelganger, The Parawarriors* (booklocker, 2004).

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Hermann Maurer, *Datenstrukturen und Programmierverfahren* (Stuttgart: Teubner, 1974).
Hermann Maurer (ed.), *HyperWave. The Next Generation Web Solution* (London: Addison-Wesley-Longman, 1996.

Meanwhile, a much simpler system, WWW, conceived at CERN by T. Berners-Lee and R. Cailiau, was set to conquer the world. Of course, the WWW systems lacked the same functions that videotext had lacked. An absence of database support, structuring mechanisms, an excessively primitive reference concept, cluttered information, and other things all lead to a situation in which the much-hated messages of the videotext era "Object not found" and "Document is being downloaded. Please wait" are again adorning computer displays and in which the proliferation of outdated, incomplete information is probably far worse than in the days of videotext.

However, Hyper-G has meanwhile been developed into a system conforming to the WWW. As HyperWave, a protected trade name in the US, Canada, and Europe, it has the potential to stem the proliferation of the WWW. In future, the usefulness of the WWW will greatly depend on the extent to which HyperWave, or rather the principles embodied by HyperWave, can succeed. The future will show whether my team can influence global developments this time around – and the signs are promising. Several global organizations have already opted for HyperWave. Munich-based HyperWave Europe commenced worldwide marketing of HyperWave in December 1996, while the Graz-based "Hyper-G Forschungs- und Entwicklungsges.m.b.H.," detached from Graz University and JR, will take care of further development.

How things tend to repeat themselves. The biggest hit on the WWW in 1996 was JAVA, a programming language that allows you to download and run program sections from servers. Thinking back to MUPID's tele-software of 1982 that did very much the same thing, I can't help having a feeling of déjà vu. And reading about the external memory-free network computer (NC) being promoted by Oracle, SUN, and others, this feeling gets even stronger. The first NC was called MUPID and was developed fifteen years ago in Graz, and HyperWave will operate the PCs and NCs of the future.

3. Prospects

Today, the WWW is the biggest and, unfortunately, the most chaotic information and communication system that has ever existed. The ideas of HyperWave will help bring order into this chaos.

WWW will not suffer the same fate as videotext. The critical point has already been passed. Anyone who refuses to use the WWW will push themselves out into the cold just like anyone who refuses to use the telephone.

WWW and its various manifestations in the future will fundamentally change our economy and society. Omnipresent information and communication will incorporate individuals to an unprecedented extent into the knowledge pool of the "being that is mankind."

Axel Pinz

Digital Visual Information: Computer Vision and Representation

This essay focuses on the processing of visual information in the computer – on the one hand 'vision' and on the other, 'representation' or 'computer vision' and 'computer graphics.' It will attempt to link this field to art as well as provide a technical introduction to this aspect of computer science. The illustrations show the multitude of current problems and applications; they are all taken from independent work done for the institute in Graz. It becomes clear that the computer, although still in most cases inferior to human sensory and spatial perception, is a supportive tool that can sensibly expand these areas in a multitude of ways. The machine is successful in areas requiring the performance of either complex interpretation tasks (for example, medical diagnoses) or high-precision measurement tasks (for example, industrial quality control). Without high-performance, three-dimensional computer graphic systems, humans would not have access to new virtual realities.

Axel Pinz, born 1958 in Vienna. Studied electric engineering and computer science at the Technical University Vienna. 1988 Ph.D. 1995 habilitation in applied data processing. Since 1983 he has worked in the field of digital picture analysis. 1983-90 at the University of Agriculture Vienna. 1990-94 Technical University Vienna. Since 1994 at the Institute of Machine Perception and Image Processing at the Technical University Graz, where he directs the workshop for image recognition, multisource fusion, neural networks and adaptive pattern recognition, as applied in long-distance reconnaissance, in medical image analysis and in industrial inspection.

1. Introduction

Vision is an extremely complex sense that is an essential basis for the perception of the space surrounding us. Through perception, we recognize objects and situations and finally come to decisions. If we attempt to model this sense as a process in a computer system, a multitude of questions opens up that perhaps only on second glance stand in connection with artistic considerations.

But how does the artist perceive? How does an observer view an artwork? How do the viewing of a scene, the construction of an 'inner map' and its subsequent reproduction function? Which inner images are conjured up by a verbal ('symbolic') description of a scene? What is a scene, 'essentially' (for example, contours, colors, textures)? How are objects 'recognized' (for example, caricatures of persons)? Can optical illusions help to explain the function of our visual system?

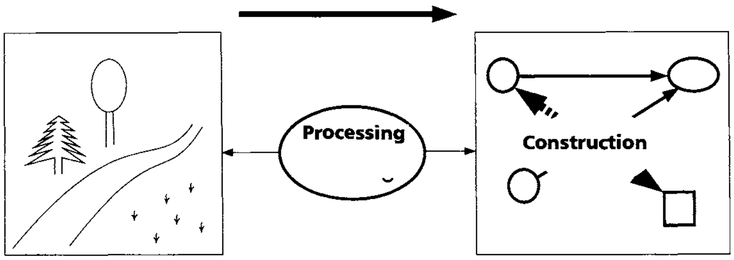

Fig. 1: Computer vision (image understanding) and computer representation (computer graphics) are inverse processes to each other.

Computer vision[1-3] and computer representation[4] can be observed as each other's inverse in Fig. 1. Computer vision is based on a real scene or an image of a real scene, and the result is a description of this scene in the computer. In computer graphics, an image is generated from this type of scene description. While some examples in the third section require computer graphics for visualization, the remainder of this article is primarily concerned with mechanical vision.

Two approaches to computer vision can be differentiated:

• Recognition, interpretation, decision: Here, the primary aim is not the most complete modeling of the scene. Rather, only the necessary information should be extracted from the images in order to solve the problem. Typically, the construction can only be completed by a decision (for example, face belongs to person X, etc.).

• 3D reconstruction: The total scene, a surface or an object is reconstructed three-dimensionally. This can occur in very different ways, for example through the triangularization of 3D point clouds.[5] The construction is completed as soon as the three-dimensional structure is satisfactorily composed. This does not necessarily contain any recognition of the reconstructed objects.

A clear characterization of the two approaches, the 'recognition school' and the 'reconstruction school,' is given by Aloimonos and Shulman.[6]

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing* (Reading, Mass.: Addison-Wesley, 1992).
2. R. M. Haralick and L. G. Shapiro, *Computer and Robot Vision, vol. 1* (Reading, Mass.: Addison-Wesley, 1992).
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5. P. Uray, "From 3D Point Clouds to Surfaces and Volumes," Ph.D. dissertation, TU Graz, 1996.
6. J. Aloimonos and D. Shulman, *Integration of Visual Modules. An Extension of the Marr Paradigm* (New York: Academic Press, 1989).

2. A System Model for Mechanical Vision

The first systematic development of a theory of sight from the viewpoint of computer and information science comes from Marr[7] in 1982. The procedure suggested by Marr influenced additional research in the 1980s so significantly that today it is often described as the 'Marr paradigm.' As a result, parts of this theory were successfully implemented by various researchers (for example, Stereo) in the form of so-called 'visual modules' and the theory was expanded (for example, by Aloimonos and Shulman[8]). Yet weaknesses in this method became apparent, such as the unsolved problem of the sequence control in a system that reads images[9] or the overly large complexity of the problem itself.[10] While Marr still analyzes static images – that is, designates one or two image entries and attempts to analyze these images in multiple stages of a process – more recent methods take other paths. Some of the most significant are: Active vision, purposive vision, qualitative vision: all three concepts are closely associated with Aloimonos.[11] The essential idea consists of: first, explicitly regarding the goal of the visual construction (purpose); second, refraining from totally reconstructing that which is unnecessary, but rather taking into account certain qualities; and third, becoming active. That means rather than a passive sensor, using a system that interacts with an observed scene. A person proceeds in quite a similar way when he or she moves in order to see behind an object that is partially covered by another object.

Neural networks: In the beginning, image understanding was conducted analogous to other disciplines of artificial intelligence. Image-understanding expert systems were developed wherein the maximum information possible should be made explicit and be symbolically processed. With the emergence of the neural networks, this was quickly adopted for image analysis,[12] primarily on account of the more efficient opportunities for automatic learning. A basic disadvantage of neural networks lies in the fact that the learned information is separately stored in the evaluation of the network and is thus not explicitly accessible. The system model for image understanding shown in Fig. 2 stems from my article 'Bildverstehen' (1994).[13] It can be seen as a further development of the Marr model, yet tries to also consider the newer developments named above. The upper half describes situations, objects, and processes of the real world; the lower half, representations and processes in the computer. A scene from the world is chosen for observation. The scene is three-dimensional and finitely defined (a compact piece of space at a certain period of time). The scene is recorded with a sensor (camera), which leads to a two-dimensional image. In the reduction of the dimensions, however, information is also lost. It is not generally possible to fully reconstruct a 3D scene with a 2D image. If the image is not available directly in digital form, it must then be digitized in order to be processed by the computer. In Fig. 2, this has been done and the 'image' is already a digital grid image. Various procedures of image processing, segmentation, and grouping produce a scene description. When more than one scene is observed, the different scene descriptions are integrated into a larger description, which then describes a larger section of the world (more points in time, different locations). If the system is active, then it can stand in direct interaction with its environment, change it, and finally record new images.

At the center of this system lies the control process that holds the data from all levels of representation and controls the necessary processes (process selection, parameter delivery, start of processes, communication between the multiple processes, termination of processes). In the next section, the multiple opportunities in the processing of digital visual information will be listed using examples from works of the Graz Institute.

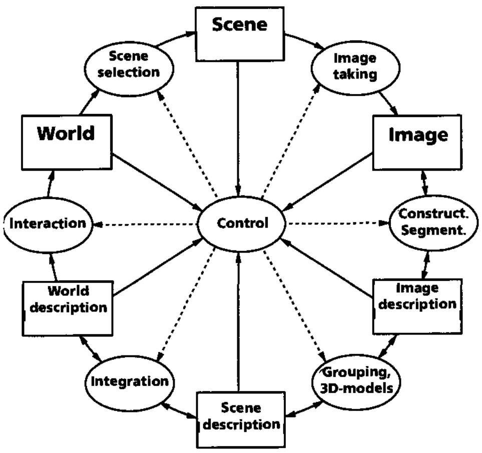

Fig. 2:
A complete systems model for image understanding.[13] The upper half of the diagram is a description of the real world, the lower half its corresponding representation in the computer. The boxes symbolize the representational levels, ellipses describe the processes. Solid arrows show data flow, broken arrows control flow.

3. Applications

We begin with an example from medical image interpretation (Fig. 3). A scanning laser ophthalmoscope (SLO) is implemented for the diagnosis of age-related macular degeneration. For this, it is necessary to record multiple images (of different wavelength areas, angiography). From each of these images, essential anatomical and pathological characteristics must be extracted. Only the compilation of all these characteristics allows for a correct diagnosis and efficient therapy. This doctor's task of interpretation is completed by the machine and results in a map of the retina.[14] Fig. 4 shows a further interpretation task from industrial quality control in steel production. The quality of the steel is controlled through metallographs that analyze specially prepared samples in a light microscope. They choose the 'worst' part of the sample and then interpret the carbide structure (light points in Fig. 4b) according to criteria such as 'consistency' or 'largest accumulation of carbide.' The corresponding mechanical visual system is implemented as an active inspection system that controls the microscope, records images, and plots structures.[15] The next image example shows a task of object reconstruction: the automatic reconstruction of the complex surface of a human head (Fig. 5). The reconstruction begins from a point cloud taken from a random visual module ('shape from X') and after a number of interim steps, leads to the final result: the triangulation of the surface.[16]

7. D. Marr, *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* (New York: W. H. Freeman, 1982).
8. J. Aloimonos and D. Shulman, *Integration of Visual Modules. An Extension of the Marr Paradigm*, op.cit.
9. T. Matsuyama, "Expert Systems for Image Processing: Knowledge-Based Composition of Image Analysis Processes," Computer Vision, Graphics and Image Processing 48 (1989): 22-49.
10. J. K. Tsotsos, "A 'Complexity Level' Analysis of Vision," in Proceedings of the 1. ICCV. International Conference on Computer Vision (IEEE Comp. Soc. Press, 1987), pp. 346-355.
11. J. Aloimonos, "Purposive and Qualitative Active Vision," Artificial Intelligence and Computer Vision (1991): 455–464.
12. Yoh-Han Pao, *Adaptive Pattern Recognition and Neural Networks* (Reading, Mass.: Addison-Wesley, 1989).
13. Axel Pinz, *Bildverstehen*, Springers Lehrbücher der Informatik (Springer, 1994).

Mapping of the human retina: With a "Scanning Laser Ophthalmoscope (SLO)" several pictures of the human retina are taken. From these pictures anatomical and pathological characteristics are extracted and combined in a map.[14]

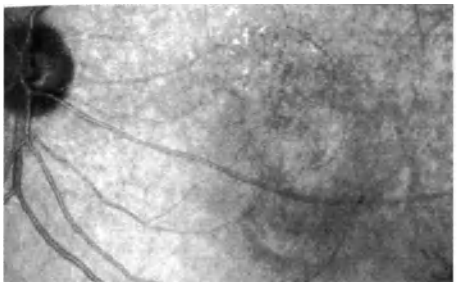

Fig. 3a: SLO-image of the human retina

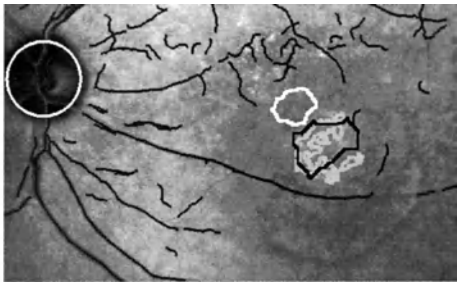

Fig. 3b: Map of the retina with anatomical and pathological characteristics

Active inspection for quality control in the steel industry: the computer controls the microscope, enlargement and lighting, selects image cut, digitizes an image and extracts the characteristic structure.[15]

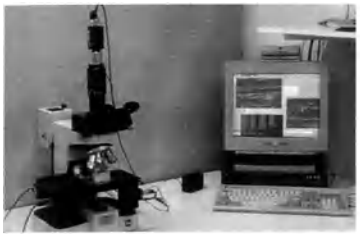

Fig. 4a: System set up

Fig. 4b: Steel sharpening image

Fig. 4c: Characteristic structure

From point clouds to surfaces: three-dimensional reconstruction of a human head.[16]

Fig. 5a: 3-D point cloud

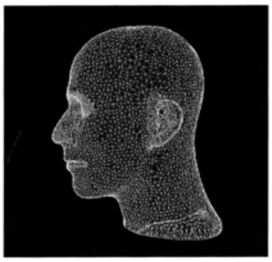

Fig. 5b: Triangulation of the surface

Abb. 5c: Graphic presentation of the surface

4. Concluding Remarks and Outlook

Through constant improvements in hardware and software for computer graphics systems, computer representation has had a continuous rapid upswing in the past. As a result, today we experience a multitude of artificially generated images and three-dimensional virtual realities, from the entertainment industry to driver and pilot simulation programs to scientific virtualizations. The procedure is linear: a random scene is manually modeled on the computer (a great deal of work), presented as realistically as possible (a long calculation), and the final product is perceived by the human. Difficult tasks for the future are the automatic generation of models from the simplest possible descriptions and the improvement of algorithms and computer components for rapid visualization.

Progress in computer vision must be more critically assessed. A general image-understanding system has not yet been built, not even with strongly limited conditions (best lighting, homogenous surfaces, few select objects known to the system). There is also no lack of appropriate self-criticism in the more serious scientific literature.[17-19] Today, the theoretical fundamentals of computer vision and the necessary algorithmic equipment can actually be considered solid and mature. The breakthrough to perception duplication by the computer is yet to come. A simple assessment of the complexities leads to the conclusion that this will remain so for some time, unless we find a revolutionarily new methodology.

14. A. Pinz, M. Prantl, and P. Datlinger, "Mapping the Human Retina," in *Selected Papers from the 9th Scandinavian Conference on Image Analysis*, ed. G. Borgefors (Singapore: World Scientific, 1995), pp. 317-329.
15. K. Wiltschi and A. Pinz, "An Active Inspection System for the Assessment of Steel Quality," in Machine Perception Applications, Proceedings IAPR-TC-8 Workshop, vol. 93, ed. A. Pinz, et al. (Vienna and Munich: R. Oldenburg, 1996), pp. 127-136.
16. P. Uray, "From 3D Point Clouds to Surfaces and Volumes," op.cit.
17. R. C. Jain and T. O. Binford, "Ignorance, Myopia, and Naïveté in Computer Vision Systems," Computer Vision, Graphics and Image Processing 53:1 (1991): 112-117.
18. T. Pavlidis, "Why Progress in Machine Vision Is So Slow," Pattern Recognition Letters 13:4 (1992): 221-225.
19. P. Zamperoni, "Plus ça va, moins ça va," Pattern Recognition Letters 17 (1996): 671-677.

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5

Thomas Natschläger

Networks of "Spiking" Neurons: A New Generation of Neural Network Models

Thomas Natschläger, born 1970 in Wels, Upper Austria. After attending the technical High school for Telecommunication and Electronics in Steyr he began to study computer science (with the major theoretical computer science) at the Technical University Graz where he graduated with distinction in June 1996. Working at the Institute of Fundamental Information Processing. In his research he focuses on the field of learning and calculating in networks of "spiking" neurons.

Introduction

Each living creature has to act suitably in response to the situations it encounters in its environment. Nowadays it is accepted that the nervous system – including the spinal cord as well as the neocortex – controls behavior. In a simplified picture, one could view the nervous system as a device that receives input from various senses, such as auditory input from the ears, and produces (that is, computes) some output in the form of movement or speech. To understand how these computations are performed is one of the most interesting and challenging tasks in science. Thus, it is not surprising that the field of neuroscience[1] attracts a lot of researchers not only from biology but also from physics and computer science.

In this essay I try to give the reader an idea of what computer scientists (especially at the Institute for Theoretical Computer Science at the Technical University of Graz) can contribute to the question of how the brain works. The central questions of a theoretical computer scientist are: How much (computational) power is needed to compute a certain function?[2] Which functions can be computed by a given 'device'? In this context, a concrete question could be: How many nerve cells are needed to be able to distinguish between a picture of your mother and your father? However, the questions addressed in this article are still on a more abstract level, since theoretical computer scientists try to make general statements about computation. An article written by W. Maass[3] investigates these kinds of questions in a more mathematical manner.[4]

Biological Neural Systems

I start with a short 'cartoon-like' description of the human nervous system, which provides the basis of all models of neural networks (for a more detailed description, see Sheperd, 1994[5]). The nervous system has on the order of 1010 nerve cells, so-called neurons (Fig. 1). Each of these neurons is connected to about 10,000 other neurons via synapses. This gigantic network of neurons and synapses builds up the 'hardware' (often called 'wetware') that carries out the computations underlying human behavior.

One of the most important parts of a neuron is its membrane, which separates the interior and the exterior of a neuron spatially and electrically. A prominent feature of the cell membrane is that it maintains a voltage difference between the interior and the exterior. This 'membrane potential' is subject to change if a neuron receives some input via its synapses (mainly located at the dendritic tree of a neuron) from other neurons. There are two basic types of input: excitatory input (via excitatory synapses) increases the membrane potential, whereas inhibitory input (via inhibitory synapses) decreases the membrane potential (Fig. 2). If enough excitatory input accumulates the membrane potential at the axon hillock eventually reaches a threshold. If this event occurs, the membrane follows a stereotyped trajectory, the 'action potential' or 'spike.' This spike travels along the axon (the 'output wire' of a neuron) to all its terminals, which connects the axon to other neurons (postsynaptic neurons) via synapses. A complicated chemical process transforms the spike into a change of the membrane potential of the postsynaptic neuron, the 'postsynaptic potential' (PSP), which comprises the above-mentioned input of the next neuron.

Fig. 1: Schematic picture of a nerve cell

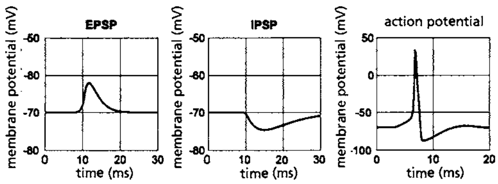


Fig. 2: Drawing of the canonical shape of a postsynaptic potential and the action potential. Excitatory synapses produce an EPSP whereas inhibitory synapses produce an IPSP.

The First Generation of Models

If one wants to understand how the nervous system computes a function, one has to think about how information about the environment or internal states is represented and transmitted. Due to the fact that the shape of an action potential is always the same, one can exclude the possibility that the voltage trajectory of an action potential carries relevant information. Thus, a central question in the field of neuroscience is how neurons encode information in the sequence of action potential they emit (Fig. 3). In this article we characterize neural network models by the assumptions about the encoding scheme.

1. Researchers in the field of neuro science try to answer the question: how does the brain work?
2. In the field of theoretical computer science a function map is a mapping from outputs to inputs.
3. Prof. Wolfgang Maass is the head of the Institute for Theoretical Computer Science at the Technical University of Graz, Austria.
4. W. Maass, *Networks of Spiking Neurons: The Third Generation of Neural Network Models, Neural Networks*, 1997.
5. G. M. Sheperd, *Neurobiology* (Oxford: Oxford University Press, 1994).

In 1943 McCulloch and Pitts proposed the first neuron model: the threshold gate. A characteristic of their model was that they treated a neuron as a binary device. That is, they only distinguished between the occurrence and absence of a spike. The threshold gate is used as building block for various network types including multilayer perceptrons, Hopfield networks, and the Boltzman machine.[6] It turned out that the threshold gate is a computationally powerful device. That is, one can compute complex functions with rather small networks made up of threshold gates.[7] From a theoretical point of view, the threshold gate is a very interesting model, but it is unlikely that real biological systems use such a binary encoding scheme. A prerequisite for such a binary coding scheme is a kind of global clocking mechanism, but it is very unlikely that such a mechanism exists in biological systems.

The Second Generation

Another possibility is that the number of spikes per second (called the firing rate) encodes relevant information. This idea led to a model neuron known as sigmoidal gate. The output of a sigmoidal gate is a number that is thought to represent the firing rate of the neuron. There exists a huge amount of literature that discusses in detail all aspects of this kind of neural network models.[8] I want to note that networks of sigmoidal gates can in principle compute any analog function and that, along with this type of models, the question of learning in neural networks was intensively investigated for the first time.

Firing Rates versus Spike Timing

It is well known that firing rates play an important role in the nervous system, especially in the primary sensory areas where low-level information processing takes place. However, recent experiments revealed that the human nervous system is able to perform complex visual tasks in time intervals as short as 150 milliseconds (ms) (1 ms = 0.001 second).[9] The pathway from the retina to higher areas in the neocortex along which visual stimuli is processed consists of about ten 'processing stages.' Furthermore, the firing rates in the areas involved in such complex computations are well below 100 spikes per second (Fig. 3). But to estimate such low firing rates, one has to wait at least 30 to 50 ms, a contradiction to the finding that a computation involving ten 'processing stages' can be carried out within 150 ms. Further experimental results indicate that some biological neural systems indeed use the exact timing of individual spikes, which further confirms the idea that the firing rate alone does not carry all the relevant information.[10]

6. A. Anderson and E. Rosenfeld, *Neurocomputing* (Cambridge, Mass.: MIT Press, 1998).
7. K.Y. Siu, V. Roychowdhury, and T. Kailath, *Discrete Neural Computation: A Theoretical Foundation*, (Cambridge, Mass.: MIT Press, 1995).
8. C. M. Bishop, *Neuronal Networks for Pattern Recognition* (Oxford: Clarendon Press, 1995).
9. S. Thorpe, D. Fize, and C. Marlot, "Speed of Processing in the Human Visual System," Nature 381 (1996): 520-22.
10. F. Rieke, D. Warland, W. Bialek, and Van Stevenik, *SPIKES: Exploring the Neural Code*, (Cambridge, Mass.: MIT Press, 1996).

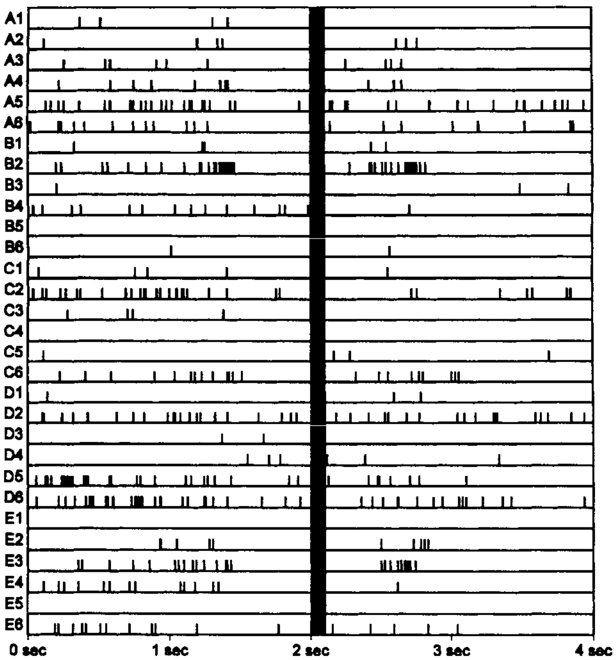


Fig. 3:
Simultaneous recordings of 30 neurons in the visual cortex of a monkey.[8] Each tick mark denotes the occurrence of a spike. The gray shaded bar marks a time interval of 150 ms. As noted in the text such a short time interval suffices to perform complex computations. However, one sees that there are only a few spikes within this time interval.

11. W. Maass and C. M. Bishop, *Pulsed Neural Networks* (Cambridge, Mass.: MIT Press, 1998).
12. J. J. Hopfield, "Pattern Recognition Computation Using Action Potential Timing for Stimulus Representation," Nature 376 (1995): 3-36.
13. W. Maass, "Fast Sigmodial Neural Networks via Spiking Neurons," Neural Computation 9 (1997): 279-304.
14. W. Maass, *Networks of Spiking Neurons*, op.cit.
15. W. Maass and T. Natschläger, "Networks of Spiking Neurons Can Emulate Arbitrary Hopfield Nets in Temporal Coding," Network: Computations in Neural Systems 8:4 (1997): 355-72.
16. J. J. Hopfield, "Pattern Recognition," op.cit.
17. C. Koch and I. Segev, *Methods in Neural Modeling: From Ions to Networks* (Cambridge, Mass.: MIT Press, 1998).

The Third Generation: Networks of Spiking Neurons

These results from experimental neurobiology gave rise to a new class of neural network models that also incorporated the timing of individual spikes.[11] Thus, time plays a central role in spiking neuron networks (SNNs), whereas in most other neural network models there is not even a notion of time.

Temporal Coding

A simple way to use time to encode information is depicted in Fig. 4. The inputs to a network of spiking neurons are encoded in the time differences between a spike and a reference time. The output is also encoded by the time difference between an output spike and some other reference time. The reference times can be given by other spikes but also through other mechanisms, such as background oscillations. There exists empirical evidence that such a type of encoding is used, for example, in the olfactory cortex.[12]

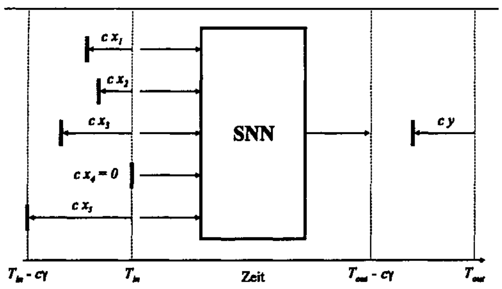


Fig. 4:
A *SNN* using a simple form of temporal coding. An analog input x is encoded by a time difference T_{in}-cx, where Tin can be given by another spike and c is an arbitrary scaling factor. The output y is also encoded by a difference T_{out}-cy.

Computational Power

What class of functions can be computed by an SNN using this type of temporal coding? An important result regarding this question is reported by Maass.[13] In this work, it is shown that a small SNN using temporal coding can easily compute the same functions as a sigmoidal gate. As noted above, a network of sigmoidal functions can in principle compute any given function and hence also a SNN can compute any given function regardless of how complex this function might be. An interesting detail of this result is that the time that the SNN needs to perform such a computation is in the order of 100 ms. At least from a theoretical point of view, this result shows a possibility of how complex computations in the human nervous system might be organized. In another article it is shown that SNNs have even more computational power than networks of sigmoidal gates. That means that there are functions that can easily be computed by a small network of spiking neurons but one needs a large net of sigmoidal gates.[14]

Hypothesis for Biological Neural Systems

In the previous subsection, I pointed out that SNNs have enough computational power to compute arbitrary functions. However, the proofs underlying these results are done on a rather abstract level and, furthermore, do not provide hints for how to construct a network of spiking neurons that computes a concrete function. However, if it would have turned out that an SNN using temporal coding has very low computational power, this would rule out such a temporal code as a potential mechanism used in real biological systems.

The question about the computational power is not the only one investigated at the Institute for Theoretical Computer Science. We are also interested in how concrete functions likely to be performed in real biological neural systems could be implemented efficiently in a network of spiking neurons. An example of such a function is the associative recall of stored memories. In the work of Maass and Natschläger[15] it is shown how such an associative memory can be implemented with a (biologically rather realistic) network of spiking neurons. Another example of a concrete problem is given by Hopfield.[16] In his work he comes up with a hypothesis for how a simple form of pattern recognition might be implemented with a network of spiking neurons. A good survey on models for concrete functions or subsystems of the nervous systems can be found in the textbook by Koch and Segev.[17] Such a hypothesis about the functionality of certain subsystems of the nervous system may lead to new experiments; the results of which allow one to make more realistic models. Thus the interplay between the experiments done by biologists and theoretical models made by physicists or computer scientists is a very fruitful interdisciplinary interplay.

Learning

One of the most challenging problems in neuroscience is the question of learning. Although substantial progress has been made regarding learning in neural networks of the second generation, these 'learning schemes' do not apply directly to biological systems (see the textbook by Bishop[18] for an overview). What is commonly accepted is that learning takes place in the connections between two neurons – that is, the synapses are the place where changes are made if we learn something. Until recently it was assumed that the changes in a synapse depend basically on the relation between the firing rates of the two neurons a synapse connects. However, results reported by Markram et al.[19] indicate that the changes in a synapse depend strongly on the timing of the individual spikes the two neurons produce. Based on these experimental results, several models have been developed for how such a time dependent learning scheme may be used in a network of spiking neurons to learn something meaningful. An example is the work of Natschläger and Ruf,[20] where it is shown that such a learning scheme might be useful to extract important features from a stimulus. Although there exist many other hypotheses regarding such a time-dependent learning scheme, none of these hypotheses can explain high-level memory phenomena. This is a characteristic phenomenon of the whole field of neuroscience. We know a lot about biological neural systems from the molecular to the cellular level, but we have basically no idea how these bits and pieces together form the most powerful computational device known.

Applications

Network models of the second generation turned out to be a very useful tool for a wide variety of problems.[21] This gave rise to the development of rapid hardware implementations of such models to be able to solve large problems in a reasonable time. One approach is to use analog devices instead of microprocessors to carry out the computations. It turned out to be advantageous if such 'silicon neurons' communicate via voltage pulses. An example of such a hardware implementation is EPSILON II, a chip developed at the University of Edinburgh. This chip not only uses pulses for communication purposes but also employs the timing of individual pulses for computation. This example shows that the principles underlying the information processing in biological neural systems also inspires engineers when designing new hardware. In the last few years, people all over the world started to develop such 'neuro-inspired' (also called neuromorphic) systems. The idea behind these efforts is to reveal solutions for problems that cannot yet efficiently be solved although it is evident that Mother Nature has developed very efficient solutions.

Conclusions

In this essay, I have briefly addressed a new class of models for neural networks that are more closely related to real biological neural systems than the models of the first and second generation. I have shown how questions about the computational power of such networks leads to possible explanations for how fast and complex computations in the nervous system might be organized. I also discussed how the question about the implementation of concrete functions gives rise to hypotheses for the functionality of certain subsystems of the nervous system. I also touched on one of the most interesting aspects of human behavior – namely, the ability to learn from experience. As indicated in the subsection on learning, we know a lot about the low-level processes in the nervous system, but there is this big missing link between the low-level physiological processes and higher-level phenomena, such as long-term memory. To bridge this gap between low- and high-level processes will be the challenge not only for biologists but also for researchers from other disciplines, such as physicists and computer scientists.

18. C. M. Bishop, *Neuronal Networks*, op.cit.
19. H. Markram, J. Lübke, M. Frotscher, A. Roth, and B. Sakmann, "Regulation of Synaptic Efficacy by Coincidence of Postsynaptic APs and EPSPs," Science 275 (1997): 213-15.
20. T. Natschläger and B. Ruf, 'Spatial and Temporal Pattern Analysis via Spiking Neurons,' Network: Computations in Neural Systems 9:3 (1998): 319-32.
21. C. M. Bishop, *Neuronal Networks*, op.cit.

5

Miklós Peternák

Hungarian Computer Art

The historical relationship between art and the computer in Hungary covers a period of two decades — that is, if we do not take into consideration any of the traditional scientific and technological innovations brought forth by Hungarians (such as John von Neumann, László Kozma, László Kalmár, Tihamér Nemes, and György János Kemény). We must also omit pertinent international applications of this relationship by foreign artists of Hungarian descent, such as Kepes's 1956 anthology, *The New Landscape*, which was probably the first publication to feature computer images in an artistic context. John Halas, Peter Földes, Charles Csuri, and Leslie Mezei all participated in the "7 bit" symposium in Zagreb, while Béla Julesz exhibited his work (although not as an 'artist') at the first computer art show at the Howard Wise Gallery in New York in 1965.

The Hungarian accomplishments in the 'special' climate of the 1950s all exemplify the fact that a particular problem can be answered in a given period, in many different ways. The answers can be independent of each other and vary in quality, even if the conclusion is finally determined by a single, victorious solution. However, it is not at all obvious when the leading methods of the present (which are, at the same time, regarded as the ultimate solution) are transformed by and substituted for something else that has new characteristics — or when an old, forgotten answer rises to the surface again. One might ask whether the methods and their messages — being 'pieces' and 'works of art,' dismissed and sentenced to temporary oblivion — could not possibly be employed for the beneficial control of an (art-related) cultural archive and (inter)discipline.[1]

1. For more on the period, see: *Magyarok a természettudomány és technika történetében* (Omikk 1986); H. H. Goldstinc, *A számítógép Pascaltól Neumannig* (Budapest: Műszaki Kiadó, 1987); second appendix: G. Kovács, "A számítógép-fejlesztés korai szakasza Magyarországon."

The heroic beauty of the period mentioned above was recognized in a four-part television series, *Mi van a dobozban?* (What's in the box?), created by Tamás Komoróczky (FRÍZ Production, 1992).In addition to contemporary documents and educational films, the series presented such relics from the past as a robot that (along with its creator) was popularly known as the *Szeged Ladybug*. (Komoróczky was a member of the Újlak artists' group, probably the most progressive art community at the end of the 1980s and beginning of the 1990s).

The avant-garde art of the 1960s and 1970s, especially the conceptual or serial art that has recently become fashionable again (note how the terms "sequential" or "serial art" — or to use a really descriptive name for the period, "geometrical abstraction" — became part of artistic terminology at the same time as concept art), produced work that can be regarded as analogous to computer art. Examples might be András Mengyán's "visual programs," as well as the systematic proportional pieces by Attila Kovács, Vera Molnár, Tibor Gáyor, Péter Türk, and Dóra Maurer.

By now it has become clear that computers are able to endlessly produce a sort of visual wallpaper, which, as a kind of pattern (i.e., screensavers) provides an artistic frame for otherwise ordinary computer functions. As such, it is a unique way to generate forms, being able to perform a certain visual process with a necessary amount of detail, and this, in itself, is quite relevant today.

The first computerized film (computer animation) in Hungary was made within a particular framework of experimental films that reflected the new impulse given them in the Béla Balázs Studio, with the help of the *Film Language Series* and the K/3 group. Titled *Psychocosms*, it was made in 1976 by Gábor Bódy and physician Sándor Szalay (currently a member of the Hungarian Academy of Science). Based on the "rules" of J.N. Conway's LIFE program, the film documents the program's progression, which continues until the situation is either complete and stable (and therefore repeats itself), or until it reaches a stage of disorder (randomness), where, in comparison to the previous conditions, no new information is offered. There were several interpretations of Conway's program: it became the cell-machine, the ordinary function computer (Béla Julesz), the video-kaleidoscope that created a separate world in itself, or "an oscillating 'spot' that expands in space, is made out of energy and information and has no weight" (T. Stonier). The originality of Bódy's 35mm film lies in the fact that an artist interprets its otherwise scientific application.

A work by Gyula Száva titled *The Affair* — preliminary drafts actually originate from as early as 1974 — almost preceded Bódy's *Psychocosms*, yet it could not be realized until

Tamás Komoróczky, *What's in the box?*, 1992

Tamás Komoróczky
born 1963 in Budapest. Studied at the Academy of Fine Arts in Budapest, 1986-1992, and at the Academy of Fine Arts in Düsseldorf, 1991 (video). Member of the Újlak group since 1989.

1990 Fiatal Művészek Klub, Budapest
Újlak cinema, Budapest
1991 Tűzoltó utca 72, Budapest
1994 Műcsarnok, Budapest
1998 Stúdió Galéria, Budapest

Group shows
1989 Hungaria Bathhouse I-II
Újlak cinema, Budapest
Távolság, Barcsay Space, Budapest
1990 *Resource Art*, performance by the Újlak group
Műcsarnok, Budapest
Inspiration, Sommer Atelier, Hanover
1998 *Rejtőzködő*, Ernst Múzeum, Budapest
1999 *Komoly és fiatal*, Ernst Múzeum, Budapest

1980, since the artist had no access to a computer that could run the program. Thus, in the linear time frame, it shares second place with István Bartók's animation work called *Dimensions*, which was also recorded on 35mm black-and-white film. This work was made in the Pannónia Film Stúdió (computer program: Miklós Báthor), while Száva's work was produced by the Béla Balázs Stúdió (program: Ferenc Deák; computer: TPA 1001/1).

Száva's work, a huge banner (one entire copy of which was attached to the windows of the Budapest Gallery), was part of the 1983 art/film festival. In 1987 it was shown at the *Entgrenzte Grenzen* (Limits unlimited) exhibition in Graz, as part of an installation called *Topologies* (voice by László Vidovszky).

The first installation in which the computer had an important part was shown in András Mengyán's work exhibited in the Műcsarnok at the end of 1985. Its color/light, film, and sound effects filled three rooms. The work, *Programmable Space I-III*, or, as the artist terms it, the "space movie," creates an environment that can be experienced; it was a mobile situation, formally continued in 1995 at the Műcsarnok under the title *Trans-Effects. Norway.*

A special Web project is *INTERMENTAL*, the first international video magazine, founded in 1980. Proposed by Gábor Bódy, it has been continuously present in Hungary since its first volume was published in 1982.[2] It was also Bódy's idea to start a computer seminar at the Berlin Film and Television Academy (DFFB). It began in 1985, and its collection was the source for a video titled Zeittransgraphie, made to commemorate Bódy's artistic activity. The publication accompanying the video mentions the fact that the basic idea of the work, the special use of programmed, time/code editing, originated in the writings of Ágnes Háy. In her study, *The Graphic Illustration of Time in Film*, she discusses how a film operates in terms of a set coordinate system:

> *The projected frame and time can be adjusted: 1 frame is 1/24 sec or 1 sec = 24 frames, and therefore the axes of the coordinates simultaneously represent time and film. Axis y is the original time or film, meaning the original order of the frames. Axis x is the special film or time, meaning the projected order of the frames. Ordinary numbers alone measure the coordinates, since (usually) films can only be projected in one (forward) direction and are divided into single frames. The x and y coordinates define the place and time of a frame. The y coordinates (frames) contain the function; what is not contained is excluded: the special film eliminates these particular frames from the original film.*

Agnes Hay – with the help of a computer – also used the same system of coordinates in her film, *Expectations*.

The first relationship between computer art and the public was created by the exhibition *Digitart*, organized by the Museum of Fine Arts in Budapest at the end of 1986, in which the majority of the participating artists had their first opportunity to use a computer (or, more precisely, animation software). The event was supported by the Computer and Automation Institute of the Hungarian Academy of Sciences, primarily thanks to one man's efforts, Academy member Tibor Vámos. (*Digitart*, which featured chiefly print works, was repeated at a later date.) Participants included Áron Gábor, János Sugár, László Révész, Károly Hantos, Zsigmond Károlyi, László Kiss, and Tamás Waliczky, winner of the 1989 Ars Electronica computer graphics award in Linz, who now works in Karlsruhe.

Organized by the French Institute, the three-day event *Dialogue Ordinaire* (an untranslatable pun involving a play on the French word *ordinateur*, meaning computer), where artists from Paris and Budapest communicated with the help of computer images, was an early demonstration of the possibilities of network communication, even if it was just through a telephone line. (Later this event was followed by other, similar ones: for instance, the project *Interferants* simultaneously transmitted recordings of live performances via telephone lines to distant places such as Albi and the Hungarian Applied Arts Academy.

The Feast of the Image, an exhibition in Lille in 1990, featured a significant number of Hungarian computer graphics and computer animation, including, for instance, the work of Ágnes Hegedüs, who at the time was living in Holland. Also in connection with France, we need to mention the Magyar Műhely (Hungarian workshop) circle, whose periodical has been published in Paris for decades. The editors, Pál Nagy, and Tibor Papp, have become more and more interested in computer art and electronic images — obviously giving priority to the poetic context these might create.

In 1989 I tried to document the "pre-conditions" in Hungary in a book titled *Az új képkorszak határán* (At the beginning of the new visual era).[2] There have been a lot of changes since the beginning of the 1990s. I would like to mention the fact that many commercial animation studios have sprung up and, due to their activity, digital culture started spreading into Hungarian television (main titles, logos, and commercials). The first Hungarian CD-ROM, *Politics*, was made in 1992, while Internet services for a large public made a first

2. Számalk Kiadó, *A számítógépes grafika és animáció kezdetei Magyarországon* (Budapest: 1989).

Miklós Peternák, born 1956 in Esztergom. Studied art history at the University of Budapest. Worked at the Hungarian National Gallery, Budapest, from 1981-83, and at the Institute for Art History at the Hungarian Academy of Sciences from 1983-87. Director of the Intermedia Department at the Academy of Fine Arts in Budapest since 1991. Since 1997, Director of the C3 – Center for Culture and Communication in Budapest, founded 1996.

appearance in an artistic context (a gallery featuring an exhibition of computer work with Internet access) in February 1996 at the *Internet Galaxy*.

Until the 1990s, the most important contact with the international arena of computer art was the Ars Electronica festival in Linz, not just from the aspect of the participating Hungarian artists, but also because of the news and reports available there. A few days after the 1990 presentation of *Virtual Reality*, due to the benevolent contribution of some lecturers in Linz, the Budapest audience was also able to hear lectures about the topic in the Műcsarnok, which was documented by the Media Research Foundation and the Béla Balázs Studio's K-Section. Hungarian television had monthly coverage on Ars Electronica in their series, *Video World*, which was edited by Judit Kopper until its suspension. (Its function was partly taken over by another series, *Mediamix*, whose scope became narrower, and which was less frequently broadcast). In 1993 Ars Electronica was introduced as part of a symposium at the Hungarian Academy of Fine Art in Budapest, simultaneously with the official start of the new intermedia department, which had been operating unofficially since 1990. It is the only place in the country that provides its students with an academic degree in the artistic application of the computer and also introduces the newest theories. After the 1993 international symposium, an annual series of conferences began. *Metaforum*, jointly organized by the Media Research Foundation and the Budapest Autumn Festival, and hosted by the Hungarian Academy of Fine Arts, lasted for several days and provided space and opportunity for presentations and discussions. In 1994 the concept focused on interactivity (CD-ROM, CD-I); it was probably the first time the World Wide Web was presented to Hungary. In 1995 the *Without Borders* conference was specifically dedicated to the topic of the Net, while the 1996 *Under Construction* series discussed issues about Web content. Its name derived from the common experience of the users, who, while surfing on the World Wide Web, often find the frustrating message, "under construction."

The Hungarian public was first introduced to interactive works and computer art by contemporary international and Hungarian artists (e.g., Zoltán Szegedy-Maszák, Péter Kiss, Gábor Győrfi, Péter Szarka, and others) through the *Butterfly Effect* exhibition in Műcsarnok at the beginning of 1996. This was the largest and most prominent exhibition of its kind; it offered broad historical material as well as the first free access to the Internet by means of five open terminals. (C3 - Center for Communication and Culture, a new center providing public Internet access and supporting a new way of joining art and science, was promoted by the Soros Foundation and Silicon Graphics, and opened after this series of events in June 1996.)

Considering the present situation, it is interesting and sometimes even amusing to take a look at the primary trends, forms, and ideologies of the computer age, which started in the 1940s and developed to include cybernetics, plotter drawings, computer graphics, simulations, animation, robots, artificial intelligence, interactivity, virtual reality, and the World Wide Web. The different phases of development have only one thing in common, and that is their ephemeral existence, whose only competition is a quick intellectual reaction to new things and a process of interpretation that helps to form a better understanding.

Gábor Bódy
Psychocosms, Computer Experiments SBB, 1976
Black-and-white, 35 mm, 12 min.
Camera: Olivér Hollós

Gábor Bódy

The Artist and the Computer

Gábor Bódy created the first computer film in Hungary. He had already worked with this medium when he was making the *Film Course* for Hungarian Television; a part of this film can be considered the prototype for *Psychocosms*. (Bódy himself referred to it in the last sentence of the film's outline below.)

It is possible to follow his change of mind on the role of computer through several written documents up to his last, longer script, the *Psychotechnics*. The first quotation is from a script titled *Cosmic Eye* (1975). This script, presented to the Béla Balázs Stúdió, was finished before the *Psychotechnics* script was; Bódy began shooting the *Cosmic Eye*, but never finished. The theory begins as follows:

Radio astronomers continuously receive signals without being able to define their origin and location. Feeding the parameters of the signals into a computer simulator generates images. An expert on semiotics interprets the images.

Instead of giving a description of the story and the precedents of the film elements, it is worth quoting a longer part from a chapter, *The Representation of Chance*, which contains references to the *Psychocosms*.

The representation of chance, or the accidental order of organic forms and events (we could say, the dialectics of the accidental and necessary) is not a new problem in twentieth-century art. In music, this aleatory has become an independent discipline simply based on the most formal musical language, dodecaphony. The role of chance also has a long tradition in the process of creating images. In this field, I tried an experiment based on a computer simulation of the so-called Brownian motion. The Brownian motion is a general formula especially suited to describing thermodynamic and quantum-mechanic phenomena. It deals with the description of the absolutely random movement of a particle; the computer solves it with a calculus of probabilities, simultaneously representing it on a connected simulator screen. Using the analogy of this image, I invited people to draw lines on paper, taking care that there should not be any regularity among the lines.
The series of experiments demonstrated that people were unable to draw spontaneous lines unless they had considerable time to think over each mark. Analogy, opposition, symmetry, proportions — the experimenters very often made these 'mistakes' in the first steps, but without exception during the fifteenth to twentieth steps. There were some people who doubted even the possibility of drawing so many irregular lines, saying that the 'mistakes' could be read into any line system. They were only convinced by the sight of the Brown movement, which proved that the task had infinite correct solutions, in which mistakes were present only as accidental borderline cases.

ABSOLUTELY ACCIDENTAL MOVEMENT NOT ONLY EXISTS, BUT ITS IMAGE SEEMS TO BE MUCH MORE REALISTIC THAN THAT OF HUMAN ATTEMPTS CARRIED OUT ACCORDING TO RULES. The other lesson of the experience was that those who were practiced in drawing shapes, like graphic artists and architects, produced better results than the others who usually began drawing regular line systems during the first steps.

The movement studies (Homage to Eadweard Muybridge, 1880-1980) links 'pre-film,' namely Muybridge's phase photos of different movements, with 'post-film,' namely computer analysis, which, however, unlike Psychocosms, is only a complementary element here.

Psychocosms (Proxemial Schemes)

This is a computer experiment meant to create the kinds of diagrams and schemes that evoke psychic sensations through the tension of the relationship of the elements to each other as they move through the space. Inside a box, we throw particles determined by various qualities (shyness, aggression, neutrality, etc.). The computer calculation makes it possible to observe the 'events' happening among the particles, and slowly a 'feeling' takes shape in us about the atmosphere in the box. We obtain a moving diagram depicting the tensions of a 'psychic space,' where the quality of the elements is variable. These diagrams help us to realize the 'significance' of spatial arrangement. One such diagram has been produced.
Sándor Szalay, a theoretical nuclear physicist, calculated the program. When I asked him why some of the small balls crashed and stuck to each other in each of the three cases, he answered that he would not have expected it and had no idea what might have caused it.

Miklós Peternak
Miklós Peternak, ed., *Új képkorszak határán. A számítógépes grafika és animáció kezdetei Magyarországon* (Budapest: Számalk, 1989).

Gábor Bódy
born 1946 in Budapest. Studied philosophy and history from 1964-71 at the University of Budapest, and from 1971-75 at the Theater and Film Academy. In 1976 he founded the experimental film group K/3 at the Béla Balázs Studio. In 1981, he taught aesthetics at the Universities in Budapest and Szeged. Received a DAAD grant in 1982 for a stay in Berlin. Instructor at the DFFB in Berlin from 1982-83. Died 1985 in Budapest.

Films
1971 *A harmadik* (his first independent film as a member of Béla Balázs Studio
1975 *Amerikai Anzix*
1976 *Psychokozmoszok*
1977 *Katonák*
1979 *Krétakör*
1980 *Nárcisz és Psyché*
1983 *A kutya éji dala*
1985 *Pszichotechnikum*

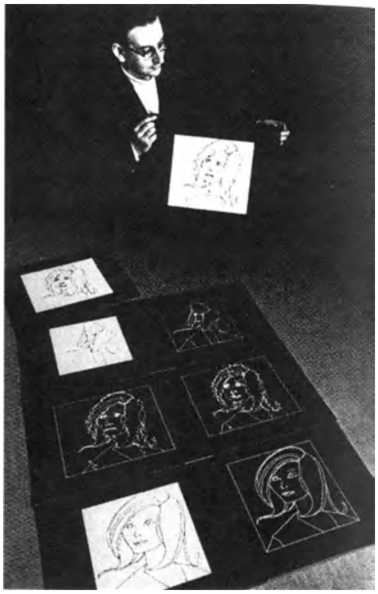
Videos
1983 *Die Geisel De occulta philosophia Ritterrüstung*
1985 *Dancing Euronyme Walzer*

References:
Gábor Bódy, Vera Bódy (eds.), *Video in Kunst und Alltag* (Cologne: Dumont, 1986).
Végtelen kép. Bódy Gábor írásai (Budapest: Pesti Szalon, 1996).

5

Leslie Mezei

Selection of publications, computer art only:
Leslie Mezi, *Artistic Design by Computer*, Computers and Automation 13,8 (Aug. 1964) 12-15.
Leslie Mezei and Arnold Rockmann, *The Electronic Computer as an Artist*. Canadian Art Magazine 21,6 (Nov./Dec. 1964) 365-367.
Leslie Mezei, *Notes on the Computer and the Arts*. Computers and Automation 15,5 (May 1966) 8-9.
Leslie Mezei, *Computers and the Visual Arts*. Computers and the Humanties 2 (1967) 41-42.
Leslie Mezei, *The Electronic Computer: a New Tool for the Artist*. Canadian Art Magazine 14 (Feb. 1967).
Leslie Mezei, *Computer Art*. Arts Canada 25 (Sept. 1968) 13-18.
Leslie Mezei, *Computer Art: a Bibliography*. Computer Studies in the Humanities and Verbal Behavior 1,1 (1968) 48-50.
Leslie Mezei, *SPARTA. A Procedure Oriented Programming Language for the Manipulation of Arbitrary Line Drawings*. Proc. IFIP Congress 1968, Vol. I. 597-604.
Leslie Mezei, *Review of A. Michael Noll's "The Digital Computer as a creative Medium"*. Computing Reviews 9 (1968) 128.
Leslie Mezei, *Science in Art in Science*. Arts Canada regular column from April 1968 to February 1970.
Leslie Mezei, *The Use of Computers as Artists, Art Critics, and Aestheticians*. in: *Exakte Ästhetik* 6 (Stuttgart: Nadolski 1969) 102-107 (lecture at the Annual Conference of the American Society for Aesthetics, Santa Fe 1966).
Leslie Mezei, *Randomness in Computer Grahics*. In: Jasia Reichardt (ed.): *Cybernetics, Art, and Ideas* (London: Studio Vista. 1971) 165-174.


Leslie Mezei with some of his works

Leslie Mezei was born on 9 July, 1931, in a small town in Hungary (his Hungarian name was Laszlo Gabriel Mezei).

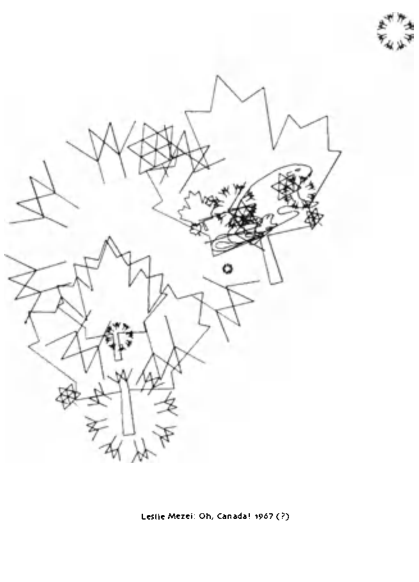
Happy circumstances helped the boy to survive the National Socialist occupation of Hungary during World War II (for some time, he and other members of his family lived under the protection of the Swedish diplomat Graf Wallenberg). Members of his family, among them his father, were deported and murdered by the Nazis. The remaining members of the family, with Leslie as the youngest, tried to illegally imigrate to Palestine in 1947. (They were on the boat *Exodus 47*.) But the British discovered their boat, and, after a short battle, forced them to return to Germany. Leslie was accepted as an orphan of war by a Canadian family in Montreal. In 1952, he moved to Toronto.

He had started his academic education at Strathcona Academy and McGill University in Montreal, but later he changed to the University of Toronto where he earned an M.A. in Physics (1954). From 1955 to 1965 he worked in Toronto as a systems analyst and manager. Partly parallel to that, in 1964, he started an academic career at the University of Toronto, first as a lecturer, then as associate professor in computer science. He held the latter position from 1966 to 1978. He resigned from it after the death of his wife, Anna, and turned to social and spiritual activities.

Back in 1966, Mezei became a pioneer of computer art. He started to write his own programs in Fortran and ran them on an IBM 7094. The output was turned into visible form on a CalComp Plotter 565. Mezei developed a graphics programming language under the name SPARTA. It was realized as a subroutine package that interfaced between Fortran and the plotter. Its explicit purpose was to make it easier for artists and designers to use the potentials of computers.

Mezei became one of the first, if not the very first, to lecture on computer art: At the Fourth Conference of the Computing and Data Processing Society of Canada, in 1964, he presented his talk, "Artistic Design by Computer". This was even before he started to write programs for his own contributions to the field. From then on, his interest focused on future aspects of design and art. Under his supervision, some of the very first Master's theses were written that took up topics of computer graphics but treated them with an artistic perspective. His graphic works were included in major international exhibitions during the second half of the 1960s.

Mezei was particularly active in publishing on computer art, both in computer science and in fine art magazines. From the mid-1960s onwards, he had his own column on art and science in *Arts Canada*. He was a Contributing Editor of *Computers and Automation*, and a member of the Editorial Board of *Computer Studies in the Humanities and Verbal Behaviour* as well as *Computers in the Humanities*.


Leslie Mezei: Oh, Canada! 1967 (?)

Mezei was perhaps the first who used figurative representations a lot (titles are *Girl's Head, Bikini Girl, Beaver, Maple Leaf* etc.). Similar to other computer artists at the same time, he used pseudo random numbers in his production of algorithmic images. He also often applied geometric or stochastic transformations to line drawings. SPARTA was tuned to this kind of work.

Mezei's specialization at the University of Toronto was in computer graphics and in applications of computers to art and documentation. He started a cooperation with art historian Arnold Rockman, and with Daniel Berlyne who was well-known for his work in experimental aesthetics. It seems as if no important ties developed to Marshall McLuhan, who then was also teaching at Toronto. One may wonder whether a great early chance was missed to foreshadow what we would now call "digital media."

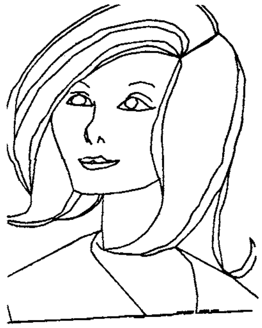
For the year 1968/69, Mezei invited Frieder Nake to Toronto, who developed his programs *Generative Aesthetics I* and

Chaos/Gestalt/Structure. Mezei was also interested in computer composition of music. During the time when he and Ron Baecker were heading the Dynamic Graphics Lab, Mezei invited William Buxton to continue his compositional experiments there. Buxton arrived in 1975, and stayed on to start a whole new career and become one of the big names in "human computer interaction."

When the then famous New York based group, *Experiments in Art and Technology (E.A.T.)*, founded a branch in Ontario, Mezei became one of its members (in the second half of the 1960s).

Mezei has to be considered one of the earliest pioneers of computer art. He later turned away from that area, obviously disappointed by the focus, as he sees it, that many of the early computer art activists took on technology. His farewell to academia in 1978 also marks his leaving computer art for good. He was, and is, convinced that issues of humanity are more important and demanding than those of technology. Art without a clear relation to the conditions of human existence was not his concern. His hopes of ten years earlier did not seem to ripen. So he quit.

Frieder Nake, 2005

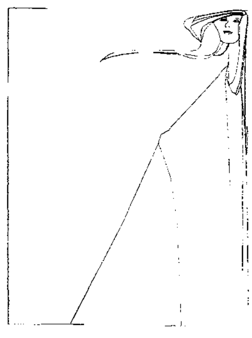


Leslie Mezei: Girl not transformed, 1968 (?)

Leslie Mezei: Girl transformed 1968 (?)

Leslie Mezei: Girl transformed 1968 (?)

Leslie Mezei: Girl transformed (conformal mapping) 1968 (?)



Leslie Mezei: Girl transformed (conformal mapping) 1968 (?)

Mezei B… …ansformed in … directions 1967

5

Gyula Száva
Rating

Gyula Száva
born 1948 in Budapest. Formerly with the Béla Balázs Studio (BBS) for experimental film art. Member of the Indigo Group since 1979. Currently doing freelance work for Hungarian television.

Group shows
1982 *Magyar kísérleti filmek*, Egyetemi Szinpad, Budapest
Festival Nationale Cinema Giovanni, Torino
1983 *Ungarischer Experimentalfilm*, Museum des 20. Jahrhunderts, Vienna
Film/Müveszet, Budapest Galéria, Budapest
1985 *20 Years of Hungarian Experimental Film*, Museum of Modern Art, New York
1987 *Entgrenzte Grenzen*, Künstlerhaus, Graz

This film was made before the spread of personal computers. It was made on an old, limited-capacity computer with a punch tape and a transistor. The strongly uneven edges of the "circles" and the sporadic interruption of the movements indicate the limitations of the hardware. We recorded the approximately 20,000 pictures required frame by frame from the monitor onto film in a dark room. Presumably because of voltage fluctuation, some rows appeared darker or lighter onscreen than others. This was hardly perceptible on the single stills. During the periods of varying lengths between exposures, as the machine continued to produce more and more pictures of various complexities, and the film progressed, these lighter and darker rows of patterns moved. Thus, the phase records always showed them at different places. During projection these changes set up a clearly visible system of movements. Continuously transforming light patterns appeared on the details of the image, which had previously seemed homogenous. This powerful and thought-provoking pattern reminds us to pay more attention to the possibilities offered by the regular fluctuation of light intensity in computer image generation. (At present we mostly create forms with the colors of the pixels. As far as I know, only high-capacity three-dimensional computer graphics deal with light intensity problems, with the purpose of generating apparently natural images.) I think that by programming a definite system of light intensity fluctuation, remarkable intact light-spaces can be created on a homogenous color surface. These patterns can also be used for the direct representation of information.

To accompany the film, I imagined a piece of music generated by the visual process. I invited László Vidovszky to help me in this work. At first we tried direct application of video signs (visual signs transformed into sound signs), but our technical equipment was not sophisticated enough to differentiate the sound medium. That is why we recorded the music of the film on a Moog synthesizer in an electronic music studio, after the digital-analog transformation of the images.

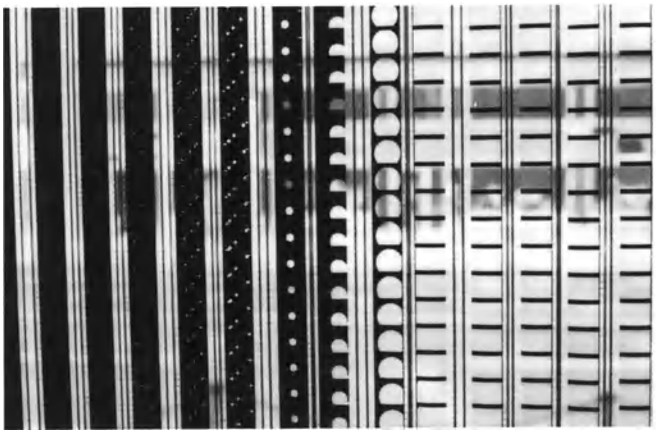
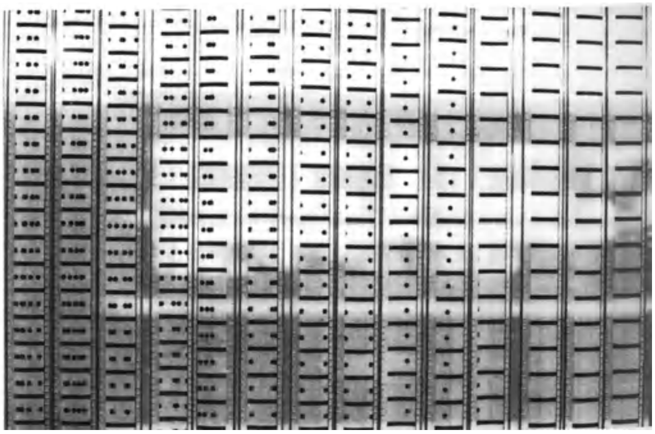
The course of the work:

1974: the first plans for the project

1980-82: the production of the film *Rating* (Eset), 35 mm, black-and-white, 14 min; Béla Balázs Stúdió, MTV experimental studio, KISZ Kísérleti Stúdió; staff: Olivér Hollós, Sándor Szalay, András Szirtes; Computer: TPA 1001/1 Eötvös Loránd University, Department of Nuclear Physics; program: Ferenc Deák

1987: video paraphrase: IFEM – Infinite Element Method; master: U-MATIC High Band, Secam, black-and-white, 54 min. Béla Balázs Stúdió, K/3 Group, MTV KISZ Kísérleti Stúdió; staff: István Horváth, István Hajdú, Zoltán Bálint-Szabó; electronic music: László Vidovszky; presentation: *Entgrenzte Grenzen*, Graz

exhibition cat. *Entgrenzte Grenzen*, Künstlerhaus Graz, 1987

Gyula Száva, *Rating*, 1980-82

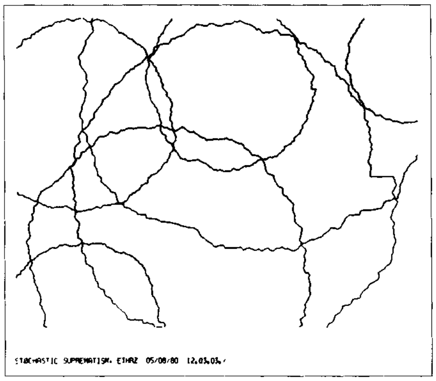
Krisztián Frey

Stochastic Suprematism

Any material can be used to make art. Matter is full of countless works of art. Artists can extract their own works of art from matter. It is just like mathematics: you can define mathematical structures in any object.
Art consists of conformity to laws and arbitrariness (as does pure mathematics, incidentally, although in this case the order is reversed). Therefore, when programmed by an artist, the computer is well-suited to creating art.
When programming images, I proceed as follows: I define just a few necessary values, such as the number of images... Otherwise I construct possibilities: for example, if a line should turn out straight or curved, continuous or dotted; where it will begin, at which point and angle. In my programs, the palette is stochastically determined; this results in programmed combinations of color, of which there are about thirty... That, then, is stochastic art.
It is Suprematist because I base my art on Malevich's fundamental attitude. If you believe that art is preceded by reality, you should be able to intrepidly draw your conclusions from my remarks.

Krisztian Frey
Fritz Billeter, Peter Killer, Willy Rotzler, eds., *Moderne Kunst – unsere Gegenwart. Ein Brückenschlag zur Schweizer Kunst seit 1939*, Seedamm-Kulturzentrum Pfäffikon SZ, p. 222.

Krisztián Frey, *12 Stochastic Poems for Dezső Tandori*
Excerpt from a computer print



Krisztián Frey
Stochastic Suprematism, 1980

Findings

The first video recordings were performed on 11 August 1983 at the computer center at ETH Zurich. They showed infinitely reproducible lines and drawings produced by various programs with prosaic concepts such as Fufetti, potatoes, dumplings, etc. The words of Arno Schmidt, made famous by Frey — "Everything transient is only an allegory" — were repeatedly displayed all over the screen alongside some rather risqué Hungarian sentences. Suddenly there were lines, circles, spirals, and shaky loops at different points on the screen, which sometimes turned out to be pseudogeometrical, three-dimensional figures. The loops, for example, would jump to the end of a spiral, chaotically, pulsatingly hacking up the geometric forms at a tremendous pace, like fast-growing cancer cells. Points became lines that fell on each other at various angles in a staccato rhythm, like virtual jackstraws. We had planned to have Brahm's second piano concert (played by Benedetto Michelangeli) as the accompaniment, but unfortunately, it was only possible to record it several years later.

Frey outlined a future concept, a program with linear variables of colors and lines, although these premises would be processed through various mathematical operations, using a random generator that would employ the current time as a continuously changing constant. In turn, this would mean that all of the images created by the computer would be different. Frey also analyzed the possibility of developing a program with a "sense of aesthetics" that would evaluate itself and thus only make "good" pictures.

Csaba Adorjani, 1996

Krisztián Frey
born 1929 in Budapest. Lived in Budapest and Zurich. Died in 1997 in Budapest.

1963 Galerie am Bohlweg, Braunschweig
1968 KFKI, KISZ-Klub, Budapest
1971 Kontaktgalerie La Fourmière, Zurich
Kunsthaus-Foyer, Zurich
1972 Galerie Schlegel, Zurich
1980 Städtische Galerie zum Strauhof, Zurich
1991 Fészek Galéria, Budapest
1994 Hungarian Cultural Center, Prague
Hungarian Cultural Center, New Delhi (with I. Várnagy)
Ernst Múzeum, Budapest

Group shows
1966 *Zuglói Kör*, Ady Endre Művelődési Otthon, Újpest
1968/69 *Ipartev I & II*, Iparterv Építésziroda, Budapest
1975 *Ungarische Avantgarde*, Galerie Schlegel, Zurich
1980 *Tendenciák 1970-80*, Óbuda Galéria, Budapest
1991 *Hatvanas évek*, Hungarian National Gallery, Budapest
1992 *Reduktivismus*, Museum moderner Kunst, Vienna
1994 *Hungarica*, Institut Hongrois, Paris
1998 *A magyar neoavantgárd elso generációja 1965-72*, Szombathelyi Képtár

Charles A. Csuri

A Technique for Computer Sculpture

Charles A. Csuri
artist and computer graphics pioneer, professor at Ohio State University. He exhibited his paintings in New York between 1955 and 1965, and began experimenting with computer graphics in 1965. Csuri was director of computer graphics research for twenty-five years, which included fifteen large projects. He is a founding member of Cranston/Csuri Productions, which produces animation for all television stations in the USA, as well as advertising spots. He is director of the Advanced Computing Center for the Arts and Design (ACCAD) at Ohio State University.

1967 4. Experimental Film Festival, Brussels
1968 *Cybernetic Serendipity,* ICA, London
1986 Venice Biennial
1989 ars electronica, Linz

Charles A. Csuri uses a light pen to draw moving objects on a monitor terminal connected to an IBM 1130 computer system.

Charles A. Csuri
Sine Curve Man, 1967
Computer drawing of a human face done with the help of a combination of sine curves.

This approach to computer sculpture involves two basic procedures. One is the mathematical and computer technique for generating x, y, z, coordinates that represent a three-dimensional shape. The second procedure requires a comprehensive set of computer programs that analyze the structure for making a continuous curve using three-dimensional processing.

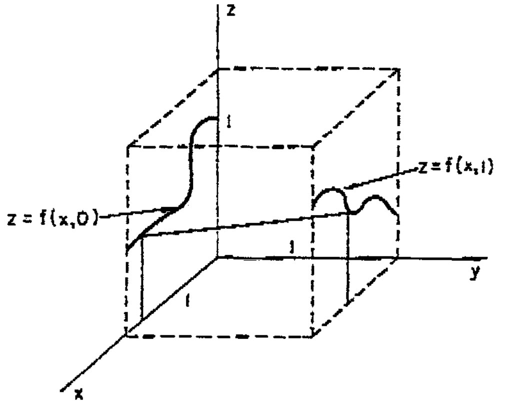


Fig. 1

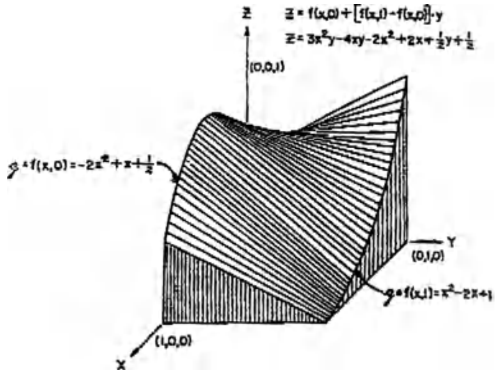


Fig. 2

Procedure I

In the mathematical variation, a unit cube was used to develop a three-dimensional surface (see fig. 1). The unit cube, with values between 0 and 1, has certain computational advantages and is a convenient module that permits the development of complicated forms. A modular concept permits the juxtaposition of many unit cubes to achieve a desired aesthetic result. The artist has the option to define the boundary curves on each of the four faces of the cube. Once the boundary curves are established, they are approximated by equations. These equations generate one hundred points along each boundary curve, and the computer program takes an average from all four sides of the unit cube. An alternate approach is to define the boundary curves on graph paper and then 'read in' their coordinates to the computer program. In fig. 2, the two opposing surfaces and their boundary curves represent a simple case of defining a surface. As one views fig. 3, it is difficult to visualize the interior of the cube based upon the four boundary curves indicated in the illustration. In those instances where lines from opposite curves intersect in the xy plane but do not meet in the z plane, a mathematical technique was used that averaged out the two zs to establish the three-dimensional coordinates of the surface and yet preserve the artist's original boundary curves.

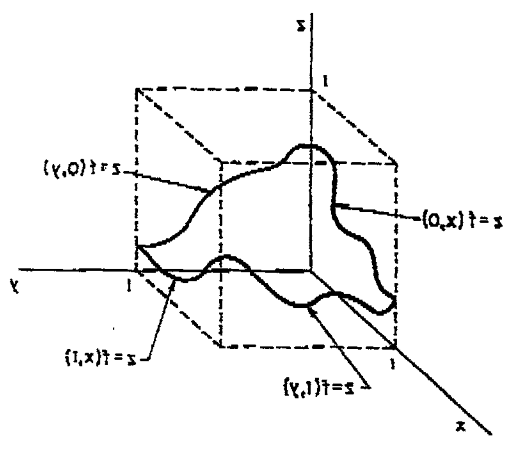


Fig. 3

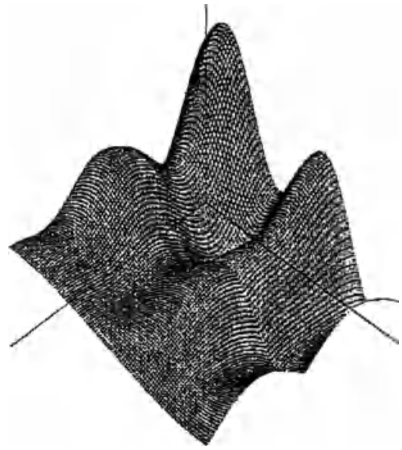


Fig. 4

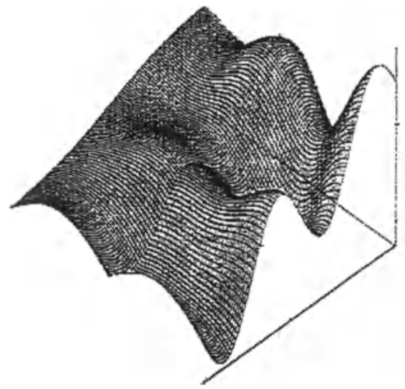


Fig. 5

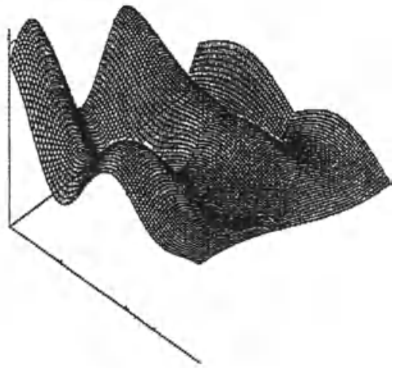


Fig. 6

Charles A. Csuri
Hummingbird, 1967
Stills from a computer-generated film

In the next step, a computer program takes the coordinates, which represent the surface, and makes the necessary calculation for computer drawings. It is a three-dimensional perspective routine that eliminates hidden lines from a specified viewing angle. The artist can indicate the viewing angle, and the computer program will give a representation of the form with the help of a graphic plotter. Figs. 4-7 are examples in which a viewing angle of 45° was specified and the form was rotated in four steps through 360°. The hidden-line routine also permits the representation of stereo pairs based on the data set, so that the artist can have some feeling for the three-dimensional experience (see fig. 8). A discussion of stereo pairs would be too lengthy for this context, but one can suggest that artists can be taught to see in this manner.

There are other interesting options available to the artist, which permit further experimentation. At an operational level, peaks and valleys can be used to manipulate the surface, which can also permit further experimentation.

Fig. 9 shows an xy plane, while fig. 10 is a representation of several peaks that have been added to the xy plane. The artist needs only to specify an x, y, z coordinate (a location on the plane, plus a height or depth) for each peak, and a computer program handles the problem. There are options in the program to specify the angle of the slope of a peak with variations on each side of the peak. Also the mathematics are such that there is a relationship established between each peak to give smooth continuity. In the same way that peaks can be made, valleys or depressions can also be indicated, and fig. 11 is an illustration of this. Fig. 12 illustrates a combination of peaks and valleys.

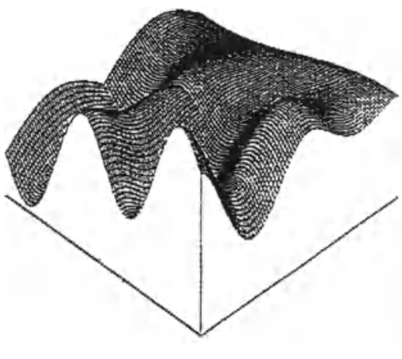


Fig. 7

Procedure II

Once the artist has decided the graphic representations are acceptable for sculpture, then the x, y, z coordinates that represent the object are given to the computer milling programs. Twenty-four subroutines had to be developed for this phase of the problem. Numerically controlled milling for artistic purposes is an exceedingly difficult task. When the z axis or the third dimension is introduced, the software needed for an operating system on an IBM 360 is tremendous. It is beyond the scope of this paper to indicate many important technical details.

bit international, 7 (Zagreb 1971): 111-118.

Tamás Waliczky

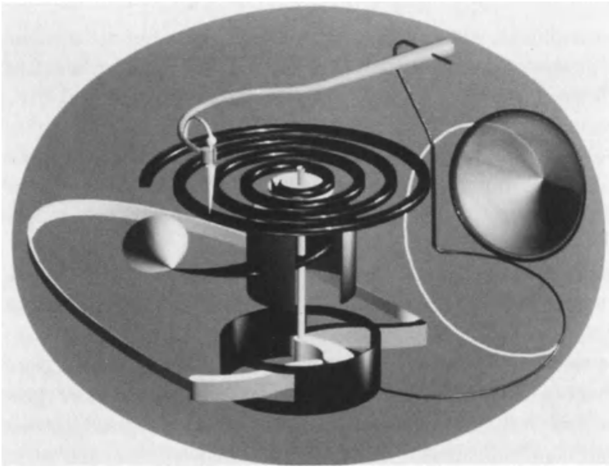
Tamás Waliczky
born 1959 in Budapest. Worked at the ZKM in Karlsruhe, 1993-97. Professor at the University of Fine Arts in Saarbrücken, 1997-2002. Since 2003 professor at the IMG, Fachschule Mainz. Lives in Germany and Hungary.

Exhibitions
1982 Collegium Hungaricum, Vienna
1986 *DIGITART I*, Szépművészeti Múzeum, Budapest
1987 Galerie Robert Doisneau, Nancy
1990 *DIGITART II*, Műcsarnok, Budapest
Tendances Multiples, Centre Georges Pompidou, Paris
1992 Galerie Robert Doisneau, Nancy
1993 *Medionale*, Hamburg
Multimedionale, Karlsruhe
1994 *Techno Art/An Interactive New Media Exhibition*, Ontario Science Centre, Ontario
1995 *Trilogy*, ICC, Tokio
1996 *The Butterfly Effect*, Műcsarnok, Budapest
ART Gallery of NSW, Sydney

Let us say that we have already created a three-dimensional model with the aid of the computer, sharing in an experience heretofore inaccessible to man, by sitting in front of a two-dimensional monitor and creating a statue in such a way that this statue extends in all directions in space. The statue has a surface, mass, and color that can either reflect or absorb light — in other words, it is a real statue in every respect except that it does not exist according to the traditional concept. If we have done all of this, then we come to realize that we have ventured so far forward into a new world that holding on to traditional concepts is just a matter of nitpicking and splitting hairs. The new mode of production changes the dramaturgy. The relationship between the viewer and the artist needs to be redefined as we leave the path of one-dimensional narrative.

Computer-generated movement has no beginning and no end. There is no film, no celluloid of any measurable length, and no metal base. Why, then, do we hold on to habits rooted in the technical limitations of the film reel and the videotape?

"The Manifest of Computer Art," 1989, *DIGITART in Eastern Europe* (Kunsthalle: Budapest 1990) p. 88.



Tamás Waliczky, *Grammophone*, 1989
Computer graphic

Gusztáv Hámos

Gusztáv Hámos
born 1955 in Budapest. Emigrated to West Berlin in 1979. Studied at the German Film and Television Academy in Berlin. Guest instructor at the School of visual Arts, New York. Has taught fundamentals of experimental filmmaking at the German Film and Television Academy in Berlin since 1995. Lives in Berlin.

Installations
1984 *Madre*, Venice Biennial
1986 *Himmel und Erde*, Kunstverein, Cologne
1988 *Animals + Living Room*, P.S.1., New York
Siegfried is dreaming of Brünhilde, Kijkhuis, Den Haag
1993 *The Hammer on the Anvil*, Ostranenie, Bauhaus, Dessau
1995 *True Fun – Mouth Open, Eyes Closed*, Peking Light Unit, Podewil, Berlin
1996 *The Butterfly Effect*, Műcsarnok, Budapest

Films and videos
1980 *Seins Fiction*, 45 min., 16 mm, 3/4 inch, PAL
1981 *Commercial I* (with Chris Dreher), 40+4 min., 3/4 inch, PAL
1985 *Le dernier jour*, 7 min., 3/4 inch, PAL
The Invincible, 85 min., 35 mm, 1 inch, PAL
1988 *Vermouth/Piolun*, 25 min., 3/4 inch, PAL

Berlin Viewfinder
(In the Footsteps of Walther Ruttmann)

In 1927 Walther Ruttmann made a film titled *Berlin, Sinfonie einer Großstadt* (Berlin, symphony of a metropolis). We holographically recorded a five-second sequence from this film onto a glass plate. The recording shows the Potsdamer Platz. I located the original position of the camera with archaeological methods and then reconstructed the camera angle with the aid of holography. My work was hampered by the fact that hardly any traces of the former city center remain.

The installation shows a situation in which the 1920s' film section appears in exactly the same place on the modern square. I recorded a panorama of 155° and digitized it on the computer using Quick Time V.R. I then projected this image as a background for the hologram. When the viewer passes by the installation, both images shift in relation to each other. With the aid of a Pholemus cube, the viewer, who carries the sensor, controls the background image so that the hologram always appears in the same place where the viewer has been walking. If the viewer moves in front of the holograph, 125 images from Ruttmann's film begin to move. With the aid of the 'inside track,' the Pholemus cube communicates the viewer's movements to the computer, which then synchronizes them with the modern-day appearance of the square.

George Legrady

Slippery Traces
Taking Up Different Trails

Slippery Traces is a non-linear visual narrative through which the viewer navigates via a network made up of 230 postcards.[1] The postcards are linked and grouped according to their literal or figurative meanings. Each postcard contains approximately five 'hot spots,' or links, to about ten other cards. By clicking on one of the hot spots, the viewer accesses a different picture, thus constructing a sequence of connected images. This sequence can be retrieved in order to retrace the meta-narrative and the links created by personal choice.

The 230 postcards were selected from my collection of more than 2000 postcards that I have put together over the past twenty years. After the first rough selection, the cards were arranged in twenty-four categories. This classification process included subjects such as nature/culture, colonialism, future, military, industry, landscape vistas, moral narratives, etc. Pictures that did not constitute a separate category were assigned to the closest subject. This amplified the significance of grouping the pictures and there emerged a dialogue, which, in addition to simply classifying, also assigned a narrative task. The aim of this selection of postcards was to present a synopsis, a world view showing how the mid-twentieth century was represented both culturally and ideologically in photography against the backdrop of global development. Other criteria included culturally significant content or visually interesting compositions illustrating a form of perception shaped by photography. The selection is not intended to portray the totality of historical experience of the twentieth century.

Slippery Traces originated from a slide show with two projectors. I wanted to investigate how the meaning of images changes when they are confronted with each other. Transferred into the non-linear, dynamic environment of the computer, the changes in meaning increase at an exponential rate. The pictures are released from their linear location in the slide magazine and are viewed in various new relations to each other, according to computer-defined criteria. The result is an imaginary, three-dimensional, nerve cell-like network, in which all 230 images are cross-linked with more than 2000 connections, thus creating a unified whole. The connections, or hot spots, have something in common with the pictures they call up. Every time a viewer clicks on a hot spot to access a different picture, he or she weaves a path through this dense labyrinth of connections that is stored in a database. *Slippery Traces* adopts the organizational structures of statistics and uses them to open them up for analysis. In addition, the process of navigation and sequencing in *Slippery Traces* integrates the form and function of database structures as a creative tool and emphasizes a philosophical approximation of programming as an aesthetic practice. In this fragmented viewing environment, which is constantly in motion, the viewer must consciously stop the act of viewing (by freezing the mouse movement) in order to see the whole picture. The central model for *Slippery Traces* is the image scanner from the film *Blade Runner*, which is used by the protagonist, Deckard, to enter the photos of the replicants in order to search for traces. Deckard uses a technical viewing prosthesis[2] to enter the photo image, thus breaking through the three-dimensional borders of traditional photography — he moves through the image. He forces it to reveal a woman's face — something he is looking for, but which was not originally in the picture, thus reinventing the picture in order to adjust it to his wishes.

art intact 3. CD-ROM Magazin interaktiver Kunst (ZKM Karlsruhe, Cantz: 1996): 85-89.

George Legrady, born 1950 in Budapest. George Legrady is Professor of Interactive Media, with joint appointment in the Media Arts & Technology program and the department of Art, UC Santa Barbara. He has previously held fulltime appointments at the Merz Akademie, Institute for Visual Communication, Stuttgart, the Conceptual Design/Information Arts program, San Francisco State University, University of Southern California, and the University of Western Ontario. He received the Masters of Fine Arts degree from the San Francisco Art Institute. Lives in California.
Recent interactive installation exhibitions have taken place at the ars electronica Festival, Linz, 2003; DEAF 03, Rotterdam, 2003; the ISEA Conference in Nagoya, Japan, and the San Francisco Museum of Modern Art, 2002; the Centre Pompidou, Paris, 2001; the Rotunde at the Siemens World Headquarters in Munich, 1999-2000; the Museum of Contemporary Art, Los Angeles, [Tracing], 1998; the Kunst und Ausstellungshalle der Bundesrepublik in Bonn, 1997-1998; the National Gallery of Canada and the Canadian Museum of Contemporary Photography, 1997-98; the Palais des beaux-arts, Brussels, 1997.

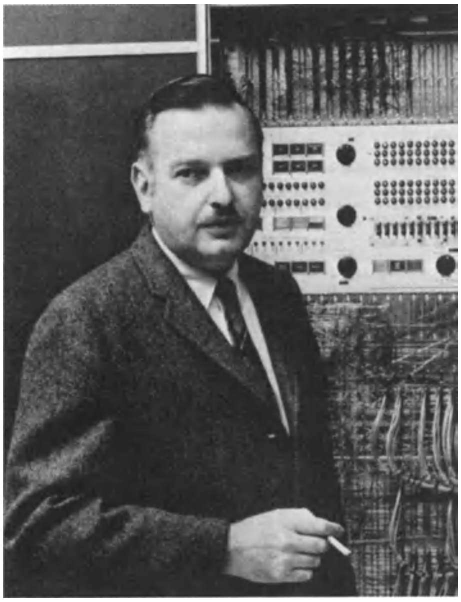
1. The installation version of Slippery Traces contains 230 postcards. For copyright reasons, the CD-ROM version was reduced by some fifty postcards (mostly of recent date).

2. Elissa Marder, "Blade Runner's Moving Still," Camera Obscura, 27 (John Hopkins University Press, Sept. 1991): 102.

George Legrady, *Slippery Traces*, 1996
Internet screenshots, http://ns.c3.hu/butterfly/main.html

5

John George Kemeny



John George Kemeny (1926-1992) in front of the Dartmouth computer system. In 1964, he invented, together with Tom Kurtz, the computer software language BASIC.

John Kemeny was born in Budapest on 31 May 1926. Though others thought him unduly alarmed, Kemeny's father believed that Hitler's march into Vienna in early 1938 augured worse things, and so he left on his own for the United States. Eighteen months later, in early 1940, he sent for his wife, daughter, and teen-aged son John. After a Budapest-to-Genoa train ride, the family sailed to America without incident. Young Kemeny attended school in New York City. In 1943 he entered Princeton, where he studied mathematics.

During his junior year, turning eighteen, Kemeny was drafted and sent to Los Alamos, where organizers of the Manhattan Project had undertaken a crash program to accelerate the development of the atom bomb. Here he was assigned to what was known as the project's computing center; in fact, it used IBM bookkeeping calculators. Kemeny joined others working eight-hour shifts, twenty-four hours a day, six days a week. Kemeny remained at Alamos through 1945 and 1946.

After the war he returned to Princeton to do a doctorate. During 1948 and 1949, while completing his dissertation, Kemeny served as Albert Einstein's research assistant at the institute for Advanced study; Einstein always had a mathematician as a research assistant. Kemeny worked three or four days a week with Einstein, who at the time was completing his work on unified field theory, trying to chose which of three possible versions was the best. Kemeny spent a good time checking Einstein's calculations.

One day, coming out of the institute, Kemeny and Einstein met John von Neumann. "You have made the wrong kind of computer," Einstein told von Neumann. "Why don't you invent a computer that would help me in my work? I don't need a numerical computer." What Einstein required was a symbolic machine—one that could perform symbolic differentiation, among other tasks. In the course of the lengthy discussion that followed, von Neumann predicted that one day computers would do the kind of work Einstein wanted. And he was right, of course.

After Kemeny received his doctorate, he taught mathematics for two years and philosophy for another two years at Princeton. He joined the Dartmouth faculty in 1953, teaching mathematics and philosophy, serving as chairman of the mathematics department from 1956 to 1968 and as president of the college from 1970 to 1981. He was a consultant to the Rand Corporation during the 1950's, on computer science and other matters. In 1979 he took time out from his duties at Dartmouth to serve as chairman of the President's Commission on the Accident at Three Mile Island.

John George Kemeny, born 1926 in Budapest. In 1940 Kemeny's family emigrated to New York. After his studies at Princeton, Kemeny joined the Mathematics Department at Dartmouth in 1953. 1955-1967 chairman of the department. In 1971 he became president of Dartmouth College, a position he held for eleven years. In 1982 he returned to full-time teaching at Dartmouth. Appointed by President Carter to chair the Presidential Commission to investigate the Three Mile Island accident, 1979. With Thomas Kurtz co-author of the computer software language BASIC, 1964. Died in 1992 in Hanover, New Hampshire.

Thomas Kurtz was born on 22 February 1928, in Oak Park, Illinois. He graduated in 1950 from Know College in Galesburg, Illinois, where he majored in mathematics. Like Kemeny, he went to graduate school at Princeton, where he did his doctoral work in statistics, receiving the degree in 1956. His thesis was on a problem of multiple comparisons in mathematical statistics. In 1951 he spent a summer working with computers at UCLA in the Institute for Numerical Analysis, a branch of the National Bureau of Standards. Kurtz arrived at Dartmouth in 1956 and began teaching mathemaics. Almost immediately he became involved with computers.

In the 1960's there was FORTRAN for the scientific community, COBOL for the business world. Both of these intimidated most amateur computer users. The two Dartmouth professors of mathematics, John Kemeny and Thomas Kurtz, set in motion the then revolutionary concept of making computers as freely available to college students as library books were. John McCarthy, who had been developing the concept of time sharing at MIT during the early 1960's, urged Kurtz to get involved in the same thing at Dartmouth. In contrast with the old system of batch processing, which allowed only technicians to get near a computer, time sharing permitted students to have direct access to the machine. Kurtz passed McCarthy's advice on to John Kemeny. "Let's do it," was the immediate reply. Because of the time sharing system, Dartmouth students, though largely non-technical had far more experience in the 1960's with computers than students elsewhere. Kemeny and Kurtz did not want to train computer scientists; their idea was rather to put the computer at the disposal of large numbers of generalists. There was a direct connection between the Dartmouth time sharing project and the development of BASIC—Beginner's All-Purpose Symbolic Instruction Code. It became clear to Kemeny and Kurtz that a high-level language would be needed for the non-expert users of the system. Nothing like that existed. Kemeny was the one who suggested to Kurtz, while they were implementing time sharing, that they ought to come up with a more user-friendly language.

The Road to BASIC was a long one. Kemeny and Kurtz had come up with DARSIMCO—DARtmouth SIMplified COde—Dartmouth's first real attempt at a computer language, in 1956. Because FORTRAN appeared soon thereafter, however, it fell into quick disuse. In 1962, Kemeny, assisted by Dartmouth student Sidney Marshall, wrote a language called DOPE—Dartmouth Oversimplified Programming Experiment—which was a precursor to BASIC. It was not a success. At one point Kurtz preferred trying to modify ALGOL and FORTRAN. But he quickly concluded that it was not possible to construct subsets of these languages that would be easier to use. So he eventually adopted Kemeny's attitude, which was to create a whole new language.

In 1963 Kemeny designed an introductory computer course but soon realized that batch-processing systems were not adequate for the course assignments. He started to work on a compiler for a draft version of BASIC in September of that year, even before the Dartmouth time sharing system was put together.

The first program in BASIC was a compiler, whereas all subsequent versions were interpreters. Kemeny and Kurtz chose a compiler for the following reason: Although most compilers were notoriously slow in 1963, they knew that fast "load and go" compilers could be written. The first BASIC program ran on 1 May 1964, at 4 a.m. on the time sharing system, implemented on the GE 225 computer.

More people have learned BASIC than Norwegian, Danish, and Swedish combined. By enabling the average person to use a computer in the 1960's, BASIC helped bring on the personal computer revolution of a decade later. And indeed, BASIC soared in popularity in 1975 after a pair of youngsters in a Harvard dormitory, Bill Gates and Paul Allen, managed to get it working on one of the earliest personal computers. Gates and Allen's version became the most widely used BASIC.

Following the Gates-Allen success BASIC spread to the Commodore, Apple, TRS-80, Atari, IBM PC, and even the Sinclair. Eventually it would run on nearly every microcomputer and serve as the basis for thousands of applications.

With PASCAL gaining increasing acceptance in the high schools because it was structured, and BASIC more and more in disfavour, Kemeny and Kurtz decided during the summer of 1983 to produce a new version of their original language. They would call it True BASIC.

In June 1986 Kemeny received some good news. He had been given the Computer Pioneer Award by the Computer Society of the Institute of Electric and Electronics Engineers, in recognition of his contributions to computer science.

Robert Slater

Károly Simonyi, born 1916 in Budapest. Studied at Technical University in Budapest. Professor for electrotechnics in 1948. Head of the Department of Nuclear Physics at the Hungarian Academy of Sciences. Various publications; his main work is the *Cultural History of Physics*. Died in 2001.

Charles Simonyi, born 1948 in Budapest. While in high school, he worked at a computer laboratory and took an interest in computing. He learned to program from one of the laboratory's engineers. In 1966 he was hired by A/S Regnecentralen, Denmark. He studied in Berkeley, California, at Stanford University, 1968-1972. Until 1977, graduate studies at Stanford University. Was hired by Xerox PARC. Development of "Bravo," the first WYSIWYG document preparation program, together with Butler Lampson. In 1981, he applied to Bill Gates for a job at Microsoft. Under his guidance, some of the most important products of Microsoft were developed: Word, Multiplan, and Excel. Developed the Hungarian notation for naming variables. In 2002, Simonyi left Microsoft and founded, together with Gregor Kiczales, the company Intentional Software. Donated funds to Oxford University to establish the "Charles Simonyi Professor of the Public Understanding of Science" (the first occupant of this position was Richard Dawkins).

Charles Simonyi

Peter Weibel

The Explosion of the Visual: Machine-aided Perception

The eye came to be the dominant sensory organ in the twentieth century. However, the eye became isolated and absolute in relation to other sensory organs with the aid of machines and media, which opened up an infinite visual horizon. In the past century and a half, the image has undergone a decisive technical transformation as a result of the mechanization of the image and its new status in different media, from the camera to the computer.

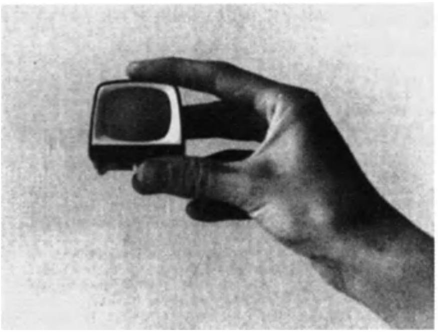
I (Stations of the Technical Image)

This evolution of machine-aided generation, transmission, and reception of images can be provisionally divided into seven stages:

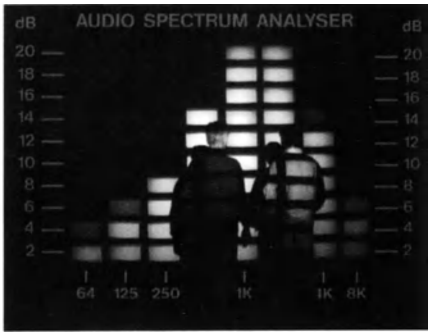
1. The first station of the technical image was, as we know, the mechanical production of photographic images (1839). The image produced itself without the helping hand of the artist, whose task was assumed by an autonomous machine, an image automaton (*auto* from the Greek, meaning self).

2. The transmission of images over long distances by means of scanning, i.e., splitting up a two-dimensional image into a linear sequence of points in time, was accomplished in the same era (1840) by psychologist Alexander Bain. The telegraph, telephone, radio telescope, and the electronic telescope (a TV system designed by Paul Nipkow in 1884) are examples of mechanical systems that transmit sound, static, and moving images. Mechanical image generation was followed by mechanical image transmission. The discovery of electromagnetic waves (Maxwell in 1873; Hertz in 1887) marks the beginning of new worlds of images.

3. The disappearance of reality (meaning real, corporeal space) was followed by the simulation of reality. The simulation of motion was an important milestone in the simulation of reality. With the aid of mechanically moved images — the mechanical illusion of motion — the spatial form of the image (painting) was followed by the temporal form of the image: film. Lessing's *Laocoon treatise* (1776) was rescinded. The image ceased to be a medium of space and became a medium of time, as did language and music.



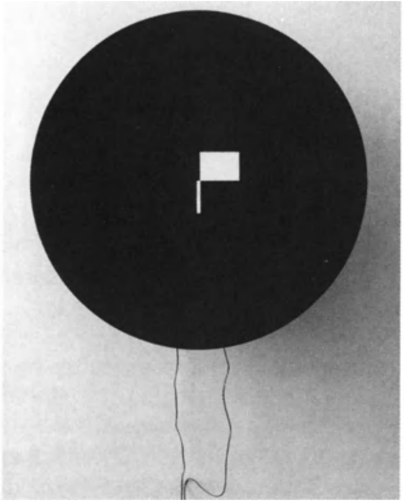
Richard Kriesche, *mariazell tv*, 1978
© VBK, Vienna, 2005



Michael Schuster, *Audio Spectrum Analyser*, 1995

Karl Neubacher, *Reproduction-Mirror Image*, 1976
16 mm film

Gundi Berghold, *Cut 1/2*, 1991
Mixed media



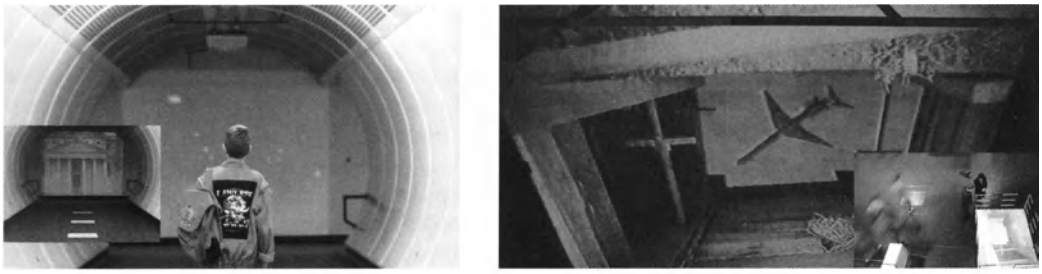
Simon Wachsmuth, *Untitled*, 1990
Black glass disk, monitor, player

Matta Wagnest, *Blue Box*, 1993
Mixed media

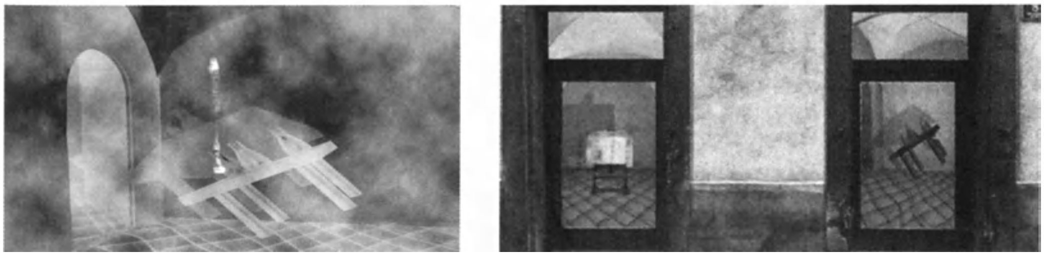
4. The discovery of the electron and the invention of the cathode ray tube (both in 1897) paved the way for electronic image generation and transmission (television). The magnetic recording of image signals (instead of sound signals, as had been the case since about 1900) with the aid of a video recorder (1951) blended film, radio, and television (sound and image recording with broadcasting) in the new medium that was video.

5. Transistor, integrated circuits, chips, and semiconductor technology had been revolutionizing information processing technology since the middle of the twentieth century and ultimately led to the totally mechanically calculated computer image. The multimedia computer not only contains all historical possibilities of mechanical image, sound, and text generation and transmission but also opens up completely new perspectives of machine-controlled worlds of images. These display fundamentally new characteristics: virtuality, variability, and viability, which enable interactivity between the image and the viewer.

6. Interactive computer terminal data transmission technology allows art in the network — televirtuality, purely immaterial art in data space. Telepresence, telerobotics, cable TV, interactive television, and digital networks spanning the globe all make up the "electronic super highway" (Nam June Paik, 1974), the World Wide Web, where intelligent autonomous software agents operate with artificial intelligence. With the aid of the radio telescope, telephone, television, telefax, wireless telegraph, radio, etc., the foundations were laid

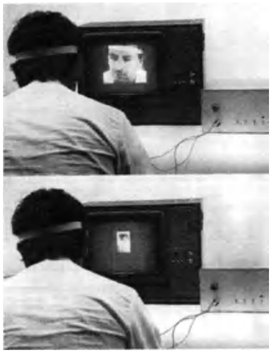


Gudrun Bielz, Ruth Schnell
The Space Between 1 and 2, 1991
Topography:
Vienna, Südtiroler Platz



Martin Kusch, *Simulation Model, Galerie Winter*, an interactive computer installation for the public space, 1997

ARTSAT – The Data Gloves, 1991 Gerfried Stocker; part of an interactive computer project with Horst Hörtner
© VBK, Vienna, 2005



Richard Kriesche, *bio-video,* 1982
© VBK, Vienna, 2005

for a telematic culture characterized by the separation of messenger and message, body and message. The material carrying the codes is negligible. Immaterial signals travel through space and time, waves expand, bodiless communication becomes possible. The realm of immaterial signals is taking root in the telematic civilization. The postindustrial information and code-based age of immaterial messages is dawning.

7. But the next step, hitherto banished to the realm of science fiction, is already becoming an actuality in the field of interface research and advanced sensor technology. Whereas we only encounter external brain wave or eye-tracker sensors in current interactive media installations, the direction is quite apparent. By circumventing classical electronic interfaces, the aim is to work with brain-chips, or neuro-chips, so as to link up the brain directly to digital worlds with as little loss as possible. The objective is to stimulate the brain to generate artificial worlds of images instead of simulating artificial and natural worlds, and to directly communicate with the aid of brain waves.

Hence, there are new places and media for the image, or the visual. The image itself is no longer merely the painted picture, the flat painting: the image can also be a technical image, a photographic image, a film image, a TV image, a video image, or a computer image. The location of the image is, therefore, no longer with the painting alone, and painting is no longer the only medium for the image. The image has a long history of changing technical carrier media. The image was once painted on rock and later on wood. For some five hundred years, oil on canvas or watercolors on paper have been the prevailing technical carrier media. Meanwhile, however, there is a host of new technical carrier media for the image. The visual has detached itself from the painted image. The idea of the visual has emigrated from the painted picture in search of new host media and has journeyed on to other media. Today, the visual is not just located in painting, but also in the cinema screen and the visual display unit. The technical, mechanical media are today the prevailing media for both the image and the view, constituting a new visual culture universe.

II (Postontological Art: Virtuality, Variability, Viability)

We have seen that one common feature of the classical technical image media (photography and film) and the classical media of art (painting and wood or stone sculpture) is that they store information in a material information carrier, which makes it difficult to instantly change this information. The information is firmly locked up in the classical physical carrier media and cannot be reversed or instantly modified. The image itself is thus frozen, static — or if it moves, then the motion is merely an illusion. No image, no frame, has any inherent movement; no part of the image changes. Only a sequence of images in time can create the illusion of movement. The opposite of this is the digital image, whose every part is movable, variable, and changeable. The image can be controlled not only as a whole but also (and most especially) locally. All parameters of the information can be instantly changed in the digital medium. In the computer, information is not fixed, but instead, free and variable. This possibility of instantly modifying the content of the picture, all the points of the image field, makes the digital image eminently suitable for virtual environments and interactive installations. Every point, every dimension, every parameter of the image is a variable, thanks to the fact that the information is virtually stored. This changes the essence of the image quite fundamentally. For the first time in its history, the image has become a dynamic system of variables, which are not, however, controlled by the organization of memory, as is the case with the film or video, but rather by the viewer. The image ceases to be a rigid surface and becomes a dynamic image system with peripheral devices, a field of variables that can be controlled locally — or to be more precise, a binary sequence of variables (0,1). The machine-generated sequences of variables make up the horizon of events for the viewer, whose behavior is what actually decides the visual and acoustic manifestations of the variables. The image thus becomes a field of events. Sound and image are specific local events in dynamic systems. Instead of image, we should instead refer to a field of events containing acoustic, visual, or olfactory variables. The field of events that can be controlled and constructed from the respective context — locally or globally, meaning at specific points or as a whole — is the new form of the image.

The conception of the image ceases to be that of a window (Alberti) through which we can only see a small part of an experience fixed in space. Instead, it becomes a door through which the viewer can enter and exit the world of multi-sensorial fields of events that describe and construct, both temporally and spatially, a dynamic and virtual experiential space.

Through all its phases of machine support, the classical image is slowly evolving into a context-controlled event world of variables. This variable, virtual image has, however, acquired a new feature as a result of its dynamic system properties: it behaves like a living system, reacts to the input of a specific context, and changes its condition and output. The interactivity of media art consists, therefore, of the three elements of the digital image: virtuality (information storage), variability (the objects in the image), and viability (the behavior of the

Constanze Ruhm, Peter Sandbichler, *Canal*, Venice Biennial, 1995, Austrian pavilion, with Kay Fricke, Bob O'Kane, Michael Saup

image). The image is thus becoming a dynamic system with lifelike behavior. If a living organism is a system that autonomously reacts to inputs, then the digital image system of multi-sensorial variables that autonomously reacts to inputs is also a living organism, too. The dynamic image system displays lifelike behavior. The characteristic of complex dynamic systems that both autonomously undergo changes of condition through feedback and react to input from their environment in a context-sensitive manner is termed "viability" — lifelike behavior — in radical constructivism. From the digital triad of the virtual information storage, variable image content, and viable image behavior there evolves an interactive, dynamic image system: the living image. The installations of interactive media art integrate one or several human viewers into computer-calculated virtual scenarios by means of computer-controlled, multi-sensory interfaces. The old passive viewer outside the image becomes a part of the image world itself. He becomes an internal viewer. His behavior influences the virtual scenarios. The simulated worlds react to the viewer, and their changes influence the viewer via feedback. The image becomes dependent on and relative to the viewer.

Genetic algorithms — intelligent autonomous software agents — will assume a key role in this process. Also, the next step — virtual agents with artificial intelligence on the data highways — is already in preparation. These "knowbots" are the consummate embodiment of the concept of postontological art. They are creatures with characteristics such as (artificial) intelligence, (artificial) life and (artificial) awareness, but without material existence, without bodies. They are subjects without any ontological status.

The price of both viable information and the system is precisely their variability and virtuality. Postontological art is a dynamic, covariant model of the viewer-interface environment, in which the viewer can be part of the environment, or the context. The viewer constitutes a dissipative structure. Genetic algorithms that detach the image from the context of the viewer constitute another dissipative structure. Thus, what evolves in lieu of the world of the image is a world of free variables in specific event worlds that can be universally occupied and replaced, and which can determine and influence each other reciprocally. The image becomes an artificial, model world, autocatalytic and context-controlled. This living image (as an environment of free variables) is the most radical transformation of the classical conception of the image.

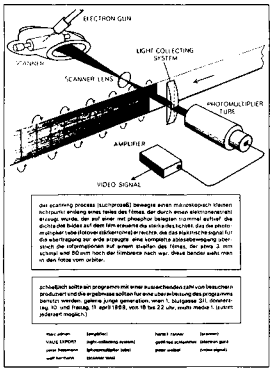
III (Persons and Institutions)

Marc Adrian made a name for himself in the 1950s with kinetic, optical images, objects, and sculptures. Between 1957 and 1959, he extended this style into the realm of technical image media and avant-garde films, which were later termed "structuralist." At the same time, he also devised a mechanical method of text production, "methodical inventionism" (1957). In 1963 he directed a camera without a lens directly at an X-ray screen that was connected to an IBM 1620-21. This is how *Random* (35 mm, b/w, sound, 285 sec.) was created, probably the first film shot with a computer in Europe. Mathematically defined random programs and random-generated mathematical series were also incorporated in *Text I* (1963, 35 mm, b/w, sound, 154 sec.) and *Text II* (1964, 35 mm, b/w, sound, 220 sec.).

A clear manifestation of the emergence of media-specific awareness was an event called *multimedia 1*, held in Vienna in 1969, in which Marc Adrian, Valie Export, Peter Weibel, and others participated. It was here for the first time that Weibel displayed viewer-dependent, interactive and closed circuit installations with the aid of video, and demonstrated the principle of scanning as well. In joint works, Export and Weibel presented the first sensor-dependent interface artworks (*The Magic Eye*, an autogenerative sound screen that transforms light into sound). Another important manifestation was Trigon – *Audiovisuelle Botschaften* (Audio-visual messages) in Graz in 1973, where, for the first time, video was the focus of a major European exhibition. The exhibition displayed works by Nam June Paik, Bruce Naumann, Peter Weibel, Richard Kriesche, and Valie Export. Media works were also presented at the 1975 Trigon festival – *Identität* (Identity).

Peter Gerwin Hoffmann
Pax Bunny, 1994

Peter Weibel,
Imaginary Tetrahedron, 1979



Video art in Austria (Gottfried Bechtold, Valie Export, Richard Kriesche, Peter Weibel) began developing in 1969 out of the Expanded Cinema movement, initiated in the mid-1960s by Weibel. With the advent of the next generation (Karl Neubacher, Friederike Pezold, Gudrun Bielz, Ruth Schnell, Franz Xaver, Ilse Gassinger, Erwin Wurm, Fedo Ertl, Gundi Berghold, Muki Pakesch, You never know, Station Rose [Gary Danner, Elisa Rose], Simon and Arye Wachsmuth, Inge Graf & Zyx, Ernst Caramelle, Karl Kowanz, Romana Scheffknecht, Werner Schmeiser, Ursula Pühringer, etc.), the video scene experienced a tremendous upturn in the 1970s and 1980s, albeit not in the art institutions dominated by new painting. The ars electronica festival of art, technology, and society, began as a coproduction of the ORF and the Brucknerhaus, initiated by the renowned Austrian science and science-fiction author and media artist Herbert W. Franke, electronic musician Hubert Bognermayr, and the director of the Upper Austria branch of the ORF broadcasting company, Hannes Leopoldseder. The festival in Linz, first held in 1979, came to be not only a national, but also an international driving force behind electronic art. Originally conceived as a biennial festival, the ars became an annual festival in 1996. Up until then, the ORF had dominated the program in a populist fashion. However, under the new directorship of the Brucknerhaus and Karl Gerbel, as well as program curators Gottfried Hattinger and Peter Weibel (who was the sole artistic director between 1992 to 1995), it was possible to give thematic and discursive shape to the festival: *offene Räume – freie Klänge / open spaces – free sounds*, 1987; *Kunst der Szene / Art from the scene*, 1988; *Im Netz der Systeme – für eine interaktive Kunst / in the network of the system – for an interactive art*, 1989; *virtuelle welten – digitale träume / virtual worlds – digital dreams*, 1990; *out of control*, 1991; *Endophysik – Nanotechnologie / endophysics – nanotechnology*, 1992; *genetische Kunst – künstliches Leben / genetic art – artificial life*, 1993; *Intelligente Ambiente / intelligent environments*, 1994; *Mythos Information – welcome to the wired world*, 1995. The ars electronica has thus taken the thematic lead internationally and provided an important impetus — asserting, for example, interactivity as a fundamental feature of digital art in 1989. All these achievements led to the foundation of an ars electronica center with a permanent building, whose director was media artist Gerfried Stocker, of Graz. There is another station in Linz concerned with electronic art, Archimedia, initiated in 1996 by Herbert Lachmayer and managed by Christian Möller, of the Frankfurt Institute of New Media (which was headed by Peter Weibel from 1989 to 1995).

A young generation has managed to move from electronic to digital art in the 1990s: Christa Sommerer, knowbotic research (Christian Hübler, Alexander Tuchacek, et al.), Martin Kusch, Markus Huemer, Orhan Kipcak, Ruth Schnell, etoy, Constanze Ruhm, Peter Kogler, as well as members of the older generations, such as Peter Weibel and Richard Kriesche. The production of CD-ROMS became a matter of course.[1] Digital art and science institutions have emerged not only in Linz, but also in Graz and Vienna. Gert Pfurtscheller, of the Institute of Biomedical Technology and the Ludwig Boltzmann Institute of Medical Computer Science and Neuro Computer Science, developed an EEG-based brain-computer interface, with which it is possible to move and control a cursor with the brain. The achievements of the Institute of Computer-Aided Geometry and Graphics at Graz Technical University and the Institute of Digital Image Processing at Joanneum Research are exceptional. Last but not least, mention should also be made of Peter Weibel's master class for visual media design at the Academy of Applied Arts in Vienna, which has been producing important Austrian media artists since 1985.

1. *Ein Telematisches Museum. Eine interaktive Reise durch die Bildankäufe aus dem Budget Kunst und Bau des Landes Steiermark 1974-1994*, a project of the Department IVa-Hochbauplanung and Neue Galerie Graz. Conception: Wolfdieter Dreibholz and Peter Weibel; software and CD-ROM production: Orhan Kipcak, 1995. *Richard Kriesche, Sphären der Kunst*, a CD-ROM production by the Neue Galerie Graz; Assistance: Jutta Steininger, Robert Gölles, eds. Production: Helmut Leitner (1996).

Otto Beckmann
ars intermedia

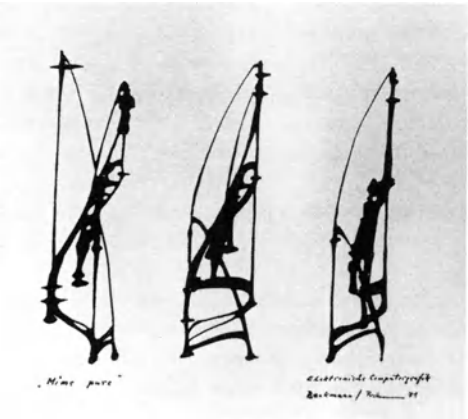
ars intermedia is an informal group comprised of artists, architects, and scientists from a variety of disciplines, which has been in existence for many years [founded in 1966 by Otto Beckmann — editor's note]. The group's work encompasses the whole field of computer art, including computer-generated laser structures. A special focus of the group is on developing and building art computers — i.e., equipment intended solely for artistic tasks. Almost all of our artistic works were created with the aid of these ars intermedia studio computers. [The first computer built by ars intermedia and Otto Beckmann, *ai 70*, and the image-sound-identical computer film created with this equipment was presented as early as 1970 on Austrian television — editor's note].

Computer Art

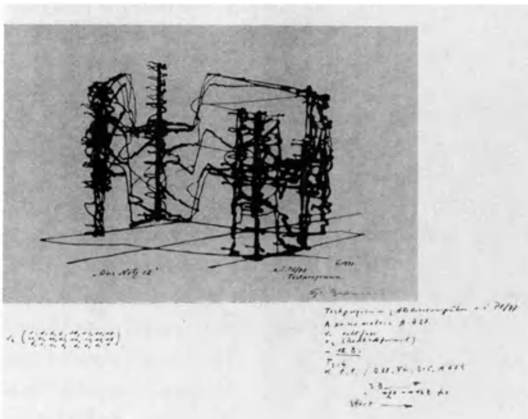
On the basis of all previous experiences, it is becoming increasingly clear that computer art is synonymous with a new era of art history and cannot be categorized as part of modernism. In its essence, it is an ars intermedia: an art of a multimedia nature with fluid transitions between the individual genres of art and their amalgamations to forge new forms of art. The turning point in the history of art marked by the advent of computer art is also characterized by a new attitude to its tools. For the first time in history, the creative human being, the artist, has at his disposal an intelligible, dialogue-based tool that displays the reflections and aspects of partnership — the computer. The programs created with the aid of this tool open up a wide variety of fields. In the category of image-sound computer films, the elements of composition are composed of audio-visual impulses. The program can run on a screen and a speaker. This output can be filmed or recorded on tape (as in image-sound assigned films *IV/70* and *Imaginäre Tonarchitektur* [Imaginary sound architecture] in 1976). But the computer film can also include a cinematric-choreographic component.

If the cinematic process is not derived from choreography but rather from the fundamental conception of an image, the result is image sequences, a temporal sequence of variations, permutations, and mutations. The image assumes a new dimension — the dimension of time. Image-sound assigned films, cinematic choreograms, and cinematic images are supplemented by a number of other forms of art, ranging as far as creative computer games. Many of these forms are based upon socialized, associative programs. In a very simplified form, they are two related random processes that in their connection constitute a new program. The output of such a program is threefold, with a strong architectural component that can be read as plan, elevation, and side elevation. It is most probably due to the system of these programs that subprograms also exist implicitly for the visual arts. In view of these suggested connections, the old notion of the common origin of architecture and visual arts could be verified. But considering that computer art is primarily focused in other areas, this evidence would be of only secondary importance.

ars intermedia, "Werkbeiträge zur Computerkunst und zur audiovisuellen Gestaltung", in *Bulletin of the Audiovisual Center and ars intermedia*, no. 1 (Graz: Palais Attems, 1976), 2-4.



Otto Beckmann, *Mime pure*, 1971
Computer graphics on aluminium, 65 × 50 cm



Otto Beckmann, *The net 12*, 1973
Computer graphics with pencil notes, 55.3 × 40.3 cm

Otto Beckmann
born 1908 in Wladiwostok. Studied sculpturing in Vienna. In 1940 lecturing at the Academy of Arts in Kraków. In 1968 foundation and direction of the experimental workshop ars intermedia. Died in 1997 in Vienna.

1969 Secession, Vienna
1971 Modern Art Galerie, Vienna
1976 Audio Visual Center, Palais Attems, Graz
1979 NÖ Landesmuseum, Vienna
1983 Museum of Modern Art, Vienna; Volkshaus, Mürzzuschlag
1986 Blau-Gelbe Galerie, Vienna
1994 Kunsthaus, Mürzzuschlag

Group shows
1970 *Impulse Computerkunst*, Kunstverein, Hannover; Kunsthaus, Hamburg; Kunstverein, Munich
Art Systems, Centro de arte y communicacion, Buenos Aires
1971 Arteonica, Sao Paulo
1972 *Canadian Computer-show*, Place Bonaventure, Montreal
1977 Geometrica 77, Tulln
1990 *Von Zuse bis Beckmann und ars electronica*, EVN-Zentrale, St. Pölten
1993 *Vorurteil-Verletzung-Menschenrecht*, Messepalast, Vienna
1995 *Fisch & Fleisch. Photographie aus Österreich 1945-1995*, Kunsthalle, Krems

References:
Otto Beckmann, *Neumagische Objekte des Kultismus und textgenerierte Maschinen* (Melk: 1986).
Otto Beckmann, *Text-Foto-Objekt*, (Vienna: Museum moderner Kunst, 1983).
Otto Beckmann, *Photographien zu Texten von Walter Buchebner* (Mürzzuschlag: Kunsthaus Galerie, 1994).

5

Kurt Ingerl

Remarks On My Programmed Structures

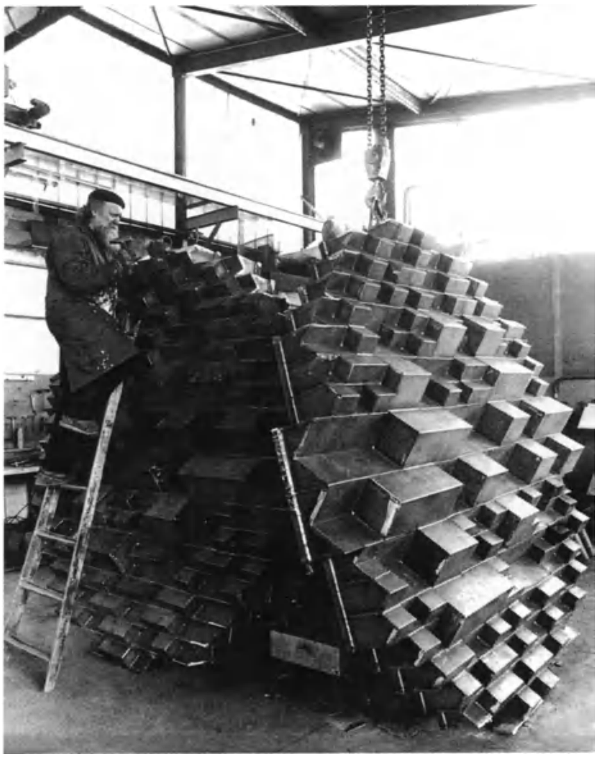
Kurt Ingerl
born in Ternitz/Lower Austria in 1935, studied sculpturing at the Academy of Fine Arts in Vienna. Assistant for sculpturing at the Academy of Applied Arts Vienna. Died in 1999 in Wiener Neustadt.

1977 Künstlerhaus, Vienna
1995 St. Peter a. d. Sperr, Wiener Neustadt
Galerie Krakora, Vienna

Group shows
1971 Biennial, Ljubljana
1972 Venice Biennial
1972/78 Salon des Réalités Nouvelles, Paris
1974 Biennial, Menton
1977 Geometrica 77, Tulln
Biennial, Santa Margharita
1983 Gogol Boulevard, Moscow
1984 Fernsehturm, Berlin
1985 Budapest; Sofia; Tbilisi (UdSSR); Sarajevo; Zagreb; Rijeka
1992 *Europäische Kunst, Perspektiven 92*, Garching/Munich
2003 *Phantom of Desire*, Neue Galerie Graz

A quote of mine to begin with: The greatest secret is clarity.

The path to form.
The method of obtaining form is construction.
Thus:
Focus on the problem of the figure after 1953.
Then:
Independence of the construction.
Thus:
Constructivist pictures and sculptures after 1960.
The image as an image,
not the image as a copy.
Free of meanings.
Aesthetics instead of semantics.
Aesthetics in the original meaning of the word.
Aesthetic structures are optimal structures of perception.
At first: "Emotional Constructivism." (Irrational use of rational elements.)
But soon:
Rational use of rational elements;
thus:
Fourth ideological generation of constructivists.
As a logical consistency:
Computer images as of 1970.
Synthesization of program and random generator.
Order and coincidence.
An analogue to the emergence of types of life.
Thus:
Constructivism is not a cold art.



Kurt Ingerl, *Steel Reliefs, Programmed Structures*, 1988
© VBK, Vienna, 2005

1.000 Principles of my computer-generated structures.
1.100 Algorithm.
1.200 Aesthetic program.
1.201 Grid.
1.211 Grid hierarchies.
1.220 Catalogue of signs.
1.230 Probabilities.
1.300 Random generator.
1.400 Machine program.
1.410 Machine: CDC CYBER 74.
1.411 Programming language: PASCAL.
1.412 Location: Vienna University of Technology, Institute of Information Technology.
1.500 Program, input, output.
2.000 Materialization.
I use scientific and technical methods to plan my art.
I use technical and industrial methods to implement my art.
It is said that:
"There is no tradition of Constructivism in Austria."
This is not true and is (still) a Fascist manipulation. (Examples to the contrary: Josef Hoffmann's abstract reliefs at the Beethoven exhibition, 1902, Lajos Kassák and Moholy-Nagy and the magazine *MA*, the *Buch neuer Künstler* [Book of new artists], etc. published in Vienna in 1924). So in 1982, Constructivism in Austria is eighty years old.

Kurt Ingerl, *Structure Forms,* 1972/73; *Mirror,* 1971
Computer images, each 200 × 80 cm
Structure, 1971
Computer graphics, lithography, 85 × 65 cm
© VBK, Vienna, 2005

Kurt Ingerl
Stacks, 1971
1:1 models for iron sculptures, height each 2.5 m, 1974 polychromed
© VBK, Vienna, 2005

And constructivism is one of the few "isms" (perhaps even the only one) that can renew itself continuously.
And:
Programmed art has a tradition particularly in my home town Wiener Neustadt, where Josef Matthias Hauer worked as an artist.
Hauer's twelve-tone music.
An algorithm.
As computer artists, we create many algorithms;
we carry on where Hauer stopped.
Our thinking is similar:
What Josef Matthias Hauer from Wiener Neustadt did for music, I, Kurt Ingerl from Wiener Neustadt, have done for painting and sculpture.
Constructivist art and programmed art are particularly well-suited to be integrated into architecture.
Integration, not application.
As of 1971, I created my computer-aided large building designs. (For example: 1971-1974 Programmed Façade, concrete relief, 940 square meters; 1973-1975 Programmed Structure; floor mosaic, slate, approx. 1000 square meters; 1974-1976 Programmed Façade, concrete relief, 180 square meters; etc.)
I created pictures, mirrors, concrete and steel sculptures for buildings.
This was made possible by using information-processing machines in planning and power machines for implementation.
Generated with the computer,
produced industrially.

The more you know about art,
the greater the element of the unknown.
Art is research.
Aesthetics is ethics.

Kurt Ingerl, *Computer-Kunst,* (Vienna: Kulturverein Favoriten, 1985): 19-21.

Richard Kriesche

telematic sculpture 4

Richard Kriesche
born 1940 in Vienna. Studied painting and printmaking at the Akademie der bildenden Künste (Academy of fine arts) in Vienna, and art history at the University of Vienna. Instructor from 1988-91 at the Technical University of Vienna. Professor from 1991-96 at the Hochschule für Gestaltung (Design college) in Offenbach/Main. Guest professor from 1995-96 at the École Supérieur des Beaux Arts, Paris. Assistant director at the Office for Science and Research, Styrian regional government, Graz, since 1996.

1981 Kunsthalle, Baden-Baden
1982 Massachussetts Institute of Technology, MIT – media lab, Boston
1982 Kunsthaus, Zurich
1985 Washington Projects for the Arts, Washington
1985/1988 Museum of Modern Art, Los Angeles
1989 Stadtmuseum, Graz (with P.G. Hoffmann)
1990 Museum of Modern Art, Oxford
1991 Museum moderner Kunst, Vienna
1996 Neue Galerie, Graz
2002 *Dermatologie und Tele-Leib*, Dom im Berg, Graz

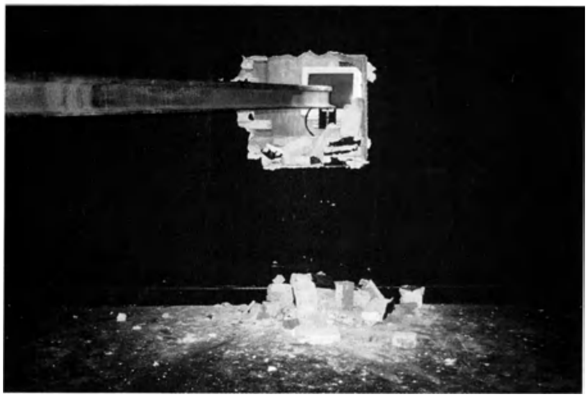
Group Shows
1969/1973 Trigon, Neue Galerie, Graz
1973 *Austrian Art*, ICA, London
1977 documenta VI, Kassel
1979 Venice Biennial
1983 *Kunst mit Photographie*, Nationalgalerie, Berlin
1987 Venice Biennial documenta VIII, Kassel
1989 ars electronica, Linz
1991 *Im Licht des Monitors*, Künstlerhaus, Graz
1995 Biennale, Venedig
1996 *The Butterfly Effect*, Mücsarnok, Budapest
1998 *Kunst ohne Unikat*, Galerie & Edition Artelier, Graz
2000 *Re-Play. Anfänge internationaler Medienkunst in Österreich*, Generali Foundation, Vienna
2003 *Meisterwerke der steirischen Moderne*, Burg Rabenstein
Einbildung, Kunsthaus, Graz

The *telematic sculpture 4 (T.S. 4)* that Richard Kriesche presented at the Austrian Pavilion in Venice in 1995 was essentially comprised of a 167-meter-long rail with a monitor fastened at one end whose movement was dependent on the flow of information on the Internet. Thus, the driving force of *T.S. 4* was information itself. All messages, coming from wherever they may, slowed down the pre-programmed movement of the machine. Only an extensive dialogue of computer and art newsgroups in the World Wide Web could have prevented *T.S. 4* from breaking through the wall of the Austrian pavilion. But this breakthrough happened at the end of September, about two weeks before the pavilion was due to be closed. Every day, a video camera located in the pavilion took a picture of the position of the monitor attached to the end of the rail, transmitted this photo automatically to the Internet and documented the invisible movement of the rail. Via an account written on the wall, which was also available as a small business card, everyone was able to log in at home and learn more about this project on-line than they would on-site. Every day they could see something about the video and audio status of *T.S. 4*, including the daily photo of the position of the rail, and additionally view information about the project, from Richard Kriesche's biography to the sponsors.

The cancellation of the historical importance of place can be seen by the fact that the local viewer learns a lot less about the project on-site than the dislocated viewer at home sitting in front of the computer screen. The absent viewer knows more than the present one. This, too, is evidence of the inversion of the dialectics and relevance of absence and presence.

Dislocated presence, virtual presence through media, triumphs in electronic space. Whereas the classical equation prior to the advent of electronic media once read "What is visible is present and what is absent is invisible," today the same equation reads "What is absent and invisible can be made visible by what is present." This dialectics of invisible and visible, absence and presence, site and non-site, changed by the new media, was a leitmotif throughout the entire Austrian pavilion.

Peter Weibel
in: Richard Kriesche, *Sphären der Kunst* (Graz: Neue Galerie am Landesmuseum Joanneum, 1996).



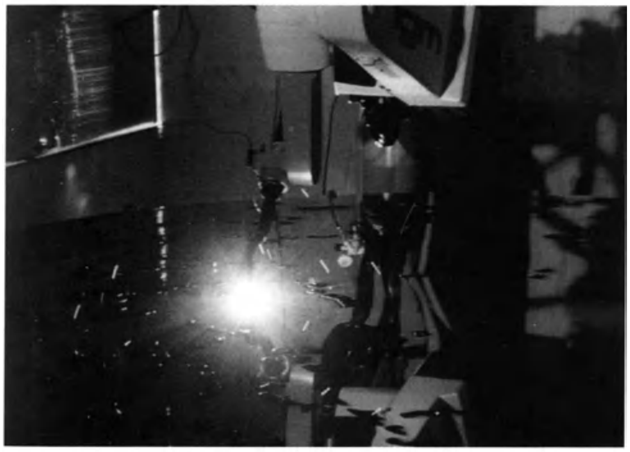
Richard Kriesche, *telematic sculpture 4*, 1995
Venice Biennial, Austrian pavilion
© VBK, Vienna, 2005

artsat 1991

this was the first art experiment during what was then the thirty-year history of soviet space travel. an austrian astronaut was at the satellite station MIR. the artist reached out into virtual space and shook hands with the astronaut while he was still in orbit. the astronaut sent clear acoustic messages to the base station in graz. this was done with the help of a specially designed keyboard. the messages were transformed into a code the welding robot (IGM) could understand, using ASCII code. the message was then welded onto a steel plate 3500 mm in diameter. the plate can now be seen on top of the schloßberg in graz (austromir).

Richard Kriesche
The Media Pavilion. Austria's Contribution to the 46th Venice Biennial, Peter Weibel, ed., 1995.

Live video, transmitted from the ORF studio in Styria to the Russian space station MIR
© VBK, Vienna, 2005



Transforming the data from MIR into ASCII code understood by IBM welding robot
© VBK, Vienna, 2005

Presentation of the smooth steel plate (3,500 mm diameter) at the Schloßberg in Graz
© VBK, Vienna, 2005

5

Gottfried Bechtold and Richard Kriesche

Chinese Electronic Whispers

Gottfried Bechtold
born 1947 in Bregenz. Lives in Hörbranz, Vorarlberg.

1971 Forum Stadtpark, Graz Galerie nächst St. Stephan, Vienna
1978 Bregenzer Kunstverein
1993/94 Neue Galerie, Graz; Magazin 4 – Vorarlberger Kunstverein, Bregenz; Galerie Museum, Bozen
1996 Bregenzer Kunstverein; Kunsthalle, Vienna
1998 *To Hear Is to See*, Goetheinstitut, Venezuela
1999 *Gottfried Bechtold – Hans Schabus. Fotoprofile*, Camera Austria, Graz
2003 Galerie Lisi Hämmerle, Bregenz

Group shows
1971 Trigon 71, Neue Galerie, Graz
1972 documenta IV, Kassel
1973 Trigon 73, Neue Galerie, Graz
1977 Trigon 77, Neue Galerie, Graz
1979 Trigon 79, Neue Galerie, Graz
1986 ars electronica, Linz
1992 *Identität : Differenz*, Neue Galerie, Graz
2000 *Get Together*, Kunsthalle, Vienna *Re-Play*, Generali Foundation, Vienna
2002 *The Mallory Project*, Künstlerhaus, Bregenz
2003 Palais Liechtenstein, Feldkirch

References:
Gottfried Bechtold. Graz/Bregenz/Bozen (Graz: Neue Galerie, 1994).
Gottfried Bechtold (Bregenz: Bregenzer Kunstverein, 1996).

Gottfried Bechtold, Richard Kriesche, stills from the film *stille elektronische post*, 1986, 37.5 min., directed by Alois Sulzer, produced by ORF
© VBK, Vienna, 2005

chinese electronic whispers (1986) is a video production by gottfried bechtold and richard kriesche in collaboration with the orf studios of upper austria and vorarlberg for the orf videonale. the project uses only existing communication lines between the two orf studios. on the basis of this electronic communication structure, real partial worlds are created at both real sites, which are separated from each other (shared people, shared cultures, shared processes, shared subjects and objects...) but become a single, undivided, electronic whole on the screen. in retrospect, it is obvious that the two-way communication of chinese electronic whispers paradigmatically anticipated the highway communication structure of the internet.

Robert Adrian X

The World in Twenty-four Hours

A project connecting artists around the world in a non-stop series of dialogues beginning at twelve noon on 27 September and ending at twelve noon on 28 September 1982 (Central European Time). Fourteen artists or groups around the world will be in communication with Linz, Austria, during the twenty-four-hour project. Each of the participating locations will be called on the telephone from the central location in Linz at twelve noon local time (for example, when it's six p.m. in Linz, it will be twelve noon in Toronto). Each contact will last about one hour, permitting the exchange of visual material via telephone by means of either slow-scan television or telefax equipment. In addition, the I.P. Sharp computer time-sharing network will be available for exchanging computer graphics and/or coordinating the projects. Participants have been offered the chance to choose any telecommunications medium for their contribution, providing that it operates via normal telephone lines and is also available in Linz. However, the present state of development only allows the three media mentioned above (and described below) to be used by artists or other private individuals.

1. Computer time sharing (I.P. Sharp APL Network)
Equipment: computer terminal
Medium: local telephone nearest to IPSA office
The I.P. Sharp office in Vienna will provide computer time and technical assistance to participants wishing to use I.P. Sharp software for computer graphics exchange.

2. Slow scan television (SSTV)
Equipment: SSTV transceiver (e.g., Robot 530)
Medium: direct long distance telephone connection
Signals from a video camera are converted by the transceiver into audio signals and transmitted via telephone. The received signal is reconverted to a video signal and displayed on a monitor. Each image takes 8.5 seconds to be completed.

3. Telefacsimile (Telefax)
Equipment: telefax transceiver (e.g., 3 M "9136," group III)
Medium: direct long distance telephone connection
Telefax transceivers convert images on paper into audio signals and transmit them via telephone. A compatible machine then converts the signal back into an image on paper. There are three different types of machines available, groups I, II, and III. The fastest of these are the group III machines, which can transmit an A4 page in under a minute. Machines like 3M's 9136 are also compatible with the slower group I and II machines.

The twenty-four-hour program will begin with an extensive European section lasting about six hours, from twelve noon until six p.m. (Central European Time). The European section will include contributions from Florence, Frankfurt, Geneva, Amsterdam, Vienna, and the final European section, Dublin. There will also be an experiment called PSI-bernetic Networking (using the I. P. Sharp time-sharing network), initiated by Roy Ascott in Bath, UK, which will be carried out over the duration of the European section.

The overseas program will comprise at least four North American locations (possibly including New York City), as well as Hawaii, Sydney/Australia, and Tokyo. The final contact will be from Turkey at eleven a.m. on 28 September (Linz time).

The schedule (based on Central European Time):

12 a.m. - 6 p.m.	Exchanges with Frankfurt, Florence, Geneva, Amsterdam, Vienna, Dublin
6 - 9 p.m.	Toronto and Pittsburgh, possibly New York
9 - 11 p.m.	San Francisco and Vancouver
11 p.m. - 3 a.m.	Hawaii (with Pacific region conference)
3 - 4 a.m.	Sydney
4 - 5 a.m.	Tokyo
5 - 9 a.m.	Open for conferencing, discussion, preparation of documentation, rest, etc.
9 - 11 a.m.	Summary and discussion of project with European participants
11 - 12 a.m.	Telex exchange with minus-delta-t in Turkey, en route to Bangkok

Hannes Leopold Eder, ed., *ars electronica 82* (Linz, 1982) pp. 155-157

Robert Adrian X
born 1935 in Toronto, Canada.
Lives in Vienna.

1963 Whitechapel Gallery, London
1967 South London Gallery, London
1976/77 Galerie im Taxis-palais, Innsbruck; Neue Galerie, Linz; Galerie nächst St. Stephan, Vienna
1982 Frankfurter Kunstverein, Frankfurt
1984 Neue Galerie, Graz
1990 EA-Generali Foundation, Vienna
1991 museum in progress, Vienna
1996 Offenes Kulturhaus, Linz (with S. Auinger)
2001 Kunsthalle Wien, Vienna
2002 *Handlungsanweisungen*, Kunsthalle Wien, Vienna
2003 *Farben*, Niederösterreichische Fotoinitiative, Wolkersdorf

Group shows
1966/67 Westside Gallery, London
1972 *Österreichische Malerei*, Neue Galerie, Graz
1977 *Malerwochen in der Steiermark*, Neue Galerie, Graz
1980 Venice Biennial
1981 *Erweiterte Fotografie*, Secession, Vienna
1982 ars electronica, Linz
1984 Venice Biennial
1990 *Kunst der 80er Jahre*, Neue Galerie, Graz
1992 *Avantgardekunst 1960-1980 in den USA und Europa*, Künstlerhaus, Bregenz
1998 *Remote Viewing*, Museum van Hedendaagse Kunst, MUHKA, Antwerp
1999 ars electronica, Linz
2000 *Re-Play. Anfänge internationaler Medienkunst in Österreich*, Generali Foundation, Vienna
2003 *Wings of Art*, Ludwig Forum für Internationale Kunst, Aachen

References:
Robert Adrian X. Picassos Auge (Vienna: 1990).
Peter Weibel (ed.), *Kunst ohne Unikat* (Cologne: 1998).

Konrad Becker

Public Netbase

Konrad Becker, born 1959 in Vienna. Has been involved with intermedia productions, exhibitions, and concerts in the fields of mathematical electronics, video installations, and event design for international festivals, cultural institutions, and galleries since 1979. His media works and essays have been published in art and other specialized publications around the world. He is also a lecturer and editor. Since 1992, co-founder and director of the Public Netbase, Austria's first public Internet access system (http://www.t0.or.at). He is director of the Institut für Neue Kulturtechnologien in Vienna.

Public Access in the Museum Quarter

Information highways, data economy, information wars, interactive media, artificial life, knowbots, cyberspace: catchphrases for new cultural technologies change the world. Economy, social interaction, language, and the concept of art are all affected by this technological shift. On the way to hypermedia and global connectivity in the infosphere, digital telecommunication provokes an interdisciplinary fusion of art and science in a technology-based society. As a cultural basis backed up by electronic information technology, the data matrix demands a new concept of art and space for the resulting ways of making art. Public Netbase (media in the message mess-age) considers itself a forum for free methods of communication, for an information society with no regrets. Konrad Becker and Francisco de Sousa Webber brought Public Netbase to life in March 1995, as a part of the Institute for New Culture Technology/t0.

Public Internet Terminals at the Institute for New Culture Technology

PC Internet terminals set up at the Depot in the Viennese Museum Quarter enable visitors to gain access to scientific, local, and private data banks on the Net as well as participate in informal, global exchanges of opinions. The t0 Netbase team offers Internet accounts and assistance in navigating and doing research on the Net. Our services (public access terminals, e-mail accounts, unlimited Internet access, dial-up possibilities (PPP), courses, technical assistance, etc.) are primarily designed to reach artists, students, and others interested in art and culture. Since 20 March 1995, Public Netbase has been offering practice-oriented, well-attended introductions to the Internet every Monday. One year later, the number of users had increased to 500. International collaborations with art and art-oriented institutions are also part of the program.

t_0 world wide web server: http://www.t0.or.at
over one million virtual visitors each month

e~scape hypermedia

Public Netbase strives to offer state of the art technology through projects such as e~scape hypermedia applications (interfaces and software developed in collaboration with t_0), virtual 3D worlds (VRML) on the net, live video feed (featuring Ingo Günther, Ulrike Gabriel, Stelarc, Konrad Becker, and others), and real audio/internet wave servers, as well as interactive applications (t_0 HYPER.CHAT, Interactive Cattle Mutilator, Very Virtual Voodoo and hypermail). A broad spectrum of internationally renowned artists and artists' groups, local initiatives, and music-oriented youth culture informational networks call Public Netbase their electronic home. Access is easy and almost free of charge. Along with the intensive support of the Public Netbase team, this has contributed to the development of an active art and Internet culture in Vienna. Public Netbase/t_0 was awarded a prize in the World Wide Web category at the Prix ars electronica competition in 1995. The institute's Web server registers over 1,000,000 hits a month, counting virtual visitors from around the world. Numerous radio and television shows have featured Public Netbase.

e~scape museum

http://www.t0.or.at/e~scape

Interactive, hypermedia network installations with public Internet terminals by Konrad Becker. An important part of the e~scape museum is online, accessible on a multi-media level throughout the world. The visitors' presence and their movements influence audio-visual sequences via remote viewing. A videoconference bridge (Internet CuSeeMe) between the e~scape museum and international CuSeeMe sites offer the possibility of worldwide hyper-communication in video and sound. An interactive billboard ("spraying the walls") is also included. Using an interactive application, virtual Internet visitors are able to influence a projection wall by implementing text and images. In doing so, they are able to actively intervene in the exhibition events.

Kunstlabor

The Electronic Gallery

The intentional overall concept of The Electronic Gallery (TEG) does not aim to support computer graphics, nor does it intend to initiate any type of discussion on the electronic picture as a painting. TEG is a structure-oriented art project that defines art along the lines of its societal, functional signifying facets. By no means do we derive our concept of structure from structural theory, yet we do understand it to be rooted within the system of theoretical context, i.e., within the necessity of autopoetic self-reproduction. Accordingly, structure stands for the reflexive situation inherent in the system.

Therefore, this project only functions due to the cooperation of cyclically and mutually conditional components: the basic communication program (the offer of mental discourse), the technical electronic configurations (hardware and software), the intervenor and his actors (involved persons), and the dynamic, complex area of communication (diverse social fields of ideology production). In Vienna during February 1996, this project proved to be a 'paradox definition.' Using an approach called 'vital experience theories,' TEG mutated, taking on an action titled cracking more devices: a MAKNoever of Kunstlabor. The evaluative, affective, and phenomenological dimensions of experience were linked to semantic dimensions.

The TEG project is not retinal art, but more a 'description of symptoms.' The gallery functions in a very simple way: diverse artists are invited to participate and can transmit their contributions via computer modem or fax at any given time. The gallery viewing spaces can be produced at any chosen place, in an unlimited number. After connecting the cables to the telephone line, this viewing space runs automatically and the program shown is automatically updated through the daily data transmission via telephone line and modem from the main office. Display of the exhibition is irrevocable and appears either on an integrated LCD monitor (LCD panel) or on your own television set, in an array of stills shown one after another, at a rhythm of one image per minute.

F.E. Rakuschan, 1996

Oskar Obereder
studied visual media design at the Hochschule für angewandte Kunst in Vienna. Ran Dead Dog Gallery from 1990-93. Part of the Tausend Meisterwerke team in 1993. Has been operating Silverserver – The Top Adress for Prosumers since 1994. Founding member of Kunstlabor. Lives in Vienna.

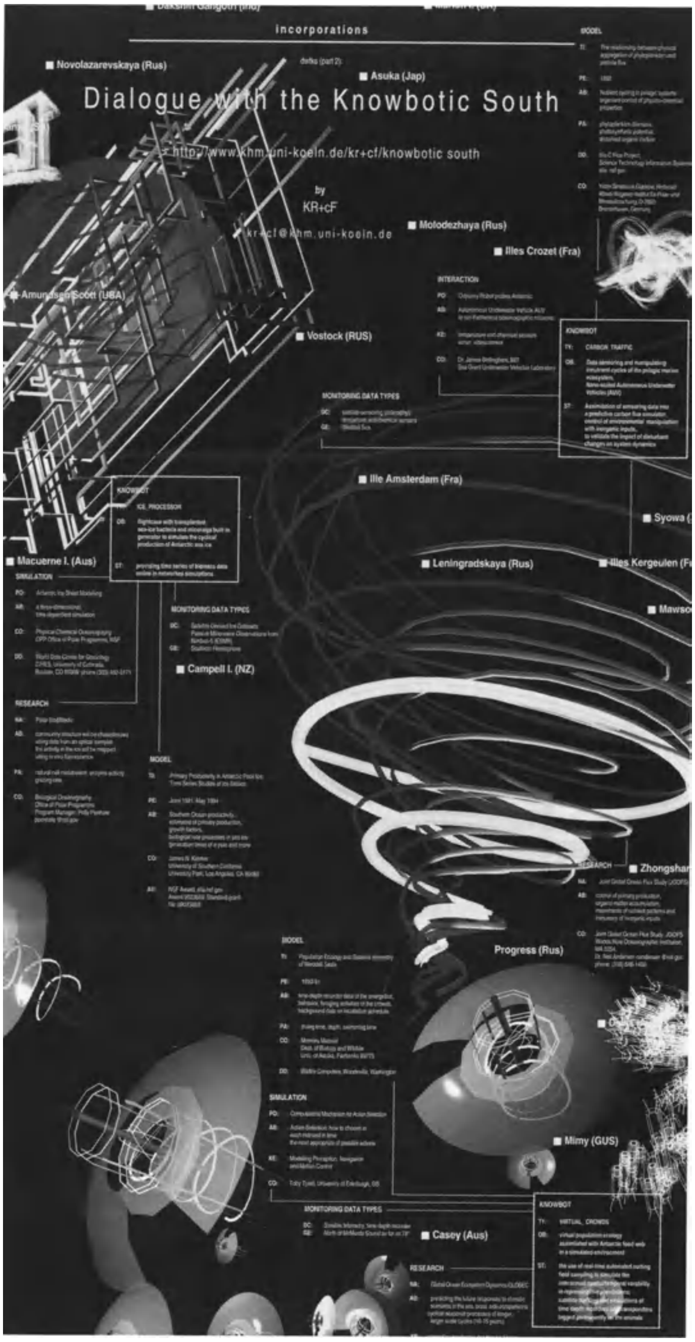
F.E. Rakuschan
Focus on art theory, media studies, essays, reviews, catalog texts, text objects in publications both in Austria and abroad, videos, lectures. Part of the Tausend Meisterwerke team in 1993. Member of Kunstlabor since 1994. Recipient of the 1994 Förderungspreis für Medienkunst. Structure-oriented interventions via the digitALL Forum in 1996. Lives in Vienna.

Franz Xaver
Franz Xaver studied with Peter Weibel in Vienna. Instructor for computer languages, audio-visual production, electronics, and electronic technology until 1992 at the Hochschule für angewandte Kunst in Vienna, as well as communications theory at the Technical University, Graz. Many exhibitions in Austria and abroad, including ars electronica, Linz; Venice Biennial, the Triennial in Milan, the Federal German Kunst- und Ausstellungshalle in Bonn, Telepolis in Luxembourg, and at the Departure Lounge at the Institute for Contemporary Art, New York. Founding member of Kunstlabor.

The Electronic Gallery, intersection of LCD panel and a work by Max Moswitzer

knowbotic research

Dialogue with the Knowbotic South



An exploratory model that appears to consist of scientifically collected and processed data, mock-ups, and simulations, all representing a conceivable reality. Strategies for a dialogue with a changing view of nature based on the information provided by current Antarctic research.

Technotop

Recorded series of measurements depict natural conditions in the form of digitally coded data structures. For the purpose of these transformation processes, Antarctica is surveyed by a formidable array of automatic measuring instruments in the deep sea, in orbit, in pack ice, and in volcanic craters. Installed and maintained by scientists, these instruments, which are extensions of perceptual organs, observe and record natural phenomena. The instruments divide the whole of nature into units of information that can be processed. Their sensory capacities are highly specialized, focused on individual phenomena that are also broken down into fragments of space and time in order to generate information output. Accordingly, this division of nature into fractions only takes into account the technologically perceptible structures of reference nature in the Antarctic.

Extraterritorialized Nature

The large volumes of acquired and corrected data representing Antarctica in our data bases are freely accessible via electronic networks, even to non-scientific users. The result is the digitized telepresence of reference nature in a publicly accessible databank.

Reconstructed Nature

Natural scientists transform extraterritorialized nature into models, formulating functional mathematical equations to reflect effects upon the system as they might occur in reference nature. These models are tested by simulation. Digital measurements fill in for the variables in these equations and are thus reorganized in a context where series of effects resemble processes. Simulation provides a means of reconstructing natural processes, which, in the case of Antarctica, mainly occur on either an infinitely small or large scale of inconceivable depths and complexities. These mathematically interpreted, invisible processes can be projected into the future to generate predictions that allow us to judge the effects of parameter manipulations. Nature becomes a concept.

Computer Aided Nature

The current scientific dialogue increasingly relies on this reconstructed form of nature. Answers are no longer supplied by reference nature via the experiment, but by a medium such as the computer. At the same time, the dialogue is popularized, in the sense that the "computertop" — meaning extraterritorialized nature in all its digitally stored forms (data series, models, simulations) — becomes generally accessible through public data networks. The circle of participants in the dialogue widens. Reconstructed nature detaches itself from its technological synthesizing process. It becomes emancipated, is disjoined from its reference basis, and assumes the role of an autonomous partner in the dialogue, emerging as Computer Aided Nature (CAN).

KR+cF

The idea is to create a Public Knowledge Space in which a potential dialogue about a potential nature can take place. KR+cF devises an infrastructure for this hypothetical space, outlining plans for the development of objects that resemble processes. These 'agents' expose the confrontation with the dynamic complexities of reconstructed nature and attach it to a discourse concerning a potential Computer Aided Nature.

Knowbots

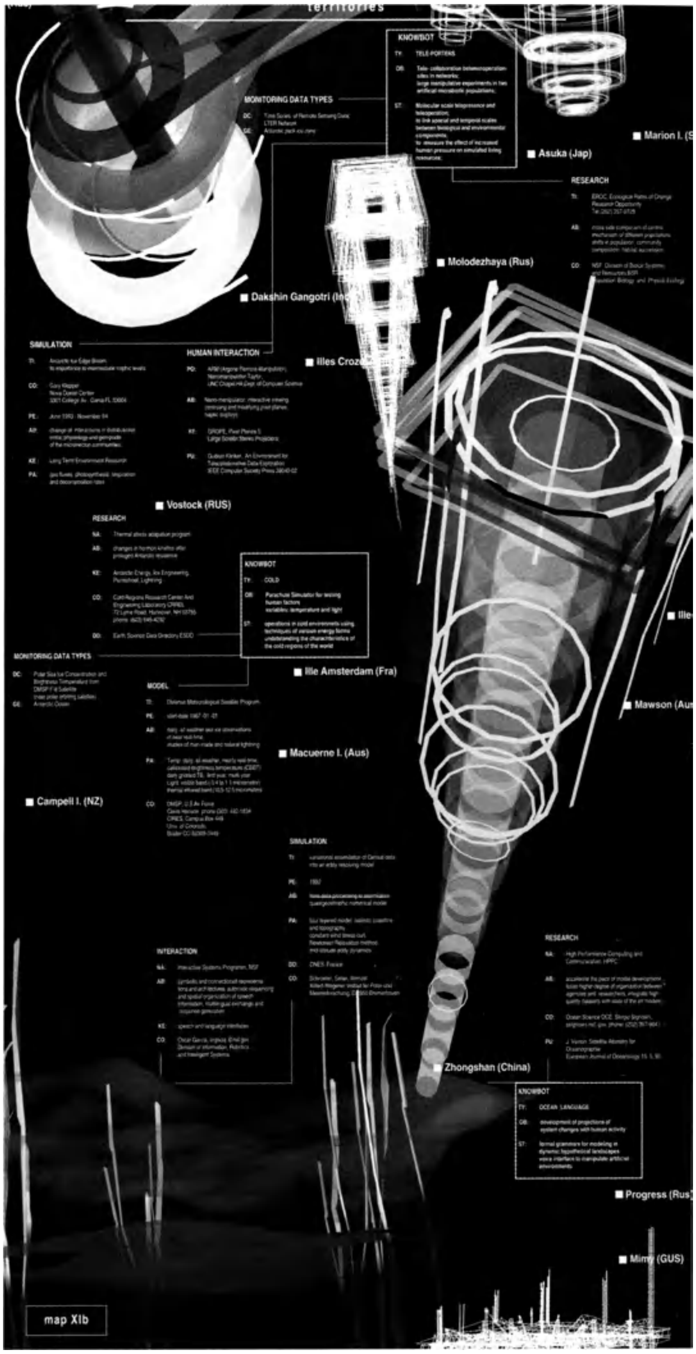
Knowbots embody the strategies that generate this dialogue on hypothetical nature. System effects reconstructed in scientific simulations, assimilated with continuously updated data series, serve as input to the operations of the knowbots. KR+cF combines strategies from the open field of Antarctic research with these operations, which are intended to coordinate a continuously recalculated nature with its potential perceptibility and effectiveness. In this way, knowbots become the immaterial generators of differences and gaps among the extended system effects of Computer Aided Nature.

Public Knowledge Space

An extension of the dialogue is achieved not through a recipe for virtual nature (limited to a perceived illusory construction), but through the interaction with knowbots in aesthetic fields of the Public Knowledge Space. These fields are generated by the tension between the inadequacy of traditional concepts of nature in the face of technological and cultural developments, for one, and the abstract conceivability of a Computer Aided Nature, for another. The result is a confrontation between the experiences of our historical (physical) presence in nature and the (spiritual) freedom prevailing in the Public Knowledge Space. Detachment from the reference nature is a precondition for the emergence of these specific aesthetic fields. The knowbots outlined by KR+cF represent no static formalization. They can be modified as they interact with the participants present in the Public Knowledge Space. For instance, in data networks, Knowbots are mobile in time and space and, thanks to copies, can be present in several locations at once. Processes inside the knowbot can be linked to external interests and contexts.The Public Knowledge Space thus creates a playground for modifying the possibilities (and hence, the formalizations and dynamics) of knowbots as part of an interdisciplinary discourse with a type of hypothetical nature.

Advanced CAN

The extended Computer Aided Nature recombines natural system correlations with specific social, cultural, and aesthetic components, so that, unlike hermetically sealed virtual worlds, it 'lives' through its connection to the real and its effectivity there. This chimerical nature is subject to the same cultural conditioning as our perception of so-called reference nature. It becomes open to economic and political exploitation, operates as a knowledge-generating source, offers the potential for aesthetic experience, and can itself become the object of scientific research. Using current approaches in Antarctic research as its material, KR+cF thus devises a visionary interaction between the actual, the virtual, and the hypothetical.



Christian Hübler, Alexander Tuchacek, et al, *intelligente ambiente – intelligent environment*, Karl Gerbel and Peter Weibel, eds., vol. 1, ars electronica 94 (Linz, 1994) pp. 243-248.

evolution theory system theory game theory

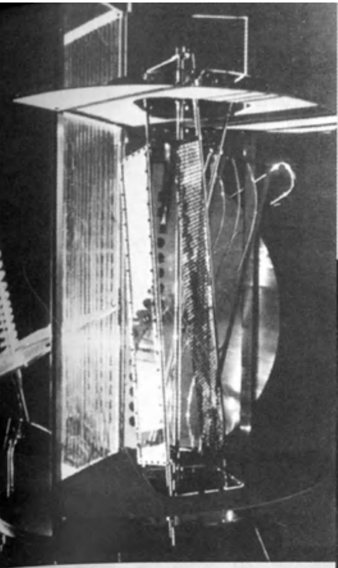
In the process of discovering form, art is not only oriented toward organic nature, but also toward mathematical models of it. Ever since Fibonacci numbers were introduced (see Peter Weibel on Fritz Hartlauer), art has become increasingly involved with numerical models of form growth (see Étienne Béothy's theory of the "golden row," 1919). The models are thus imbued with meaning far beyond the actual realm of biology. In addition, Friedrich Kiesler's design theory is defined in biotechnical terms.

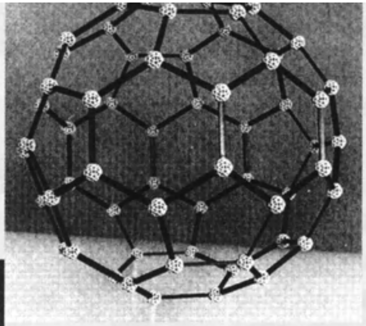
An essential characteristic of living organisms is their systematic organization. Modern systems theory offers a mathematically exact, holistic approach to biological processes, but their philosophical origins are largely forgotten. This is especially true in the case of Ludwig von Bertalanffy, who is considered to be the founder of general systems theory (Veronika Hofer). Raoul H. Francé, whose theories anticipated bionics, could be considered a precursor to systems theory (Franz Pichler). In the area of art, similar ideas are found in ErnőKállai's work. Arthur Koestler, whose concept of holons reveals extremely current references, also enjoyed a popularity comparable with that of Francé's. (Franz Pichler). Philosophically, there is a continuity from systems theory to evolutionary epistemology (Werner Leinfellner), while along the way, anti-empiricist roots have lost some of their significance. The aesthetic reference of systems theory has remained undisputed since its beginnings, allowing us to observe social systems as art and art as a viable system (Christa Sommerer and Laurent Mignonneau). We must differentiate between models and systems that merely abstract biological patterns, and those which use purely formal abstract methods to model social systems, such as game theory.

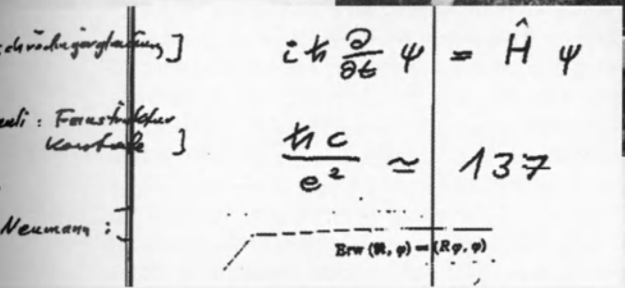
Game theory began as a joint Austrian-Hungarian project (John von Neumann, Oskar Morgenstern, *Theory of Games and Economic Behavior*, 1947). It was based on both the Austrian economic school, which highlighted the concept of use in the economy, and on John von Neumann's essay *Zur Theorie der Gesellschaftsspiele* (On the theory of social games), 1928 (Werner Leinfellner). Game theory observes humans as formal market participants who follow various interests and prefer certain states to others (order of preference), attributing a numerical value to this, the use value. As in most of the physical/chemical systems, market participants strive for a state of equilibrium (Chikako Nakayama). However, there are certain prerequisites that a situation must fulfill to even have a state of equilibrium toward which the market participants can then move (Karl Menger).

Game theory describes the effects on behavior when humans, animals, or automatons behave according to certain rational norms. Theory can then define a social use, precisely when humans do not act in a purely egotistical manner. There are competitive and cooperative models of social behavior, as well as mixed forms of these models. Consequently, one of the pioneers of game theory, John C. Harsanyi, employed extensive ethical and social theoretical considerations (Eckehart Köhler). Game theory, however, reveals important references to evolutionary theory (overview by Werner Leinfellner), artificial intelligence, and evolution in the molecular world (Peter Schuster). It shows that the relationship between genetic information and biological meaning is extremely complex. There are many coincidences, a great number of games, which remain evolutionarily neutral. Life can be played and re-played (Karl Sigmund).

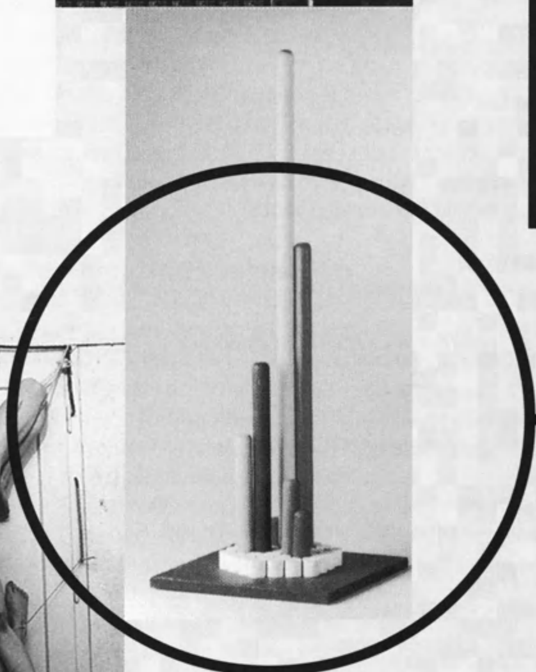
As far as evolution is concerned, artists (Dóra Maurer, etc.) are particularly inspired by the notion of chance (László Beke). Thus the view shifts from result to process, as the discoverer of vitamin C, Albert Szent-Györgi, emphasizes in an interview.

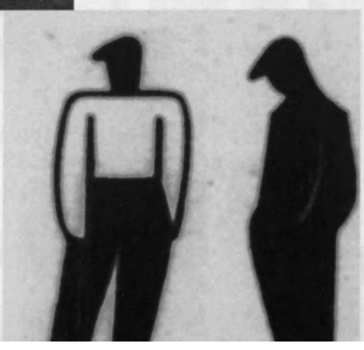





$i\hbar \frac{\partial}{\partial t}\psi = \hat{H}\psi$
$\frac{\hbar c}{e^2} \simeq 137$
Neumann :
Erw (R, φ) = (Rφ, φ)

6





6

evolution theory
system theory
game theory

6

Franz Pichler

The Contribution of Raoul H. Francé: Biocentric Modeling

Without a doubt, biology — the science of living systems — requires the utmost skill in the art of modeling in order to analyze all the different observed phenomena. Biological processes usually have a high degree of complexity, partly because of the large number of components (or parameters) and interacting channels ("network-complexity") involved, and partly because of the enormous computational effort necessary to create the algorithms associated with such processes ("Turing machine complexity"). Systems theory, which is defined as a discipline dealing with the formal part of modeling (in this case, mainly in the engineering disciplines) has not yet succeeded in controlling the complexity of biological modeling efforts.

However, in the past, systems theory has gained by its involvement with biology. First, the contribution of Austrian biologist Ludwig von Bertalanffy, founder of the field of "General Systems Theory," has to be mentioned. Von Bertalanffy, dissatisfied with the leading mechanistic point of view in modeling biological systems, introduced important new concepts to biology, such as the concept of equifinality and open systems, and emphasized the need for general concepts in high-level systems modeling.

This paper will deal with the work of another Austrian biologist, Raoul Heinrich Francé, who is nearly forgotten today. I would like to draw attention to the importance of Francé's work to the field of systems theory.

In his work, Francé (botanist, writer, artist, and polyhistorian, as was Humboldt) emphasized the importance of biological models for other scientific disciplines. His goal was to provide the requisite philosophical orientation. Francé's main achievement was to view nature as a hierarchical system — starting from protoplasma, followed by cell structures, complex organisms, and ultimately, organized social systems. He believed in the harmonic adaptation of individual components, in order to attain what would be considered a holistic optimum. These lines of thought run through his entire œuvre, starting with his first book *Der Wert der Wissenschaft* (The value of science, 1900), in which he defined his position on the question of modeling. He rejected the traditional approaches of his time, on the basis of his own experiences during his academic studies in Budapest. With his approach — which regarded biology as a rich source of modeling concepts — he made an important contribution to the development of scientific knowledge, and Francé deserves to be considered one of the pioneers of modern science. In the following, we will try to prove this for the case of "bionics," a field that Francé envisioned very early on.

Raoul H. Francé, born 1874 in Vienna. Lived in Budapest during his youth and as a student. In 1905 he founded the Biologisches Institut in Munich, and the Deutsche Naturwissenschaftliche Gesellschaft in 1909. His most important works are *Die technischen Leistungen der Pflanzen* (1919), which gave life to the discipline of biotechnics; *München, die Gesetze einer Stadt* (1920), a pioneering book on applied systems analysis; *Bios. Die Gesetze der Welt* (1921), which was the foundation of his objective philosophy. Died in 1943 in Budapest.

R.H. Francé, *Die technischen Leistungen der Pflanzen* (Leipzig: Veit & Comp, 1919)
R.H. Francé, *Das Edaphon* (Stuttgart: Franckh'sche Verlagshandlung, 1913, 2nd edition: 1921)
R.H. Francé, *Plasmatik. Die Wissenschaft der Zukunft* (Stuttgart: W. Seifert, 1923)
R.H. Francé, *Das Buch des Lebens. Ein Weltbild der Gegenwart* (Berlin, Ullstein AG, 1924)

Bionics — Nature as a Teacher in Technology and Engineering

Bionics can be defined as the type of technology that applies the "inventions" made by nature as it evolves to engineering tasks. Examples of bionic approaches of this kind include Leonardo da Vinci's flying apparatus, whose wing construction was based on that of the bat; Otto Lilienthal, who constructed wings based on those of the stork; and Franz Reuleaux, whose kinematic mechanical systems followed the examples of insects. In his 1919 book, *Die technischen Leistungen der Pflanzen* (The technical achievements of plants), Francé presented for the first time a complete definition of the field of bionics (which he called "Biotechnik" — biotechnics) as an independent scientific discipline. In his following books, Francé described the field of bionics for the general public (*Die Pflanze als Erfinder* — Plants as inventors, 1920) and provided many important specific examples and applications. His book *Das Edaphon* (1921) — which deals with the ecology of microorganisms in soil and shows how this knowledge can be applied to produce compost from waste products — is considered his most important contribution.

According to Francé, the reason for the important role of nature's creations in engineering modeling is that nature enforces a selection mechanism over a long period of time to achieve optimal functioning. In his *Das Buch des Lebens* (The doctrine of life, 1924), the work best suited for learning about Francé's "doctrine of life," the following appears in a chapter called "Hochschule der Erfinder" (university of inventors):

> *Optimal engineering design is realized in animals and plants, since any non-optimal performance will suffer in the competition for survival. Such a performance lowers vitality and the power to reproduce, and it will disappear after a long period of time. Since life has existed for such a long time, we are only surrounded by the good — in fact, the exceptionally good — 'engineering designs.'*

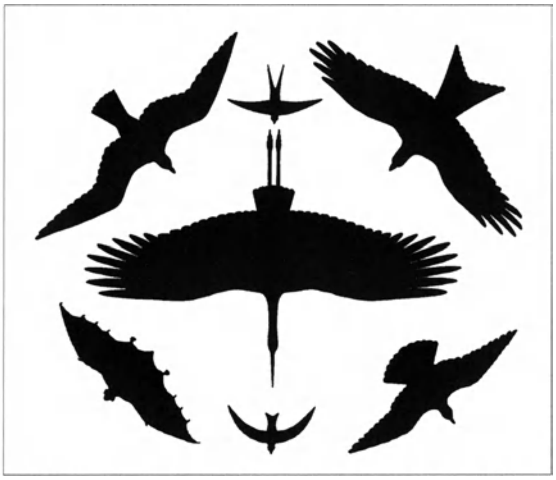
He continues:

> *It is already a certainty that mankind will make bionics — which until now has only been used intuitively — the foundation of civilization.*

Raoul H. Francé at the age of fifty.

To Raoul Francé, it is quite clear that the application of biotechnical procedures and its accompanying industrialization have natural bounds proscribed by the "laws of harmony." In this context, he writes in the

Title page of the work that began biotechnics



Silhouettes of bird wings from various birds and a bat (taken from Lilienthal's *Der Vogelflug als Grundlage der Fliegekunst*)

R.R. Roth, "The Foundation of Bionics," Perspectives in Biology and Medicine (26: 2, winter 1983) 229-242.

O. Lilienthal, *Der Vogelflug als Grundlage der Fliegekunst*, 4th ed. (Munich/Berlin: R. Oldenbourg, 1943)

F. Pichler, "The Concept of Harmony after Raoul H. Francé's and Its Relation to General Systems Science," manuscript for a lecture at the Annual Meeting of the Society for General Systems, San Francisco 1980.

H. Marguerre, *Bionik – Von der Natur lernen* (Berlin/Munich: Siemens Aktiengesellschaft, 1991).

R. Riedl, *Biologie der Erkenntnis* (Berlin/Hamburg: Paul Parey, 1979).

I. Prigogine/I. Stengers, *Dialog mit der Natur* (Munich/Zurich: Piper, 1990).

R. K. Roth, *Raoul H. Francé and the True Doctrine of Life* (ArtBooks Library, 2000).

chapter "Der Sieg des biotechnischen Gedankens" (The success of the bionic approach) about the negative experience of industrialization in the past:

This kind of industrialization and materialistic thinking — where nature, the people's welfare, and the steadfast laws of harmony are completely neglected — this 'industrial dictatorship' causes the degeneration and recession of humble craftsmanship and trade of the past. The balance among people is ruined, life becomes abnormal and unlawful, people become unhappy, and society is thrown into confusion. It has contaminated our whole way of thinking.

In the chapter "Die Zukunftsaufgabe der Industrie" (Future tasks for industry), Francé provides guidelines for a 'permissible industrialization':

So far may industrialization of our country extend: it must choose the kinds of forms that do not disturb the balance between nature and man and the even more important balance among men. Limits to consumption must be established, so that the industry, comparable to craftsmanship of the past, manufactures only necessary goods.

Francé urgently called for research into the application of bionic methods to the chemical industry, which in his time was the source of most environmental pollution.

With his contribution to the field of bionics, Francé can be considered one of the true founders of this field. Although Major Jack E. Steele of the Aerospace Division of the U.S. Air Force has recently brought this field again to public attention, priority for the proper definition of bionics should be given to Raoul Francé. This point of view is also taken by Hans Marguerre in his 1991 book *Bionik – Von der Natur lernen* (Bionics – learning from nature). Marguerre considers Franz Reuleaux (1829-1905), Vitus Graber (1844-1892), and Raoul Francé (1874-1943) to be the intellectual ancestors of bionics. René Roth, a zoologist who is an internationally recognized expert on the work of Raoul Francé, also takes this view.

Plasmatics – The Science of the Future

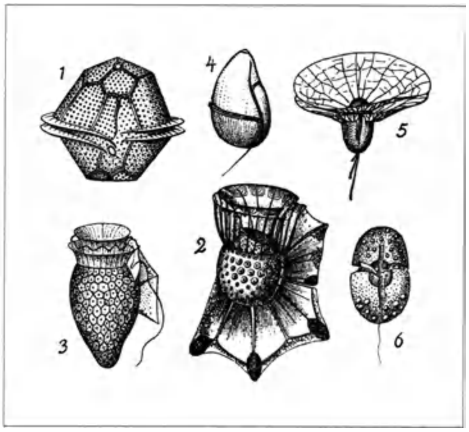
In addition to bionics, as mentioned above, we want to briefly discuss Francé's contribution to the field of plasmatics. As Francé saw it, plasmatics is part of a "metabiology" contributing to the foundations of biology. It provides biology with a framework in which to see models of cells, organs, and living organisms from a common point of view, to "discover" for example, "the true nature of mankind for the humanities," and so create a comparable kind of biology that makes it possible "to view all of the natural and cultural sciences, not dogmatically, but as a whole."

The basis for such a holistic viewpoint is "plasma," the material of life, which makes life possible and leads to "a plasmatic point of view." When hearing of Francé's "plasma," we are tempted — negatively — to think of it as similar to the "ether," which, nineteenth-century physics assumed, filled the interior of the black box of physical space. However, Francé's plasma is better associated with modern developments in microbiology, such as those regarding the creation of macroscopic phenomena by deterministic microscopic mechanisms, as discussed by I. Prigogine and his school. Also, the constructions of the "evolutionary theory of the mind," developed by the Viennese school led by biologist Rupert Riedl, could be seen as closely related to the field of plasmatics as proposed by Francé.

The question of what role plasmatics will play in today's biology is still open. In any case, Francé's concept of plasmatics is a valuable contribution to biology, moving as it does toward a biocentric view of various scientific disciplines.

W. Seifert Verlag, Stuttgart 1926.

Kosmos, Gesellschaft der Naturfreunde, Franckh'sche Verlagshandlung, Stuttgart, 1920



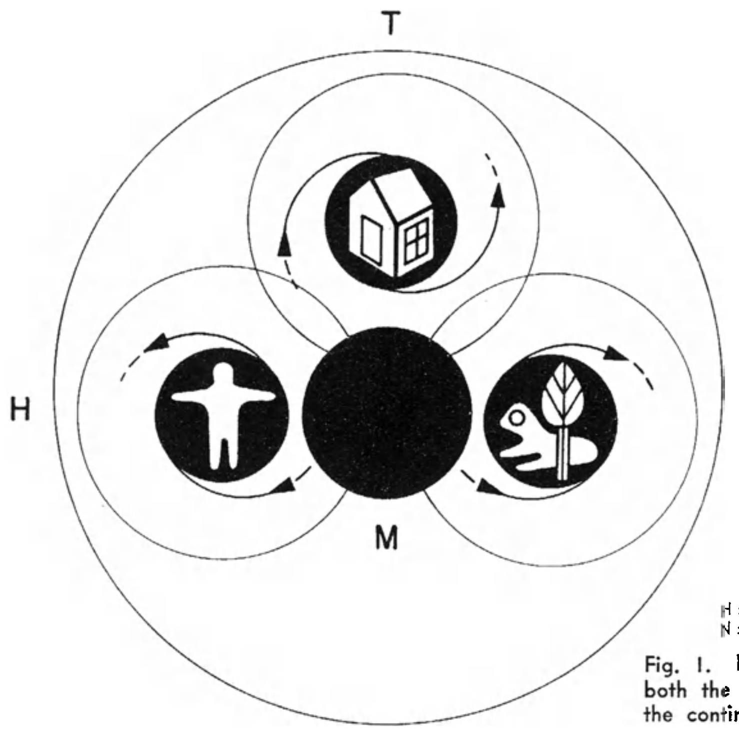
Plankton as natural models of turbine constructions

The Work of Raoul Francé Today

Francé's work was very popular from 1920 to 1930, and his numerous books (we should specifically mention the volumes published by Kosmos) were read by many people. However, his books before and after this very successful period are also remarkable. With its more than one thousand pages, *Die Alpen* (The alps, 1902) is unique to its kind; the edition of eight volumes of *Das Leben der Pflanzen* (Life of the plants), where Francé himself is the author of the first four volumes, is a masterpiece. This work has also been correctly called the "plant Brehm," in comparison with Brehm's famous zoological work. It is still considered an important compendium for the ecology of plants. Many of Francé's books have gone through several editions. As regards the bionic method, Francé's most important contributions are *Das Edaphon* (1959 and 1982), and the popular science volumes, *Die Welt der Tiere* (The world of animals, 1968) and *Die Welt der Pflanzen* (The world of plants, 1969). Francé's wife, the writer Annie Francé-Harrar, continued the work of her husband in her many books. René Roth, zoologist and professor emeritus at the University of Ontario in London, Ontario, is the curator of Francé's legacy. It can be hoped that Francé's many original notes and sketchbooks with their beautiful drawings and paintings (unfortunately, this paper could not deal with Francé's artistic talents, as well) will finally find a permanent place in a public library or institution in Austria, Germany, or Hungary, the countries in which Francé lived. Professor Roth is today by far the most knowledgeable expert on Francé and his work. In 1993 on the occasion of the fiftieth anniversary of Francé's death, I organized an international symposium in Salzburg, Austria, where Professor Roth and other participants from Hungary, Austria, and Germany presented lectures.

Raoul Francé was certainly one of the few scientists who, in the tradition of Alexander von Humboldt, possessed a complete polyhistorical knowledge and whose scientific work at the same time contributed to solutions for important problems of his time. The work of Raoul Francé is still important today to those who take a biologically centered approach to modeling.

Franz Pichler, born 1936 in Salzburg. Education in telecommunication (Graz, 1954) and mathematics (PhD. Innsbruck, 1967). Professor for systems theory in the field of computer science at the Johannes Kepler University in Linz since 1973. Visiting professorships (University of Maryland 1970; SUNY Binghamton 1975/76, 1982/83). Head of the Institute of Systems Theory and Simulation at the Johannes Kepler University in Linz. Along with Werner Schimanovich and Roberto Moreno-Diaz, Pichler has organized regular symposia on the topic of CAST (computer-supported systems theory) in Austria and Spain. Lives in Linz.



ON CORREA

DEFINITION AND TEST

by FREDERICK J. KIESLER

Director, Laboratory of Design-Correlation
Columbia School of Architecture

H = Human environment
N = Natural environment
T = Technological environment
M = Man—Heredity

Fig. 1. Man = heredity + environment. This diagram expresses both the continual action of the total environment on man and the continual interaction of its constituent parts on one another.

In this paper* I propose to show that the perennial** crisis in architectural history is due to the perennial lack of a science dealing with the fundamental laws which seem to govern *man as a nucleus of forces;* that until we develop and apply such a science to the field of building design, it will continue to exist as a series of disparate, overspecialized, and unevenly distributed products; and that only such a new science can eliminate the arbitrary divisions of architecture into: Art, Technology, and Economy, and make architecture a socially constructive factor in man's daily activities.

Today we face the task of formulating the *general* laws of the foundations that underly the many specialized sciences, not in terms of metaphysics (such as religion or philosophy) but in terms of work-energies; and the *specific* task of formulating those that govern building design. But the two are intimately related and we in the building field cannot solve our special problems without comprehension of the foundations of such part-sciences, e.g. physics, chemistry, biology, etc. Thus, it would seem imperative that we summarize some of the concepts of modern science and investigate their validity for our specific problem.

Concepts of sciences and the building designer

Man is born in evolution of hereditary trends. He is the nucleus of forces which act upon him, and upon which he acts. Forces are energies. We assume, with contemporary science, that they are of an electromagnetic nature. The interrelation of organic and inorganic matter is a mutual bombardment of energies which have two characteristics: those of integration and those of disintegration.

By means of gravitation, electricity generates energy into solids of visible matter. This is integration. By magnetism and radiation, electricity degenerates energy into tenuous, invisible matter. This is disintegration.

If this general principle of anabolic and catabolic energies were the sole principle of existence, we would have a static, unchanging world. But these two forces (positive and negative) interchange through physico-chemical reactions, one force striving always for a preponderance over the other. In this way *variations* are constantly created; and in this process of creation, new nuclear concepts and new environments are in continual formation.

Reality and form

The mutual biological interdependence of organisms is, in the final analysis, the result of the primary demands of all creatures: proper food, habitat, reproduction, defense against inimical forces. Life is an expression of the cooperation, jostling, and strife of individual with individual, and of species with species, for these primary needs.

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*In an earlier manuscript of Mr. Kiesler's ("From Architecture to Life," for Brewer, Warren and Putnam, 1930) the groundwork of this paper was laid; it was first read in approximately its present form at a Symposium on Science and Design held by the Alumnae Assocaition of the Massachusetts Institute of Technology, June 6, 1938; this is its first appearance in print.—Ed.
**See Index.

LISM AND BIOTECHNIQUE

OF A NEW APPROACH TO BUILDING DESIGN

The visible result of these activating forces is usually called *matter* and constitutes what is commonly understood as reality. The reason for this superficial interpretation of reality lies in the limitation of man's senses in relation to the forces of the universe. For matter is only one of the expressions of Reality, and not reality itself. If matter alone were reality, life would be static.

What we call "forms," whether they are natural or artificial, are only the visible trading posts of integrating and disintegrating forces mutating at low rates of speed. Reality consists of these two categories of forces which inter-act constantly in visible and invisible configurations (Fig. 2). *This exchange of inter-acting forces I call* CO-REALITY, *and the science of the laws of interrelationships,* CORREALISM. *The term "correalism" expresses the dynamics of continual interaction between man and his natural and technological environments.*

Natural, social, and technological heredity

Biology has divided these forces into two main categories: Heredity and Environment. Man had to evolve a method for dealing with the effects of these overwhelming forces upon himself. For this purpose he created technological environment to help him in his physical survival even within the short span of the age-potential of his own species. This is made more difficult because man is biologically unfit to transmit his experiences to his offspring: each child has to begin anew its adaptations to nature. In short: contrary to prevailing belief, acquired traits and habits of parents can not be transmuted into the make-up of body cells and, by way of procreation, given to their children.*

By providing unchangeable genes within the germ-cells *Nature* has safeguarded herself from man interfering fundamentally with her aims, whatever they may be. This "sealed order" of the germ cell contains nature's will which man can influence *during his own life-time, but not beyond that.* This places a deep responsibility upon those who "design" technological environment, because the restriction of its application to only *one* life-span makes it so much more needed as part of man's defense-mechanism. It appears, then, that the only human experiences that can be inherited by children are those of customs and habits by way of: training and education, thus "social heredity" is the only tool man can rely upon. Just as all living organisms are generated through their own species from a long chain of generations, so do ideologies or man-made objects generate from a long line of older ideologies or objects of similar functions. Thus a contemporary chair, for instance, is the product of many generations of other tools for man to rest his body in fatigue. This is heredity in technology transmitted through education.

What is technological environment?

When the biologist speaks of environment, he invariably means the geographical and animal environment. This definition is perhaps accurate for all creatures except man. For man alone has developed a third environment: a *technological* one which has been his steady companion from his very inception. This technological environment, from "shirts to shelter," has become one of the constituent parts of his total environment. Thus, the classification of environment becomes three- instead of two-fold, as in Fig. 1:

1. natural environment
2. human environment
3. technological environment

*The part of Darwin's theory which stated that *"acquired characteristics are inheritable"* has been disproven. (August Weissmann, 1880.) Thomas H. Morgan: ". . . the belief in the inheritance of acquired characteristics is not based on scientific evidence but on the very human desire to pass on one's acquisitions to one's children."

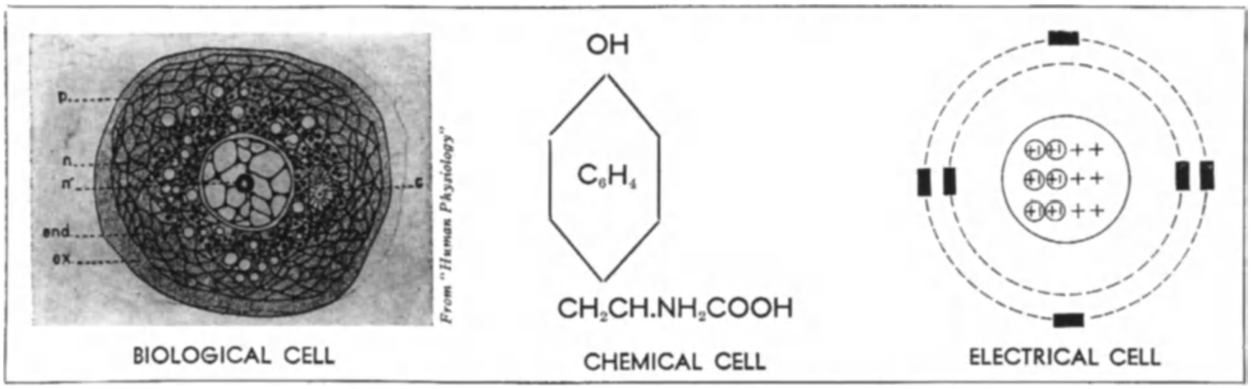

Fig. 2—The nuclear concept of production as expressed in three of the sciences. Note that though the forces involved are expressed in different terms, their basic organization is similar. Technological design must also be seen in the light of a nuclear concept.

Dieter Bogner (ed.), *Friedrich Kiesler. Architekt, Maler, Bildhauer 1890-1965*, Löcker Verlag, Vienna 1988, p. 92f.

6

Veronika Hofer

Ludwig von Bertalanffy
Theoretical Biologist and Founder of the General System Theory

Ludwig von Bertalanffy, born 1901 in Atzgersdorf near Vienna. Studied art history, archeology, philosophy, and biology (two semesters) at the universities of Innsbruck and Vienna, where he became a student of Moritz Schlick. Doctorate, 1926. In 1934 habilitation with his thesis "Theoretische Biologie", vol 1. Rockefeller Fellow at the University of Chicago, 1937/38 (working there with the Russian physicist Nicolaus Rashevsky). During the National Socialist regime in Austria and after the end of the war, professor at the Department of Zoology, University of Vienna, 1939-1948, and had therefore in 1949 to emigrate to Canada. Professor of Biology and Director of Research at the Faculty of Medicine, University of Ottawa. Professor for Theoretical Psychology at the University of Alberta, Edmonton, Canada, 1966-69. Professor at the Center for Theoretical Biology at the State University of New York, Buffalo. With his scientific, theoretic strategy of "scientific vitality," he selected a standpoint that sought to connect natural philosophy with the precise demands of physics. With his *General System Theory*, 1968), von Bertalanffy went further with his dream of a universal holistic theory. Died in Buffalo 1972.

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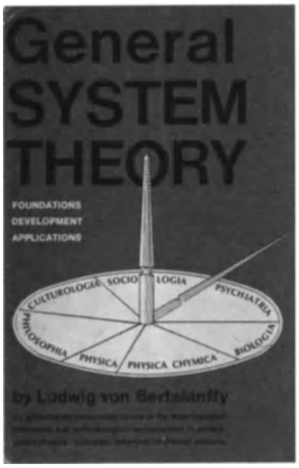
L. v. Bertalanffy, *Theoretische Biologie, vol. 1* (Berlin: 1932)
L. v. Bertalanffy, *Das biologische Weltbild. Die Stellung des Lebens in Natur und Wissenschaft* (Bern: 1949; reprint: Böhlau, 1990)
L. v. Bertalanffy, *Biophysik des Fließgleichgewichts. Einführung in die Physik offener Systeme und ihrer Anwendung in der Biologie* (Braunschweig: 1953)



New York, 1968

The name Ludwig von Bertalanffy is connected with a phase in the history of holistic theories of nature that is characterized as much by the beginning of a scientific approach to ecology as by a change in the attitude toward environmental relations. Von Bertalanffy applied this new thinking to the concept of the organism and emphatically anchored the aspect of the relationship between system and environment in theoretical biology. Furthermore, with the general system theory, he worked out a framework that was (and still is) considered to be the new paradigm in non-physical sciences. The intended goal of this approach is to analyze the qualities and categories that any complex system has, independent of its concrete content. In this framework of thought, every organized complex whose parts are interrelated — regardless of what type of parts they are and how they are interrelated — is considered to be a system.

Von Bertalanffy wanted to create a formal universal theory that would juxtapose an analytical understanding of the world with an image of the world made up of complex entities. These system complexes or totalities maintain themselves through the interactions of their elements and thus form a coherence of structure and function. Von Bertalanffy tried to develop and generalize this concept of systems, initially developed in biology, into a strictly formal science of systems. As a founding member of the Society for General Research, founded in 1954 in the U.S., along with scientists such as Kenneth Boulding and Anatol Rapoport, von Bertalanffy tried to set this approach in motion. In generously drawn analogies especially concerning disciplines such as psychiatry, psychology, sociology, and biology, they worked out the formal attributes of structures and examined their comparability. This interdisciplinary work method corresponded to von Bertalanffy's favorite idea: inclusion of areas that previously could not be formalized into the system theory, like a mathesis universalis. The system theory approach originated in the tradition of natural philosophy. After World War I, holistic thought underwent an ideologically induced transformation. Rapid societal changes, under the pressure of an increasingly internationalized economy, seemed to threaten the individual with total isolation. An organic image of society promised protection from detachment, from being crushed by the impenetrable dynamics of economics. The whole can be interpreted as a protective entity that assigns social roles to its parts. Von Bertalanffy's system theory resulted from this historical situation, with its proliferation of conservative social concepts. His notion of the whole was solidly anchored in a concept of an orderly world, which views nature as an allegory for harmony and stability, whose secrets are expressed in formal, balanced relationships.

Von Bertalanffy constructed his theory of biology on a new holistic notion of life, which was most concentratively articulated in system theory's definition of an organism as an open system. "Living beings are hierarchically organized, open systems of mostly organic connections resulting from mathematical theory."[1] His fundamental concern — formulating principles of laws for the arrangement and organization of living systems — is contained in this new notion of the organism. One of the principles is articulated by the term *Fließgleichgewicht* (floating balance) which describes a state independent of time, produced by a permanent exchange of matter, energy, and information with the environment. The open system is in a dynamic balance of continuous import and export that can support a continuous construction and deconstruction within the system. In creating the notions of "open system" and "floating balance," von Bertalanffy has provided a general model for reflecting upon and explaining characteristic organic behavior such as "equifinality" (independence from initial conditions, which allows the system to attain a final reproductive state) and the increase in stability and order. Contrary to closed chemical systems, the entropy of an open system can be negative. This

1. Ludwig von Bertalanffy, "Die Biophysik offener Systeme," Naturwissenschaftliche Rundschau (18: 1965) 467-469.

accounts not only for the irreversible process of evolution so characteristic of life, but also for the maintenance of and increase in the degree of organization within the organic system. The capacity of the open system organism to attract negative entropy from its environment explains the behavior of organisms that apparently contradicts the second law of thermodynamics.

The Critique of System Theory

A characteristic that goes back to the roots of system theory and its initial synthesis with the philosophy of life, is that ontological aspect where 'life' as an object of nature is quasi-personified and treated as an independent existence, apart from the organisms themselves. This was epistemologically precipitated by von Bertalanffy's search for a theoretical biology that would understand biology as a science of 'life.' Such a theoretical biology would be able to handle its relationship to experimental science at its own will and to subordinate expert knowledge to its meta-theory. Von Bertalanffy tried to establish the common, still currently known general theory of biology, which is a compound of hypotheses, knowledge, and research results — the collected knowledge of experts — as a meta-theory of biology, using a construct of theoretical biology parallel to theoretical physics. Von Bertalanffy was following his intention of pushing biology toward more exactitude by providing it with a theoretical framework, logically clarifying its hypotheses and strengthening the role of mathematics. This was supposed to prepare biology to take over physics' leading role in the natural sciences. Von Bertalanffy's preference for thought grounded in subordination is reflected in the core of his biological theory of science, by defining the hierarchically organized succession of procedural elements as constituent for the system. The fundamental concept in system theory is precisely that of hierarchically graded parts whose function is proscribed by the whole in the interest of preserving the whole.

Thanks to its vivid imagery, system theory promised to lead to clearer explanations. Since Ludwig von Bertalanffy always concentrated upon its development as a holistic concept, system theory suggested that it could deliver a simple solution for diverse problems in a variety of domains of the natural sciences and humanities. The attraction of thinking in systems lies in the ever-present promise of creating an intelligible and connected structure out of the unintelligible, the heterogeneous, and the contingent. The fact that conservative or totalitarian societies construe and politically exploit the notion of wholeness as unity or membership in a society is not just an obvious interpretation of the concept, but is hidden in the history of this notion.

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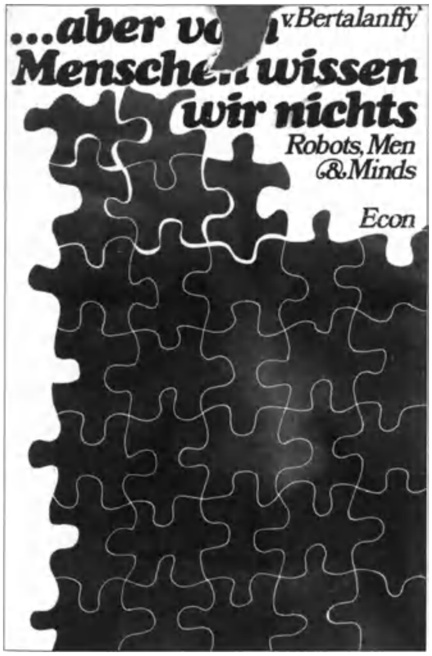

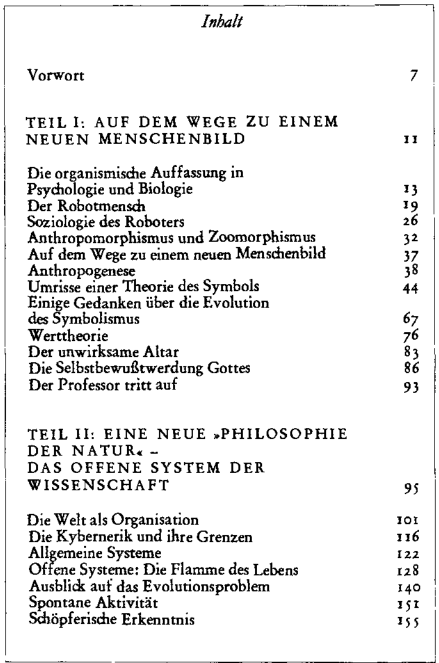
Inhalt

New York, 1967

Veronika Hofer studied history and German in Vienna. At the beginning of the 1990s, she was researched the history of the Universität für Bodencultur (agricultural university) in Vienna. In 1996 she finished her dissertation on von Bertalanffy's early works on system theory. Editor at the University of Brünn. Currently a historian at the historical institute at the University of Vienna. Her fields of interest are history of biology in the twentieth century, biology as a cultural science, and critique of ideology and theory. Lives in Vienna.

6

Franz Pichler

Searching for Arthur Koestler's Holons – a Systems Theory Perspective

Arthur Koestler, born 1905 in Budapest. Studied psychology and electronic technology in Vienna. Foreign correspondent for various European magazines. Fought in the Spanish Civil War; prisoner of war. Later joined the French Foreign Legion, and after fleeing in 1940, joined the British army and became a British citizen. Died in 1983. He is the author of many books, including

Darkness at Noon (1940)
Thieves in the Night (1959)
The Sleepwalkers: A History of Man's Changing Vision of the Universe (1959)
The Ghost in the Machine (1968)
Arrow in the Blue (1969)
The Case of the Midwife Toad (1972)
The Roots of Coincidence (1972)
A Collection of Critical Essays (1978)

Our world in its different appearances has recently become very complex, surpassing all previously experienced dimensions. Today, both science and art have serious difficulties dealing with this complexity using conventional theoretical frameworks, methods, and tools. Science and art urgently need new models and associated modeling methods to meet the challenges. This paper will introduce some promising ideas for the development of modeling methods for complex scientific problems, especially for the field of engineering. The leading role in our discussion will be given to Arthur Koestler and his writings concerning the art of modeling complex systems. Using the framework developed by Koestler and other scientists working in this area of systems theory, it should be possible to define goals for research, which, when pursued, might possibly tame the complexity of the models.

In systems theory as put forth by Arthur Koestler, the concept of a holon plays a leading role. A holon, according to Koestler, is a model component with a Janus face: one side looking "down" and acting as an autonomous system giving directions to "lower" components, while the other side looks "up," serving as a part of a "higher" holon. Holons, in Koestler's sense, are essential components of hierarchical systems, which can perform intelligently. They allow the modeling of complex phenomena in a non-reductionist way. As M. Mesarovic sees it, in a hierarchy consisting of multiple strata (a hierarchically ordered system where every level is a domain-specific abstract version of the overall complex real system), holons are the components used to model parts of the system at different levels. They emerge in this case from the dependent holons in the model of the next lower level. In the case of multistrata hierarchies, the mathematical concept of structural morphisms — used to relate models of different levels to each other — plays an important role. Using this concept, there is a good chance that a rigorous mathematical approach to constructing such models does exist, and that strong, mathematically oriented means for their analysis will be available. According to Mesarovic, hierarchies that are multilayer systems provide a different situation. These are hierarchies that model the overall system, where the components receive 'orders' from components above and transmit 'orders' to components on the next lower layer of the model. When Koestler introduced his concept of a "Self-organizing Open Hierarchical Order" (SOHO) he had a multilayer hierarchy in mind, with holons as its components.

Holons, in Koestler's thinking, are important tools for modeling components of any hierarchical model of a real system with complex behavior. Systems theory, the scientific discipline that provides formal models for solving complex problems in science and engineering, has the task of elaborating the concept of holon and holonic-related models and providing methods and computerized tools for their application.

The following will try to explain Koestler's approach and indicate some ideas for further research.

Arthur Koestler

The Janus Effect

First, we again mention the concept of the Janus-faced nature of a holon, as emphasized by Koestler. This concept assures compactness of a SOHO structure with respect to the vertical coupling of its layers as well as the independence of holons (which are the components) in each layer. Immediately one is confronted here with the question of what happens to the Janus-faced holons in both the uppermost and the lowermost edges of the "holarchy." We believe that such holons must rely a great deal on a point of view connected with 'art' for their function. In order to provide guidance and orientation to the holons below, the highest-level holons need a reference system on which to base their decisions. Since they have to invent this themselves, they are required to participate in an 'artistic' activity, in the broadest sense of the word. The Janus face of those holons cannot usually 'look up' solely by learning how to, but needs a certain talent to build the proper reference system.

On the other hand, the downward-facing Janus face, holons situated on the lowest layer, need a skill comparable to a handicraft in order to realize and integrate the processes that define the lower boundary of the SOHO structure. Again, this skill can be considered a kind of art, which can only be acquired by practical experience. From this point of view, the holons on the upper and lower boundaries of a SOHO structure play an important role and deserve special attention. It is mainly their proper functioning that defines the quality of performance of a SOHO structure. Although such considerations might be regarded as trivial, it might be interesting for readers to construct their own examples. In the organizational structure of a company, the people at the highest management level and the workers on the lowest level are crucial holons in the sense we are discussing, as they realize the input/output processes in the interfaces of a SOHO structure embedded in a market environment.

Following our arguments above, the holons of the middle layers are classified as a type of administrative assistant. The realization of their Janus face does not need the kind of art or skill necessary to the holons on the upper and lower boundaries of a holarchy (SOHO structure). However, this does not make them less important. To avoid bureaucracy, these holons have to perform their Janus-faced function in an intelligent

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Christian Buchard, *Arthur Koestler. ein extremes leben* (Beck, 2004)

manner and must possess a certain autonomy. Furthermore, the holons on intermediate levels are responsible for the self-organizing property of a SOHO structure. Using constraints, they detect the need for restructuring the hierarchical order, including the cancellation of holons and their dependent parts, or the addition of new holons in order to adapt to required changes, as well as to improve performance. Although flat hierarchies with a small number of intermediate levels are often desirable, the complexity that exists in a real system, or is demanded of it, very often requires a certain number of intermediate levels.

The choice of words that we use suggests to the reader the organizational structure of a country, a company, or a governmental administrative division as a valid example of a SOHO structure. However, Koestler's conceptual framework has a much wider domain of application: for example, a living organism, a forest, cells, or a fully automated factory are real systems to which this framework can be applied.

"Enlightenment" of the topmost holons in a SOHO structure (etching by Robert Fludd)

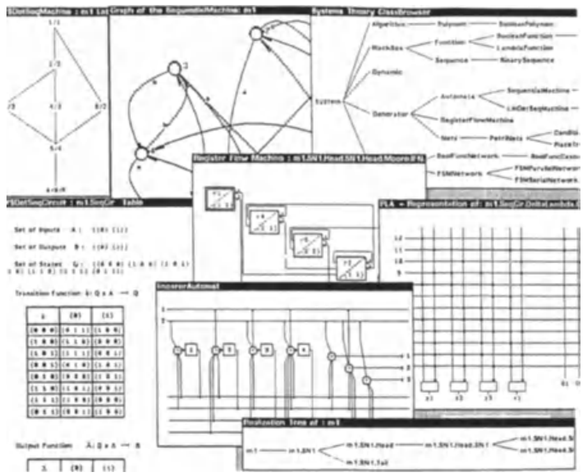
Decomposition

Hierarchies are already models in a decomposed form. The different control and communication channels among the holons constitute the coupling system for the decomposition process. A hierarchy whose components are holons — a holarchy — constitutes a very desirable decomposition of the overall system.

In the case of a "multistrata holarchy" (as Mesarovic/Koestler would say), the overall model is dissected into different levels, where each level models the real system in discussion from a certain domain-specific, abstract point of view. In a domain-specific view of modeling, the model represented by a multistrata hierarchy at a certain level is a refinement of the models of the levels above. Very often this refinement is realized by an accompanying decomposition, so that for a component of a level model, several components are assigned in the refined version of this component at the next lower level. In this case, components of a certain level in a multistrata model have a Janus face, following Koestler's idea. The question is whether the necessary additional features of components of this kind can be found, so that they can be considered holons. The answer could be positive, if we assume that the performance of the model also has a stratified structure, so that every model on every level has to meet certain performance criteria as determined for each particular level. Then intelligent behavior of the level components is required, and self-organization of some kind might be necessary to meet the performance requirements.

Examples are "design hierarchies," as used in the design of microelectronic circuits or in system engineering methods in general. Other examples are "evolution hierarchies," as represented by models of evolving, living systems or also, in some respect, by the evolution of machines such as transportation devices (e.g., cars, railways, airplanes, and ships) or machining tools (e.g., lathes, toolmaking machines, or robots).

Another type of decomposition of a model as discussed above is provided by a multilayered representation of the model. There, the individual components are hierarchically ordered and, depending on the level in the hierarchy, have to fulfill specific functions. Examples of typical applications of multilayered hierarchies are a company's organizational charts, which determine who has responsibility for decision making, supervision, and workload distribution. Although many system theory methods exist for multistrata decomposition of formal models, not so many methods for multilayered decomposition are known. Their existence very often depends



Multilevel models in a microelectronic design process

Multilayered depiction of a pump (image by Boeckler) on an evolutionary process that occurs over a rather long period of time. As mentioned already in the introduction, multilayered hierarchies are, however, appropriate frameworks for a holarchy. The performance of such a multilayered holarchy depends strongly on the degree of autonomy of the individual holons. The extreme case, where the holons' functioning depends completely on the leading holons of the uppermost layer, represents dictatorship with a central organization — enforcing bureaucracy. The other extreme case, in which the individual holons of a multilayered holarchy are completely independent, defines an uncoordinated system that most likely performs in a chaotic manner. To find a balance between these extreme cases is an important goal in the design of complex systems. However, it seems that a mathematical approach to support such a design is not currently available. In practice, this results, for example, in permanently changing constructs of socio-economic systems that depend on the political orientation of the decision-makers. In the case where the upper holons of the holarchy emphasize the free market, they trust that self-organization will eventually bring the system into the desired balance. In many practical cases, this might not happen during the envisaged time period and the goal is not reached. On the other hand, a completely planned and controlled market always runs the risk that certain holons or clusters of holons of the hierarchy will not function as planned and therefore will not contribute to the desired balance.

Rules and Strategies

Koestler explicitly defines what he means by the "Janus-faced property" of a holon in the SOHO structure. When facing downward, a holon represents a quasi-autonomous whole (the tendency to assert itself), so that the dependent holons on the next level have no need to couple their input- and output channels to other holons in order to perform their main function. On the other hand, when facing upward, a holon integrates its functions into an existing or developing whole (the ability to integrate). In the case of living systems, Koestler points out that in adult holons, the tendency to assert itself is realized through the emphasis of instinct-based rituals, as well as by stereotypical thinking that originates in past experience. The ability to integrate is supported by the ability of the holon to creatively adapt to the new needs of the associated whole.

Sampling and Scanning

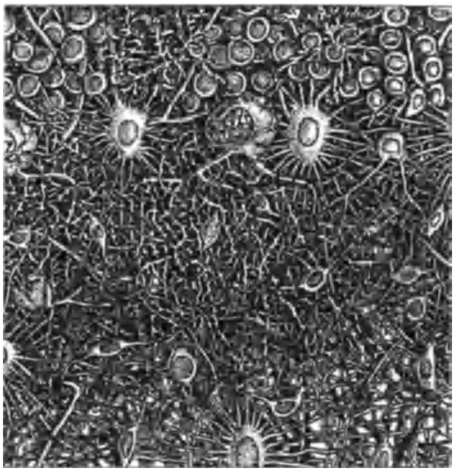
Koestler distinguishes between input hierarchies and output hierarchies. As Koestler sees it, input hierarchies operate by obtaining an abstraction or generalization represented by signals and states of holons on upper levels from signals and states associated with holons on lower levels. Therefore, the main function of input hierarchies is to compute the emerging properties of a holarchy. Koestler defines output hierarchies, on the other hand, as holarchies that operate in opposition to an input hierarchy. They take signals and states from holons of upper levels and transform them into specific concrete signals and states suitable for the proper operation of holons in the lower levels of a holarchy. Further properties introduced by Koestler in his tractatus sistemicus that specify a SOHO structure have to do with the degree to which a holarchy branches out and its degree of reticulation. Further, he discusses the importance of regulation channels, which take care that signals are transmitted only one step at a time, up or down, within a holarchy. The holons of a SOHO structure have to be balanced between being mechanized and having a certain degree of freedom. Holons on higher levels usually have more freedom for their operation, while holons at lower levels will usually have to follow more mechanized patterns in their operation. Another important property of a SOHO structure concerns its degree of performance between dynamic equilibrium and complete disorder. Dynamic equilibrium is achieved if the holons' tendency to self-assertion and tendency to integrate counterbalance each other. Disorder appears if one of the tendencies dominates the other.

Epilogue

The human brain: will we find Koestler-type holons in it?

With his introduction of the SOHO structure in hierarchical systems, Arthur Koestler has made an important contribution to the field of general systems theory (as L. v. Bertalanffy defined it) and specifically to the subject of hierarchies. The discussion that followed his lecture at the Alpbach Symposium in 1968, which included prominent scientists such as Ludwig von Bertalanffy (Buffalo), Paul A. Weiss (New York), and Viktor E. Frankl (Vienna) praised his attempt to reconcile atomism and holism.

Since Koestler's time, a number of new modeling paradigms have been proposed. Systems theory, the field that looks at the formal structure of such modeling concepts, has the task of exploring these new developments in the available theories for problem solving. In connection with our search for Koestler's holons, the example of artificial neural networks and related constructions deserve primary attention. From a general point of view, such networks are hierarchical systems that form a kind of multilayered model. Its nodes (e.g., an artificial neuron) could be considered holons, in Koestler's sense of the word. After a learning phase, artificial neural networks perform an operation resembling that of Koestler's output hierarchy: as it is transformed by the artificial neural network, an unstructured input signal becomes a well-structured signal that can be classified. However, artificial neural networks, as they are usually defined, are very specific holarchies. Its holons, the artificial neurons, follow simple rules and have only limited power to change those rules. In addition, every artificial neuron has the same operational power, regardless of its associated level. The idea of holons aggregating to form a kind of super holon situated on a higher level does not seem to be supported by existing theory in this case. It is therefore not feasible to model artificial neural networks using the concept of a multistrata hierarchy of some depth. For artificial neural networks, a trivial multistrata decomposition, consisting of a black box to describe the behavior on the uppermost level and the network of artificial neurons on the next lower level, seems therefore the only possibility. The improved artificial neural network model as a type of Koestler holarchy, where the holons have different operational capabilities depending on their associated level, still seems to be a subject of research.

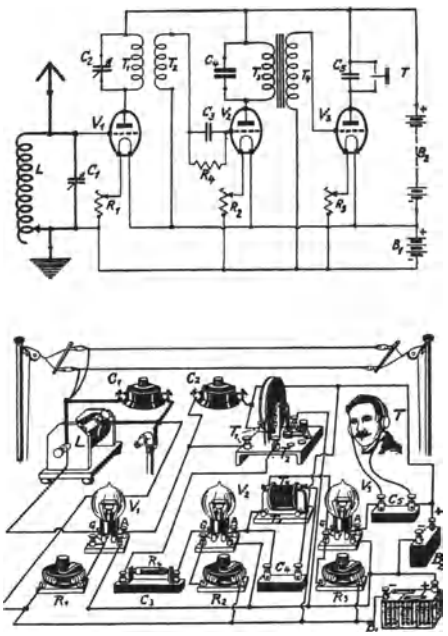


Detailed structure of the human brain as a model for the bionic invention of neural networks (original drawing by R. H. Francé)

Another example is the (human) brain. Holons of a nontrivial kind in the brain, which could be the building blocks for a Koestler holarchy, and which, at the same time, also have a formal systems theory structure, also seem to be unknown. We add here a speculation from a layman's point of view: using specific inputs to the brain (probably well-known to marketing experts), certain holons in the brain holarchy are affected and lead to deterministic response actions (e.g., shopping for a certain product). However, considering the way in which nature determines the evolution of complex systems, one has reason to be skeptical about finding Koestler's holons in any holarchy built by nature. This also applies to the case of the (human) brain.

Another set of examples of actual interest in connection with holarchies consists of the much-praised global networks of people, computers, production units, companies, countries, etc., realized by transport channels for material, energy, and information. From the viewpoint of systems theory, we are advised to use coupling mechanisms for the realization of such channels in a controllable manner, so that the associated functions of upper holons can be predicted. An uncontrolled growth of such channels caused by the unreflected belief in a "free market," with associated mechanisms for evolution, should therefore be considered with skepticism.

The construction of suitable holons, which allow integrating lower holons to achieve a desirable emergent operation, assumes an invention and can therefore be considered an element of art. In other words (pointing to specific examples), surfing the Internet or browsing in a library is only of interest when such an activity gives rise to an innovative idea for the construction of a desired holon. Otherwise, the search for Koestler's holons, even with the best technology, will have no success.



Two-level model of an (historical) radio device: electric circuit and wiring diagrams for the components

References:
M.D. Mesarovic, D. Macko, Y. Takahara, *Theory of Hierarchical, Multilevel Systems* (New York: Academic Press Inc., 1970).

Herbert A. Simon, "The Architecture of Complexity," Proceedings of the American Philosophical Society, 106: 6 (December 1962).

Ernő Kállai

The Hidden Face of Nature

Ernő Kállai, born 1890 in Szalkaháza. Studied at the State Citizens' Teaching School in Budapest, 1910 to 1913. Fought in World War I from 1914 to 1918. Taught from 1919 to 1920. Went to Germany in 1920, became a journalist for German and Hungarian art magazines and editor of *Socialistisches Monatsheft* (the socialist monthly). Chief writer for *Bauhaus magazine* and editor of *Der Kunstnarr* (The fool for art) from 1928 to 1929. Artistic consultant for the Ferdinand Möller gallery in Berlin. Returned to Budapest in 1935. Became a professor at the University of Applied Arts in Budapest in 1946. Died in Budapest in 1954.

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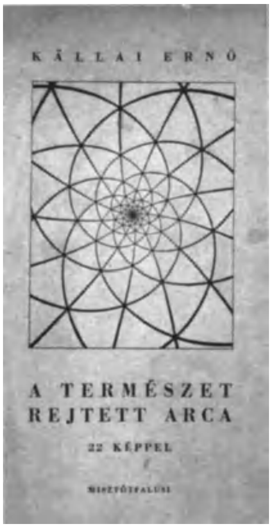
Tanja Frank, ed., *Ernő Kállai, Vision und Formgesetz. Aufsätze über Kunst und Künstler von 1921 bis 1933* (Leipzig/Weimar: Akademie der bildenden Künste der DDR, 1986).
Wulf Herogenrath, *Bauhaus Utopien* (Stuttgart, 1988).



Ernő Kállai, *The Hidden Face of Nature*, 1947

The fascination with depth induces the same emotional unrest in modern art as it does in modern natural sciences. Natural sciences also strive to see through the closely meshed fabric of the divine veil. With the aid of refined analytical methods, photomicrography, X-ray photography, and the film camera, their inquisitive spirit descries and reveals even the deepest secrets of nature. We need only consider the invisible beams that interweave with the earthly realms of our life and the starry sky, beams that have nevertheless been precisely measured and identified. Or, to cite another example, every atom is a microcosm of revolving electrons and comprises the enormous tension of hidden forces within. In the pictures of the astral mists, as in the structure of some shells, on the leaves of certain plants, and in the arrangement of pollen carriers of individual blossoms, we discover the same spiral forms... Today, even modern anatomy has advanced so far as to accept the age-old wisdom that claims that a spiritual power is manifested in nature, i.e., every organic structure contains the fundamental formula of its fully developed form and order of life, even in its germinal form. In the elementarily simple world of germs there unfold, ab ovo, the broadest, most complex perspectives of animate life. The greatest natural scientists and mathematicians of our age are convinced that the form and fate of the universe are determined and dictated by an animate creative force. This underlying structure predominates from crystals and cells to planets and spiraling, eddying astral mists: the same universal rhythm and the same exhilarating power of life rules everywhere. This insight rekindles the supernatural, transcendental correlations that materialism of the previous century sought to disregard with all its might...

Elementary geometric or organic forms are necessary, since they are, by merit of their infinite simplicity, suitable to reveal the common meaning and living context of all things both centrally and individually. Universal, generally valid perspectives can only be merged in infinitely simple forms. We should recall the Byzantine mosaics, the Roman sculptures and miniatures, which, with extremely simple forms, symbolized the infinite, eternal power of the divine world order. With its abstract fantasy, modern art, too, avails itself of simple symbolic forms in order to express its ecumenical vision, a vision that penetrates the hidden core of things. And even if, to a certain extent, it employs elements of representation, then it only does so with the aim of drawing attention to the emotional opposite side of appearances, their supernatural background...

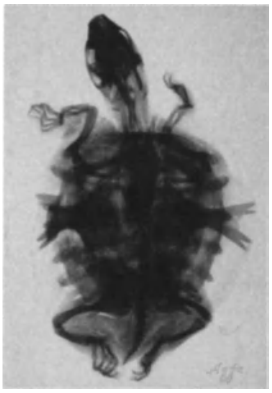
Bioromanticism: at this point I must explain this concept in some detail — a concept I coined fifteen years ago in order to denote the common intellectual perspective and the emotional approach employed in the various movements of modern painting and sculpture. Romantic art of the nineteenth century focused its imaginary world on the human being, emotionally heightening individual character and fate, glorifying the individual as either an active hero or passive victim. The background of this romantic vision of the human being was the historical or mythological past; distant, alien, exotic environments, or landscapes that appealed to the imagination with the stunning power of their snow-capped mountains, oceans, deserts, primeval forests, thunder, and storms. The immeasurably heightened significance of the extraordinary individual, sometimes monumentalized to superhuman status, was brought out against this equally extraordinary and monumental backdrop. In its yearnings, presentiments, and visions, romantic art of the twentieth century tends toward the opposite extreme, having turned away entirely from this proud, three-dimensional sense of identity. The human being of new romanticism feels like a tiny dot, a non-entity amid the animate, living forces that imbue not only his or her organism and consciousness, but also the infinite expanses of the universe...

When confronted with many surrealistic or abstract pictures, we feel as if our eyes are looking into nature's secret workshop, sensing the very heartbeat of life. Again, these paintings are not to be viewed as though the artists were seeking merely to depict microscopic or X-ray photographs, although it cannot be completely ruled out that precisely such things do fire their imagination at times. The human being is a child of nature. Nature lives and works in living, profound tensions, in the inner dynamism and the inner rhythm of the human's organism, even though it may be intimately adjusted to the specific essence and temperament of the human being. This biological legacy, rooted in age-old depths, passed on by an infinite number of predecessors — this uninterrupted, pulsating, natural process of life can be tapped, as it were, and transformed into painterly and sculptural conceptions without, in so transforming, having to resort to the circuitous path of objective representation...

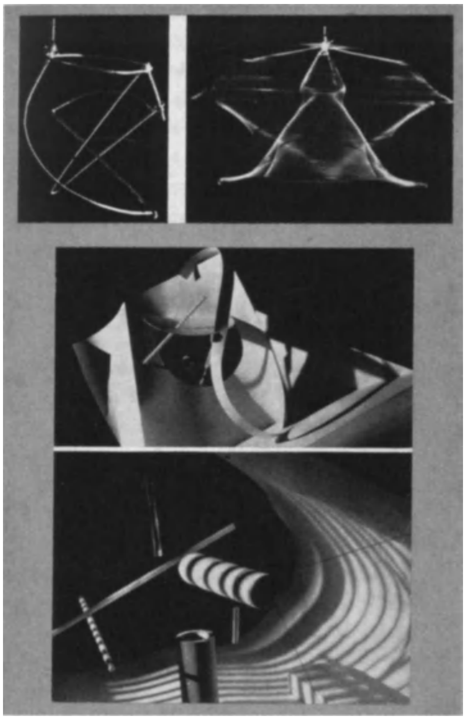
It is not abstract theorizing, but rather the aspiration for intuitive organic expression, when we sometimes discover in the depths of these structures that simple, basic geometric forms are the core and backbone of a composition: forms that constitute a constantly expanding, dynamic order in space around a central point — consummately matching the order that we have just detected in reality.

The human being is not just a *zoon politikon*, not only a political being, as Aristotle maintained. A human being is not only a function and motor of social conditions, but also, in accordance with its roots, an offspring of nature originally related to plants and animals. These biological roots inseparably bind them to the depths of organic nature. But equally fundamental, life-determining correlations link the human being with the world of mathematical laws and geometric forms. The mind, existing among these correlations determined by bios and logos, is capable of scientific discoveries, and the fact that there are scientists who devote their entire lives and complete attention to research does not give fanatic economists or politicians cause for surprise, even when not all scientific research can be exploited for the purpose of industrial production and murderous wars. So why, then, do we expect art to devote itself to social and political practice? We can have no objection to painting or sculpture that depicts man from the perspective of these conditions or indeed with the keen-eyed, concrete objectivity of realism. On the other hand, we must understand and accept that there are artists who give shape to these universal, intellectual aspects determined by bios and logos in their painterly and sculptural creations. In their own way, in their peculiar visual arrangement of two-dimensional and three-dimensional forms, they also contribute substantially to enriching our knowledge of the world by means of new revelations, enhancing our sense of beauty by means of new harmonies. The justification for these visions and their meaning in the roots of reality must also be recognized when their focus is not on the human being, just as we cannot expect science to deal exclusively with anthropology, sociology, and history.

E. Kállai, *A természet rejtett arca* (Budapest: Misztótfalusi publishers, 1947).



Tortoise, X-ray. Modern science illuminates the internal structure of the creature. Objects and materials with rationally conceived, technological tools.



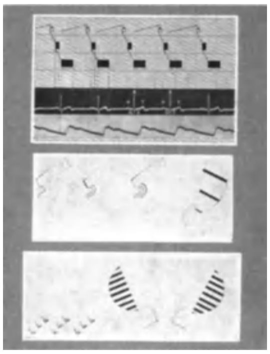
Lásló Moholy-Nagy, experiments at the School of Design in Chicago.
(a) turning sculpture; left, the steel framework; right, the virtual form, whose shape is created as the illuminated structure turns. This recalls physics experiments that shed light on the effects of centrifugal force using a revolving metal tire. As it rotated, the metal tire became a transparent, shimmering sphere.
(b) Abstract design with light
© VBK, Vienna, 2005

Painting – bioromanticism makes us feel the wonderful, inexhaustible pulsation of life flowing deep in the phenomena. (painting by Paul Klee)

New World View

We have arranged this exhibition [*Új világkép* / New world view] so that abstract paintings and sculptures can be viewed next to photographs, technical drawings, blueprints, and scientific charts and diagrams depicting the natural sciences, modern technology, and architecture. Among other things, our intention with this arrangement is to offer an answer to those who deny the relationship between abstract art and real life. This exhibition proves the opposite. Not, of course, in the tradition of realism, which only takes the seemingly objective exterior image or the concrete surface into consideration. In grasping reality, abstract art pushes forward through the outer shell to the core of things. It follows the same path as do the modern natural sciences in pursuing artistic sensory perception: intuition. We have micro and X-ray photographs as well as diagrams next to paintings and sculptures in order to illustrate the intellectual parallels between these pieces and, with the help of scientific images, to teach the observer that nature and reality are not merely objects. Moreover, the observer should become conscious of those deep sources of power and connections that create and maintain the object world and essentially determine its structure, form, and function.

Kázmér Fejér, *Új világkép* (Budapest: Ernst Museum, 1947).



Rhythm in the human being and art
(a) electrocardiogram showing a heartbeat
(b) sections of an abstract film by Swedish artist Viking Eggeling

6

Étienne Béothy

The Theory behind the "Golden Series"

Étienne (István) Béothy, born 1897 in Jászapáti. Studied sculpture and architecture in Budapest. In 1919, he joined up with László Moholy-Nagy and the MA circle. Moved to Paris in 1925. Friendship with August Herbin. Co-founded the Abstraction-Création group in 1933 with Vantongerloo and Herbin. They published six issues, starting in 1932. In 1939, he published his treatment of "La Série d'or," which he had written in 1919. He attempted to arrange visual material according to musical and mathematical principles. In 1946, he and Herbin had an exhibition at the Denise René gallery in Paris. There was a large retrospective of his work at the Maeght gallery in Paris in 1948. In 1951, he, Léger, and Le Corbusier put out a magazine titled Formes et Vie. Founding of the Espace group. Director of the architecture class at the École des Beaux Arts, Paris, 1952-53. Died in 1962 in Paris.

Anne Béothy-Steiner, born 1902 in Siebenbürgen. Studied for four years at the art academy in Budapest. Journeyed to Austria, Germany, and Italy. Moved to Paris in 1927, where she married Étienne Béothy. Friendships with Herbin, Kupka, Vantongerloo.

The problem of proportions focuses on the proportionality of dimensions. The element of proportion is the length measured as a spatial value between characteristic end points. The length measure (segment) can be undivided, i.e., of a simple nature, or divided, i.e., composite. Hence, from certain viewpoints, these characteristic end points constitute the end of the real body or its component parts. The proportionality of undivided segments (length measures) is obtained with the aid of a random geometric progression. The relationship between two length measures (segments) must be seen as a ratio.

If we consider the relationship between segments A and B, it follows that

$$\frac{B}{A} = r \quad \textbf{or} \quad B = A \cdot r$$

If we add a third segment that is to B as B is to A, according to the following principle it follows that

$$C = B \cdot r$$

The equivalence of both ratios creates proportion. We thus obtain the ratio

$$\frac{B}{A} = \frac{C}{B} = r$$

Or A, B, and C are elements of the same geometric progression. The number of the geometric progression is infinite as we can assume any value for these ratios. In visual art, we almost always choose divided segments, and therefore the most important task is to examine the proportionality of divided segments.

With the aid of a few drawings, we obtain a three-dimensional image: the possibility of three-dimensional, solid representation. A substantial deviation of our method from the method of engineers is their use of the metric system, whereas we use the Golden Series and its scale of division as the instrument of our measurements and their representation.

Following these remarks, we will now take a close look at the method of the practical applications of the Golden Series:

1. Let us imagine in our mind's eye an object that aims to achieve a physical or psychological effect, such as a work of craftsmanship or art.

2. We draw a sketch of this object so that its front and side views are projected onto the plane.

3. On the basis of the aforementioned principles, we select the size that is to be the starting value for applying the Golden Series. Starting with this unit, we construct our scale of division. One method of construction that can be used to create random Golden Series is briefly outlined below. Using graph paper, we mark off the same Golden Series on two parallel lines. We connect point 0 of one line with point 1 of the other, continuing in this fashion until every element of one line is connected with the next lower element of the other. We then draw a third parallel line at any distance from the first two. The sequence of oblique lines divides this new line according to the law of the Golden Series. In this way we can mark off the division of any distance on a strip of paper or ruler. This is an awkward construction requiring the greatest accuracy in order to achieve good results.

4. Now, according to this principle — in the characteristic and essential proportionality of the sketch — we look for the relationships, whose simplest formula is the Golden Series.

5. If this division of the draft sketch produces a result that is distinctly approximate to a simple proportional value, we proceed to define the exact dimension more precisely.

6. By pursuing with logical consistency one or more formulae of the divisions that result from the characteristic division of the sketch, we add the secondary divisions to these formulae: we repeat, adapt, and compare them. If we revise the values of the spatial dimensions of the sketch, they are subjected to a process of perfecting. The changes we make to their measurements in the process effectuate a kind of crystallization of the initial rough idea — the art object is invested with the certain character of absolute necessity.

7. With regard to these remarks, it is important to bear in mind a crucial aspect: the changes made do not weaken but rather amplify the functional intentions of the initial, intuitive draft; the aim of the effect or the function is focused on more closely.

8. We will record our results in the form of new drawings that correspond to the above-mentioned method of representative description. With the aid of the dimensions of the main axis, we construct parallelograms of the projected views. We then enter the main points of division, i.e., the maximum and minimum values of the contour and the axis of movement. Their coordinates are entered in the simplest manner, either by marking off the ordinal number on an auxiliary line ending in two arrows, or using the formula of the ordinal numbers corresponding to the spatial values, or we note down these ordinal numbers next to an arrow while the other

threshold value is indicated on the other side of the parallelogram situated in the opposite direction to the arrow, i.e., on the number side.

9. If we wish to plot out an object according to this kind of representative description, we must first specify its size. In view of the fact that geometric representation with the values of the Golden Series is only an abstract method of proportioning, which we can always employ without the initially selected size entailing any change of the formulae, the problem of scaling up and down takes care of itself.

10. Now, as in the sketch, we create a scale of division based upon the dimensions of the object. With the aid of this scale of values, we can understand the signs of geometric representation directly and accurately, applying them to the solid material or handling them when constructing the object.

We will now examine the simultaneous application of Golden Series based upon different units of size. This simultaneous application is necessary when dealing with the proportions of a living being in a momentary pose, where the primary dimensions are based on a different unit than the absolute primary measurements. Let us assume that a person is this living being and is sitting in the momentary pose. Evidently, the fundamental unit of size of the absolute human proportions — the height of the person standing — differs from the unit of size of the current proportions in a particular pose — the height of the person sitting.

Let me cite another case in which different Golden Series have to be applied simultaneously. Such a case exists when we wish to see a completed object with its own proportions in a different spatial dimension. It is now important to create an extremely close relationship between the Golden Series of the new space and that of our object, since the object is determined — indeed often restricted — by the possibility of the new space. In terms of the results, it is essential that the possibilities of one of the two sizes are not fixed. Ideally, it is possible to converge both even at the stage of conception: for example, when dealing with a public square, a monument, a plinth and a statue, or a wall and a relief.

Golden Series that are comprised of different units of size are written differently, for example: 0, 1, 2, 3, 4, ... 0', 1', 2', 3', 4', ... In order to designate the absolute proportions of a living being, it is sufficient to indicate the relation between both Golden Series.

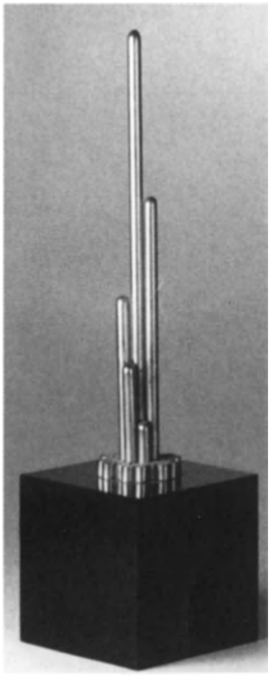
0' (the height of a woman) = 0 - 5, or:
0' (the height of a child) = 2 + 5

In order to construct our Golden Series, we first prepare the various systems of rules and then apply them, depending on whether their formulae need to be checked individually or transposed to the other series.

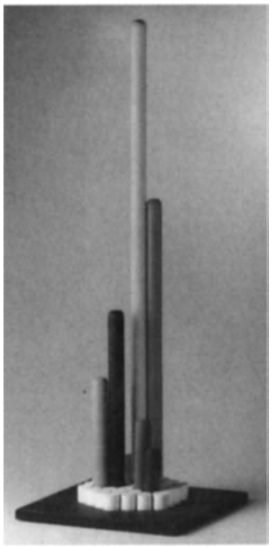
A special case of constituting an object made up of repetitive, uniform elements should also be mentioned — for example, the case of textile fabric. In this case, we work by adding the values of the series. If we have a sufficiently large number of elements, the result is approximated to the harmonizing possibilities of the Golden Series. The most useful natural addition series is the following

... 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ...

La Série d'or, written in 1919, published in 1939, reprinted in *Étienne Béothy. Ein Klassiker der Bildhauerei* (Marl: Glaskasten Museum of Sculpture, 1979).



Étienne Béothy, *Aranysor*, 1919
Golden section, steel, wooden pedestal, 55 × 12.5 × 12.5 cm
© VBK, Vienna, 2005

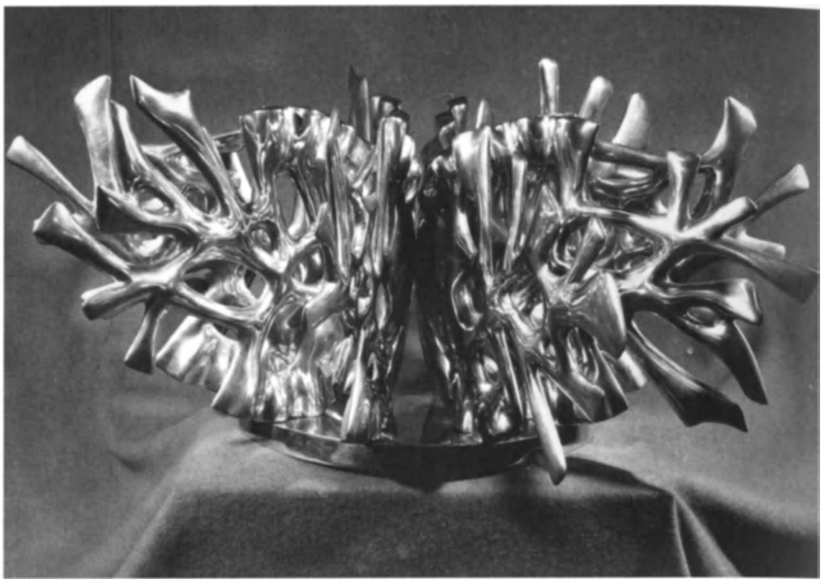


Étienne Béothy, *La Série d'or*, 1949
Wood, paint, 75 × 27 × 27 cm
© VBK, Vienna, 2005

Étienne Béothy

Étienne Hajdú

Étienne Béothy, *Nuclear Form*
Ebony, height: 30 cm
© VBK, Vienna, 2005



Étienne Hajdú, *Convergences*, 1968
Aluminium, 42 × 91 × 90 cm
© VBK, Vienna, 2005

Zoltán Kemény

Zoltán Kemény, born in Banica in 1907. Painter and sculptor, originally trained as a cabinet-maker. In 1924 he attended a School of Arts and Crafts. 1927-30 Academy of Fine Arts (with János Vaszary). 1930-40 he worked as a painter and a master builder in Paris, designed glass windows and studied commercial planning. From 1942 he lived in Zurich working as a fashion-designer. During the war he took up painting again and made reliefs, which (around 1950) were assigned to Art brut, as well as surreal works made from scraps of cloth, glue, and sand. These works were followed by used recombinations of metal cut-outs. His reliefs were exhibited in the Kröller-Müller-Museum in Otterlo in 1963. In 1964 he won the Grand Prix of the Venice Biennial. Died in Zurich in 1965.

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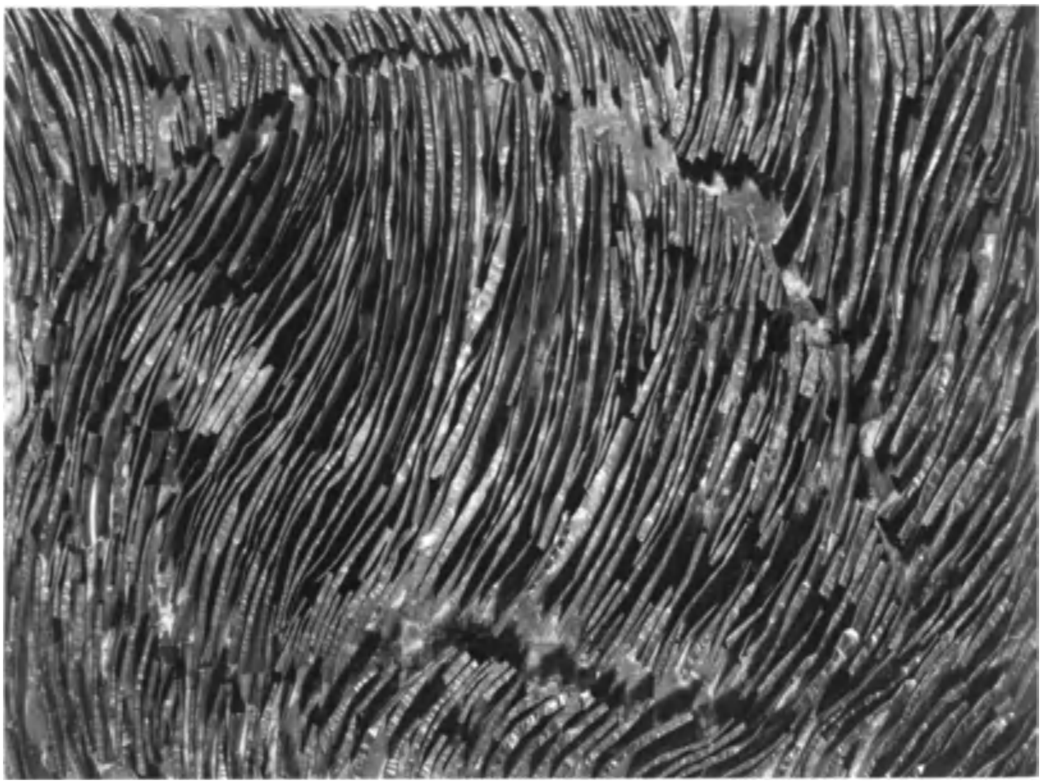
Zoltan Kemeny, les donations de Madeleine Kemeny (Paris: Édition du Centre Pompidou, 2004).



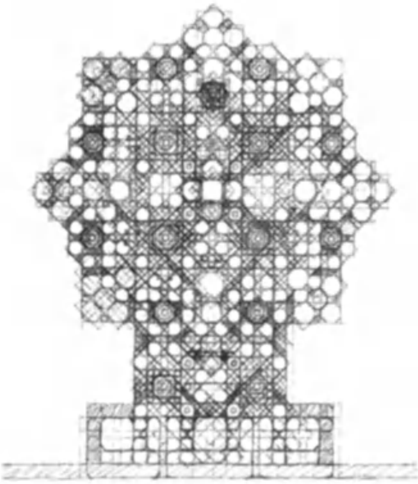
Zoltán Kemény, *Whirling Lines*, 1955
Gold copper, 87 × 112 cm

Peter Weibel

6

Fritz Hartlauer's Contribution to the Theory of Morphogenesis Self-Similarity and Sculpture

Fritz Hartlauer, *Synthetic Work on the Original Cell*, 1957, bronze relief



Fritz Hartlauer, *Original Cell*, 1958, design for St. Margarthen

Fritz Hartlauer
born 1919 in Kumberg/Graz.
Died 1985 in Graz.

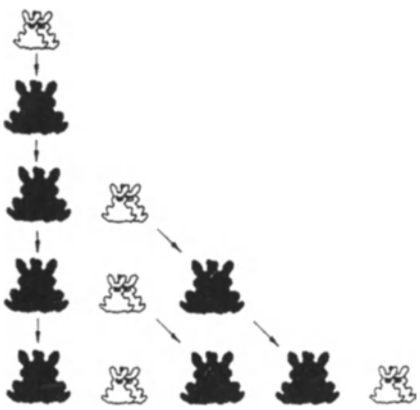
1962 Galerie Wulfengasse 14, Klagenfurt (with K. Prantl)
1966 Galerie nächst St. Stephan, Vienna (with G. Capogrossi, O. Zadkine)
1970 Galerie Moser, Graz (with R. Kriesche)
1975 *Urzelle-Kreuz-Gesetzmäßigkeit*, Neue Galerie, Graz
1991 *Plastiken-Reliefs-Zeichnungen*, Rupertinum, Salzburg
1995 Neue Galerie, Graz

Group shows
1963 Trigon, Neue Galerie, Graz; Salon d'Art Sacré, Musée d'Art Moderne, Paris; Deuxième Salon de Marcoussis, Paris
1964 *Gruppe Forum Stadtpark*, Graz; Rathaus, Zurich; Döttinger Gallery, Munich; Technical University, Stuttgart; Galeries Du Haut Parés, Paris; Galerie nächst St. Stephan, Vienna
1965 Forum Stadtpark, Graz
1967 Expo 67, Montreal
1989 Rupertinum, Salzburg

References:
Alexandra Foitl, *Fritz Hartlauer*, (Graz: Neue Galerie am Landesmuseum Joanneum, 1995).

Fritz Hartlauer was one of the few artists in Austria who — despite the conservative mood in the world of culture after 1945, when all modern art was either banished or compelled to align itself with the model of the human figure — did not emigrate, but went on carrying out his ideas. Originally, Hartlauer was rooted in the tradition of European rationality, which had germinated the theory of symmetry and proportion in art. As an organizing principle of not only art but also physics and biology, symmetry is based upon the proportions existing among the individual parts of a work and the work as a whole. Symmetry, then, not only exists in artistic artifacts or in geometry (e.g., the five regular Platonic solids), but also in organic beings. Symmetry is thus a universal formal principle. It was because of its universal applicability that Hartlauer was so interested in symmetry, for he could use it to forge a link between inorganic structures made of stone or paper and organic beings. Whereas symmetric concepts in art are normally static, Hartlauer began looking for a dynamic, evolutionary principle of symmetry at a very early stage. His aim was not to disrupt perception, a procedure celebrated in Op Art, nor to establish proportions in order to create a harmonious overall impression (golden section), but rather, with the aid of his studies in symmetry and proportions, he sought to unravel a great secret, a great natural law: the growth of forms. The historical model for this notion are the famous Fibonacci numbers, a series of numbers in which each number is the sum of the two previous numbers (1, 1, 2, 3, 5, 8, 13, 21, 34, etc.). According to Fibonacci, this ratio could be used to define the reproduction of plants and animals and the growth of branches and rabbits. It was, then, about the possibility of creating a mathematical formalization of growth processes.

At this point it is necessary to eliminate a misunderstanding. Symmetric concepts are not primarily designed to generate beauty, pleasure, harmony, and order; rather, a dynamic, evolutionary theory of symmetry aims to unravel the laws of life. The famous classical work by D'Arcy Thompson, *On Growth and Form*,[1] published in 1917, embarked on precisely this path. Subsequent authors such as Allan Turing, John von Neumann, John Horton Conway (1988's *Game of Life*,[2] the most famous cellular automaton, describes the growth and death of a population of cells according to relatively simple rules) have also attempted to set up a formal mathematical theory of morphogenesis, i.e., a mathematical model of the emergence and growth of life forms. These scientific programs can, in principle, be reduced to the following simplification: how can paper creatures, i.e., two-dimensional entities, reproduce on a surface. These creatures were termed cellular automata,[3] after Stan Ulam *(On Some Mathematical Problems Connected with Patterns of Growths of Figures)*. John von Neumann developed the underlying theory in his work *Theory of*



Reproduction of rabbits as Fibonacci saw it.

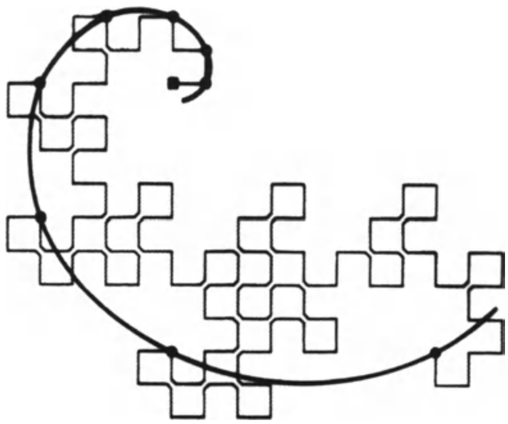
1. D'Arcy Thompson, *On Growth and Form* (1917).
2. E.R. Berlekamp, J.H. Conway, R. Guy, *Winning Ways for Your Mathematical Plays* (New York, 1982); M. Gardner, "Mathematical Games. The Fantastic Combinations of John Conway's New Solitaire Game Life," Scientific American (Oct. 1970) 112-117.
3. See also Stan M. Ulam, *Adventures of a Mathematician* (New York, 1976) and N.G. Cooper, "A Historical Perspective. From Turing and von Neumann to the Present," Los Alamos Science (9: 1983).

4. John von Neumann, *Theory of Selfreproducing Automata*, A.W. Burks, ed. (University of Illinois Press, 1966); Arthur W. Burks, ed., *Essays on Cellular Automata* (University of Illinois Press, 1970).
5. C.H. Langton, ed., *Artificial Life* (Reading, MA: Santa Fé Institute, 1989).
6. P. Prusinkiewicz, A. Lindenmayer, *The Algorithmic Beauty of Plants* (Berlin: Springer, 1991); Manfred Schroeder, *Fraktale, Chaos und Selbstähnlichkeit – Notizen aus dem Paradies der Unendlichkeit!* (Heidelberg/Berlin/Oxford: Spektrum, 1994).

Self-reproducing Automata[4] (1966), in which he demonstrated that a characteristic behavior of organisms — self-reproduction — could also be accomplished by machines. These works on cellular automata, two-dimensional paper creatures, and the self-replication of artificial, cell-like structures led to the development of algorithms at the end of the 1980s, which were able to simulate mathematical processes of growth and evolution, and were thus called genetic algorithms. The mathematical models for the biomorphology of the creation and growth of life forms led to the theory of artificial life.[5]

> *Such an unknown structure, an unknown encountered at all possible levels, I shall call 'core or pointality' (Punkthaftigkeit). Due to its infinite possibilities or forms, this core can always be seen in a completely new way. For ages, different peoples and currents of thought have researched this core, and in the course of time it has had many names and many forms. (Hartlauer)*

And so Hartlauer's thoughts on the growth of forms were correct: a form — a square, for example — could reproduce itself on paper and thus simulate growth. The fact that Hartlauer almost always used the square in his studies on the growth of forms attests to his intuitive understanding of natural laws. For example, he very often employs the notion of self-similarity, when one part resembles the whole, because this is a fundamental symmetry guaranteeing consistent spatial or temporal shifts. He often uses rotational symmetry, which is when a square rotates with a quarter-turn. Mirror symmetry, rotational symmetry, and displacement symmetry are the most common operations with which Hartlauer demonstrates the logarithmic growth of forms, advancing even as far as the realm of fractal geometry, which is created by iteration (repetition of the same) and self-similarity. He also draws upon principles of natural science, periodicity and scale invariance. Squares remain squares: even when they are larger or smaller, they are independent of scale. The occurrence of increasingly finer-grained and smaller repetitions of the same structure is today called fractals.[6] By applying the same mathematical operations on increasingly smaller scales, there evolve, almost inevitably, self-similar structures displaying visual forms that would seem to bear a remarkable resemblance to the chaotic manifestations of nature. Thus, self-similarity ultimately generates deterministic chaos. Like his sculptural objects, Hartlauer's works on paper did not (as is wrongly maintained) force a substitution of natural organic forms with geometrical figures around 1955. Quite the contrary: after 1995, Hartlauer really went about accomplishing the task at hand of portraying natural processes by means of homomorphisms, diffeomorphisms, geometrical operations of self-similarity and differentiability, all of which are necessary to describe the dynamics of a living system in differentiable diversities as the growth of geometrical forms.



Discrete self-similarity, "dragon curve," created by successively folding right-angle bends

Hartlauer, then, is indeed a pioneer, an artist of morphogenesis, who anticipated the conceptual models of the natural sciences by decades ("dynamic systems," "chaos," and "fractal geometry"). His chains of codes of primeval cell systems (after 1958) are not only a unique form of abstraction in Austrian sculpture but also an incredibly early contribution to studies of the laws, creation, and growth of forms in nature.

Christa Sommerer and Laurent Mignonneau

Art as Living System

Sommerer and Mignonneau have been working with interactive computer installations since 1992. Their collaboration has been influenced by the combination of their different fields of interest, such as art, biology, modern installation, performance, music computer graphics, and communication. After joining these interests in 1992, Sommerer and Mignonneau created interactive systems such as *Interactive Plant Growing* (1992/93), *Anthroposcope* (1993), *A-Volve* (1994), *Trans Plant* (1995), *Intro Act* (1995), and *MIC Exploration Space* (1995). Their main interest is in connecting art and living systems, such as real life, artificial life, and virtual life, for the creation of interactive computer installations. Focusing on real-time interaction and evolutionary image processes, those visiting these interactive computer installations become essential parts of the installations themselves by transmitting their individual behavior, emotions, and personality to the visual processes of the works. Images in these installations are no longer static, predetermined, and predictable, but become living systems themselves, representing the minute changes of the viewers, interactions, and perceptions. Thus the process of creating images and the images themselves are not reproducible, as they are continuously changing and evolving, representing the current status quo of the viewers' actions.

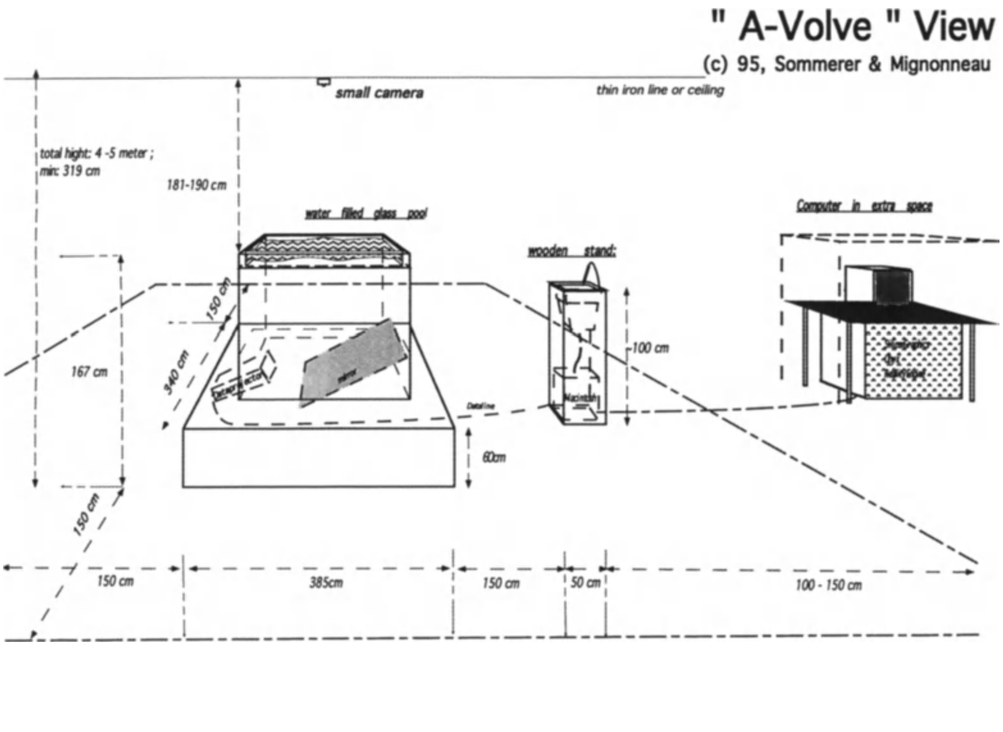
Interactive Works can be divided into Two Different Groups

1. Pre-designed and pre-programmed path of interaction: the authors design most of the CD-ROM and interactive art works so that the viewers have a variety of choices and paths to follow. These paths are controlled by the artistsc design, and exploration of unexpected new paths is, of course, limited.

2. Evolutionary image process linked to interaction: Sommerer and Mignonneau have been working with evolutionary biology, becoming more and more interested in how natural evolution can function as a tool of the creation process.

A random process can constantly provide new results. Used in programming technology to avoid predictable results and systematization, random processing is used for creating variety and variability. Sommerer and Mignonneau are not working with computerized random processing, but with human and organic random processing, which, in fact, we can call personality. Human factors of micro and macro scale — for example, frequency of movement, speed of movement, body tension, human pulse, etc. — can be chosen as randomizing parameters. Transmitted by interface and protocol to the computer and linked in real time to image events on the screen, the parameters guarantee a great variety of unpredictable generated images. Since the system is very flexible, improvisation and feedback become essential for the visitor. The visitor engages in a personal experience that is uniquely linked to his or her personality and will not be performed by any other person in the same way.

Greatest attention is paid to real-time interaction, meaning interaction without the delay of feedback. The design, functionality, and content essentially carry the message and the content of the whole interactive exhibit. Sommerer and Mignonneau have been most interested in the invention of natural interfaces, as they transport the content of life, variation, and personality.



Christa Sommerer
born 1964 in Ohlsdorf, Gmunden. Studied botany, and at the Academy of Fine Arts, Vienna.
Laurent Mignonneau
born 1967 in Angouleme, France. Studied at the academy of fine arts, Angouleme.
The artists have been working together since 1992. From 1991 to 1993, at the Institut für Neue Medien at the Staedelschule in Frankfurt am Main. In 1993, artist-in-residence at the National Center for Supercomputing Applications in Urbana, Illinois. Artist-in-residence at the ICC-NTT, Japan, in 1994. Guest researcher and artist at the ATR Advanced Telecommunications Research Lab, Kyoto, 1995-2001. Associate professor, International Academy of Media Arts and Sciences, Gifu, Japan, until 1997. Since 2001 Associate Professors at IAMAS, Gifu, Japan.

1992 *Junge Szene*, Secession, Vienna
1993 ars electronica '93, Linz
1995 Kwangju Biennale, Korea
1996 *Wunschmaschine Welterfindung*, Kunsthalle, Vienna
1997 Media Museum of the ZKM, Karlsruhe
The Interaction '97, International interactive computer art, Gifu, Japan
1999 Künstlerhaus, Vienna
Biennal du Mercosul, Brasil
2000 Artspace, Sydney
Museum of Modern Art, New York
2001 Microwave Media Art Festival, City Hall, Hong Kong
Bits and Pieces, Hartford Art School, Hartford
2002 *Cibervision 02*, Museo Conde Dugue, Madrid
Situated Realities, Maryland Institute of the Arts, Baltimore
2003 *Science + Fiction*, ZKM, Karslsruhe
Technogeist Festival, Mexico City
2004 DEAF Dutch Electronic Festival, Rotterdam
ArtInteractive Gallery, Cambridge, MA

A-Volve, an Interactive Environment in Real Time, USA/Japan 1994

In an interactive, real-time environment called *A-Volve*, visitors interact with virtual creatures in a glass pool filled with water. These virtual creatures are products of evolutionary rules and are influenced by human creation and decision. Able to design any kind of shape and profile with their finger on a touch screen, visitors will "give birth to" virtual three-dimensional creatures that automatically "come to life" and swim in the real water of the pool. The form of the virtual creature — the way the viewer designed it on the touch screen — determines its movement and behavior. Behavior in space is, so to speak, an expression of form. Form is an expression of adaptation to the environment. Form and movement are closely connected: the creatures' ability to move will decide its viability in the pool. The fittest creature will survive longest and will be able to mate and reproduce. The creatures will compete by trying to get as much energy as possible. Thus predator creatures will hunt for prey creatures, trying to kill them.

The creatures also interact with the visitors, by reacting to the movements of their hands in the water. If a visitor tries to catch a creature, it will try to flee or, if it gets caught, it stays still. Thus the visitor is able to influence the evolution, for example, by protecting prey against predators. If two strong creatures meet, they can create an offspring and a new creature can be born that carries the genetic code of its parents. Mutation and crossover provide a lifelike reproductive mechanism that follows Mendel's genetic laws. The newly born offspring will also react and live in the pool, interacting with visitors and other creatures.

Algorithms developed by Mignonneau and Sommerer ensure smooth, natural movements and the animal-like behavior of the creatures. None of the creatures is pre-calculated: they are all born exclusively in real time through the interaction of the visitors and the interaction of the creatures. Thus a great variety of forms are possible, representing human and evolutionary rules.

Trans Plant, an Interactive Computer Installation, Tokyo Metropolitan Museum of Photography, 1995

Trans Plant is an interactive computer installation, developed in 1995 for the Tokyo Metropolitan Museum of Photography and displayed there for a period of three years. *Trans Plant* was realized at ATR Advanced Telecommunications Research Laboratories, Japan. In *Trans Plant*, visitors enter a semi-circular room and become part of a virtual jungle, which starts to surround them. As visitors step forward into the installation space, they see their reflection on a projection screen in front of them. By walking around freely, without any devices, they soon discover that grass is growing wherever they walk, following each step and movement. When the visitors stop and stand still, trees and bushes grow on the place where they stand. Changing the speed and frequency of movements, the visitor thus creates a biotope, which is full of different plant species. The size, color, and shape of these plants depend solely on the size of the person. Small children will usually create different plants than their parents, but if they extend their arms, the size of the plants can increase. By moving the body slightly backward or forward, the color density can be altered as well. Since all the visitors will create different plants, they will raise their own personal forest, which is an expression of personal attention and feeling for the virtual space. As the growth becomes more and more dense, and the space fills with different plant species, the visitor will become ever more engulfed in this virtual jungle and will penetrate ever more deeply into the growth, appearing as a three-dimensional person in the virtual space.

Werner Leinfellner

Evolutionary Epistemology
A Turning Point in Philosophy?

In the 1980s, Vienna suddenly became the center of a new scientific discipline, evolutionary epistemology, or, as it is referred to in short by its supporters, "EE." Biologists, scientific philosophers, other scientists, and philosophers from a variety of fields met in groups for lively discussions. For example, the Altenberger circle centered around K. Lorenz (Nobel Prize winner for ethology); a circle gathered around biologist R. Riedl, and another around scientific philosophers E. Oeser, F. Wuketits, and others; and scientific philosopher H. Götschi was the middle point of the first outpost. Evolutionary epistemology arose from the clash occurring within the new, dynamic concept of the world and science offered by quantum theory, genetics, the biological theory of evolution, and artificial intelligence, and it soon ran afoul of the static, traditional concept of the world and science as held by philosophical tradition. Since the beginning of the century, traditional philosophy had been suffering under the growing pressure of skyrocketing scientific and technical research. Philosophy, which was mainly concerned with its own history, got into a tight spot. In contrast, evolutionary epistemology focused on the evolutionary dynamics of scientific progress, the analysis of contemporary methods of thought and cognition, and finally the evolutionary dynamics of thought itself. The great impetus emanating from the research of evolutionary biologists and scientific philosophers called for a revision of our perception of human cognition, demanding that we finally see it as one gigantic evolutionary process. This promptly engendered the opposition of all subscribers to traditional philosophy — traditionalist views were too firmly rooted in the dualistic dogma that contrasted the placeless and timeless, the non-empirical spirit and empirical matter, the subject and the object, the analytic and the synthetic. To exaggerate, one might say that once again some three thousand years of traditional philosophy were at stake in the groups discussing evolutionary epistemology.

The astonishing thing was that philosophers from all disciplines, who had previously had little contact with each other, now began to speak to each other in these discussion groups, even if only to defend traditional philosophical positions. Defamatory philosophical catchwords such as "biologicization" and "Darwinization," long believed defunct, began to loom large.

Evolutionary ethics (Wuketits, Leinfellner, Mohr), which explained the change and adaptation of ethical principles to our modern societies, was particularly successful. But one question remained in the background: was the oldest pillar of philosophy — epistemology — still strong enough to carry traditional philosophy. The unvoiced question was whether evolutionary epistemology, as so many sciences before, was about to withdraw from the field of philosophy and become an independent scientific discipline beyond philosophy.

For traditional philosophers — who had once crusaded against the Vienna Circle and empirical neopositivism, brandishing a warning of the impending physicalization of philosophy — the new motive was to combat the "biologization" — indeed, the "Darwinization" — of philosophy. But what they failed to realize was that not only modern physics but modern biology as well had dynamically changed our worldview and our century. Opponents and supporters were attracted to the events of evolutionary epistemology. Success was not long in coming. For the first time since the Vienna Circle, numerous translations of modern Viennese philosophy were published in English and other languages. Naturally enough, evolutionary epistemology also included philosophers from Germany (Vollmer, Mohr, Lütterfelds) and English-speaking countries (Ruse, Bartley, Leinfellner). Equally naturally, many versions of the evolutionary dynamics of cognition and thought were supported and vehemently discussed.

However, evolutionary epistemology did not come to a standstill at the evolutionary dynamization of epistemology. Its greatest achievement is that it focused on what were perhaps the most important questions of our modern culture: what is the significance of the evolutionary dynamics of thought for scientific research and our culture; from what did it evolve; what evolutionary rules does its evolution follow? According to Leinfellner, Seitelberger, and others, the answer to the first question is as follows: human thought and cognition is inseparably, causally linked to the evolution of organic systems such as our sensory organs, which are the outposts of our nervous system and brain. They are also linked to the activity of our brain itself, to language, and our social culture, but not, as Dennett and Searle maintain, exclusively to the neuronal activity of the brain. Any form of dualism — for instance, the separation of the mind and body, or the natural sciences and humanities — is a romantic fiction.

Thus, our concepts, categories, and methods of thought, as well as what we call the "mind," are seen as empirical factors and functions, albeit not in the sense of classical materialism. Scientifically investigating why and how their evolution can influence our cognition, thought, our solutions to conflicts and problems, and our ethical activity became the task of (not only) evolutionary epistemology.

And so evolutionary epistemologists entered into stark conflict with Kant's idealist philosophy, all shades of Platonism, and all flavors of dualism, which features irreconcilable contrasts between the empirical body and non-empirical soul (mind), between hardware and software. However, according to the evolutionary counter-hypothesis of evolutionary epistemology, our methods of thought, the products of thought and

Werner Leinfellner, scientist and philosopher. Professor at Lincoln University (USA) and the University of Graz, and guest professor at the universities of Vienna, Munich, Basel, Boston, Heidelberg, Paderborn, Paris, Taipai, and Canberra. International prizes for research, and one hundred and fifty publications in seven different languages. Founder of the magazine *Theory and Decision*, 1970. Research of instrumental methods in the fields of science, methodology, and the social sciences. He specializes in the theory of biological intelligence and modern social evolutionary theory. Lives in Vienna.

cognition in the sciences, and our culture, too, are all of an empirical nature: they only differ in their functions. They develop by means of evolutionary, adaptive, selective processes under the influence of chance and the attractor's optimization of our individual and social stability. This optimization of evolutionary dynamics as carried out by attractors was scientifically underpinned by evolutionary game theory (Schuster, Sigmund, Leinfellner). This also entailed a rejection of social Darwinism and the Darwinization of thought.

Yet within evolutionary epistemology there are almost as many variations of the evolutionary dynamics of cognition and thought as there are subscribers. One example of this, and at the same time, of the lively and fair discussions, is provided by the discussion of Popper's version. Sir Karl Popper, one of the founding fathers of evolutionary epistemology, declared at a symposium in Vienna in 1986 that his version conflicted with the biological version of Lorenz (incidentally, Popper was a close friend of Lorenz for many years). To him, "evolution" meant simply the "repetition of trial-and-error under the influence of mutation or chance, in search of a better world." In his opinion, it should replace the selective/adaptive processes of biological evolution. Not content to leave it there, Popper suddenly declared to the astonishment of all that he was not an evolutionary epistemologist. Only after the participants and Riedl had shown, with the aid of citations, that Popper himself had founded the discipline, alongside the physicist Mach, the ethologist Lorenz, and the Viennese representatives of evolutionary epistemology, did Popper concede the point with a friendly smile.

To conclude, I would like to briefly outline the Viennese rejection of the prevailing traditional Kantian epistemology. Two rivaling epistemologies battled for their empirical verifiability and their pragmatic utility in a fair, scientific/philosophical conflict. This battle actually ended with evolutionary epistemology withdrawing from the field of philosophy and becoming a science. On the traditional Kantian side, we have the view that although the content of our cognition — our sensory perception — is empirical (in scientific jargon, "a posteriori"), our spatial/temporal forms of viewing and the conceptual forms of thought (categories) that bring forth our cognition are "transcendental" and "a priori," or, in plain English, non-empirical. To make it clear, philosophy students are told that it is the same as baking bread: like the content of thought, the dough is also empirical; its form, however, is determined by the baking tin, which must perforce have existed before the dough did. Paradoxically, Kant's forms of thought are non-empirical. This is where evolutionary epistemologists unmercifully pounce. Forms of thought must be equally empirical: what does not exist cannot have a causal effect on that which exists. Our views of space and time are empirical brain functions that have been formed over the course of the biological, genetic evolution of our brain and our culture. According to Popper, Lorenz, Riedl, Wuketits, and others, they are not transcendental a priori, but rather genetic a priori.

Millennia of biological, cerebro-physiological, and socio-cultural co-evolution (Lumsden and Wilson, Leinfellner) have inscribed codified rules onto the human genome (as if it were an oversized memory) governing the ways in which viewing and thinking are performed by our brain and our socio-cultural behavior. Although these rules restrict our free will, they do not inhibit it in principle. Our ways of viewing and thinking are optimal empirical products of a long, biological, genetic, and cultural evolution. The American-French gene project involving the decoding of the human genome is about to replace the self-knowledge of Socratic philosophy with a scientific self-knowledge. For the American philosophers Searle and P. Churchland, this is becoming a scientific search for a new theory of the human brain and its evolutionary foundations — and not the 1001st repeat of traditional philosophical theories of the mind. In brief, evolutionary epistemology is not Kant plus biology, but rather a completely new beginning.

Unfortunately, it is not possible to go into all the other results of evolutionary epistemology in this paper. But they are detailed in German and English books such as *Die Evolutionäre Erkenntnistheorie*, edited by Rupert Riedl and Franz M. Wuketits, or *Concepts and Approaches in Evolutionary Epistemology: Towards an Evolutionary Theory of Knowledge* by F.M. Wuketitz.

István Kardos

A Television Interview with Albert Szent-Györgyi

Albert Szent-Györgi: Nature is based on universal principles. There is no specific principle referring to a tree, a bush, a flower, or a man. Everything is based on one great, common principle. That means it does not ultimately matter what we study, as long as we are clever enough to understand the principle and structure of life. At one time, at the beginning of my studies, I was concerned with plants, because they seemed to be simpler. They were not, but it seemed so, and I soon came to the conclusion that there are two kinds of plants. One turns brown when it is hurt: for example, everybody knows that a brownish speck appears on the surface of an apple when it falls and hits something. So there are the sorts of plants that turn brown, and this phenomenon meant to me that there is an extraordinary process that can be studied. Because, apart from the thoughts of the scientist, science also has the question of what can be examined by means of experimentation. Turning brown could be examined easily, so I started to study. Later on, it became obvious that it was an interesting process, but it did not lead where I wanted to go. Turning brown is a protective reaction of the cells. After that, I turned to the plants that do not react by turning brown, like oranges or lemons for example. You may drop them or trample on them, but they will never turn brown. I started to study these kinds of plants, and I observed that in terms of certain reactions there was a tiny delay. When a reaction should have happened, there was a delay of one or just a half-a-second. All of my results are owing to the fact that I love life, I live with it, and I observe everything I see. Not every scientist does so, because machines are more and more important. They put the data in a machine, do something, then read the result from the indicator. I always deal with living material, touch it, see it, observe each tiny thing and this leads me down the right path.

Albert Szent-Györgyi, born 1893 in Budapest. Studied biochemistry. Professor at the University of Szeged from 1928 to 1945. Received the Nobel Prize for physiology in 1937. During World War II, he served in important positions in various peace movements. Professor at Budapest University from 1945 to 1947. Lived in the USA from 1947 on as a laboratory scientist at the Marine Biology Institute in Wood Hole. His most important fields of research were cellular aspiration, cell oxidation theory (publication, 1937), muscle biochemistry, bioelectronics, biogenetics, and cancer therapy. Szent-Györgyi is known as the discoverer of vitamin C. Died in 1986 in Wood Hole.

István Kardos: So you are not interested in the result, but the process?

Not the result, but the process! In this case, I saw a short delay, and I knew that a substance had caused it. If a chemist sees a process and knows that a substance causes it, he isolates this substance. This is very important. Isolation means that we find out what this substance is. And it is rather difficult sometimes. It seems to be simple, but it is rather difficult, because there are hundreds of different substances in each cell, usually in a very low concentration, and in order to determine which substance it is, I have to clearly separate it from the other hundred. This process may be long and tiresome sometimes, but this is the task of a chemist. When I started to examine the cause of the delay, I discovered that a reductive substance generates the process, and at the end I was able to crystallize the substance, which later proved to be vitamin C.

Albert Szent-Györgyi

That means, ascorbic acid?

Yes, ascorbic acid.

Was it clear from the beginning that ascorbic acid is identical with vitamin C?

No, it was only clear later. Actually, I was not very interested in vitamins. For a childish reason — I do not know why — I always thought that vitamins were a cook's business. A vitamin is a substance that you have to eat so that you do not become ill.

Its absence causes trouble?

Its absence causes trouble, so you have to eat it. It's the cook's business, not mine, what we eat. I was not really interested in vitamins. It occurred to me that it could be vitamin C. But to prove that, I would have to have started another type of experiment with animals, and I did not feel like doing that. So I put the whole thing away in a drawer. Some years later, a very clever American boy of Hungarian origin visited me and told me that he had spent all his life trying to determine whether something is a vitamin or not. I told him to look at this powder. He examined it and confirmed that was vitamin C. Then the thing suddenly became very significant.

As far as I know, the fate of vitamin C was not so simple.

The fate of vitamin C was not simple at all because then, when we had the substance in its pure form, we had to define what it was. We had to determine its chemical components and synthesize it, in order to produce it chemically. But there was only a small amount of it. I had to go to America because that was the only place where I could find the material from which I could crystallize this substance. After working for a year, I returned with fifteen grams of this material. This was an enormous success; I was really proud of it, but we used these fifteen grams without defining the composition of the material. So that experiment came to an end at that point. I had examined each plant of the world, but I could not find the necessary amount. And then I arrived in Szeged. It is well-known that Szeged is the center of bell pepper cultivation. One evening, my wife served me a bell pepper for dinner. I didn't have an appetite for it, but I didn't dare tell her. I looked at the bell pepper, and I realized that I had never examined this plant. I told my wife that I wouldn't eat it, but that I would take it to the laboratory, and that same night, I discovered that the bell pepper contains a treasure trove of vitamin C. A week later, I had one-and-a-half kilos of vitamin C in my hands, whereas previously I had only been able to extract one thousandth of a gram. I sent the material everywhere, and other experiments confirmed that that was what it really was. Nowadays tons of it are produced. It became a source for good health, a very important medicine.

So that was how an excuse to not eat dinner led to a discovery worthy of a Nobel Prize?

It was more the cowardice of a husband.

But the courage of the scientist was necessary. Professor, you mentioned that when you discovered it, you put it away in a drawer. There were hot debates on vitamins at that time in the world of science. How did the scientific world react when it was proven that ascorbic acid is identical with vitamin C? Was it accepted?

A modern discovery is a discovery because it always conflicts with common knowledge. If it is not controversial, it is merely a small contribution. I have discovered three things in my life, and I have become used to the fact that a new thing will be immediately rejected and declared wrong. At that time, there was a vitamin C expert in London who immediately published an article, in which he wrote that he knew very little about vitamin C, but that what I had done was terrible, completely wrong. Later, unfortunately, he was fired from his job, because his statement had held up the entire development. I made other discoveries later, which were at first rejected by 'standard' science just because they were novelties. Now, when something is rejected, I say to myself, this might be good, this is a new discovery. But if something is accepted right away, it makes me sad, because it seems as if I'm getting old and won't be able to discover anything new any more.

Albert Szent-Györgyi: *Az élet jellege* (Budapest: Magvető, 1973): 64-68.

István Kardos, István Kardos, born 1942 in Galánta (now in Slovakia). Studied Hungarian and history at the University of Budapest between 1960 and 1965. School instructor and author from 1966 to 1975. Wrote his first screenplay in 1968, became a full-time screenwriter in 1975. He is currently director of a film studio, Hétfői Műhely.

6

László Beke

The Aesthetics of Chance

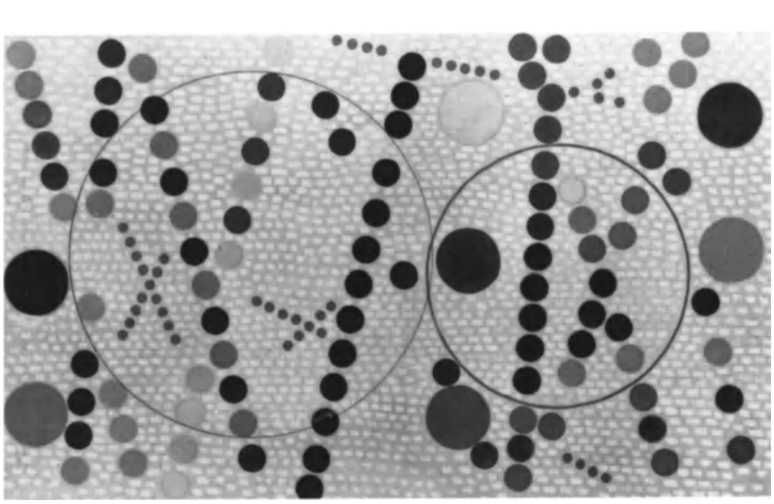
Chance is God's pun. (Chesterton)

To clarify the concept, we must stress that we definitely distinguish between chance in the sense of incidental, insignificant chance, and meaningful chance (coincidence, which in a negative sense is accident, in a positive sense, luck). All of them play an important role in art.

After the aesthetic strategies of "un coup de dés..." (Mallarmé), and "nature follows art," or "le hazard objective" (Breton), it was especially Informel and conceptual art that paid attention to chance. Since the late 1960s, many geometrically inspired works art were created on the basis statistics, practically with dicing or 'generating chance.' Dóra Maurer's film, *Kalah*, is one of them; its abstract light emissions were marked by the steps of a traditional Arabic game (Zoltán Jeney's soundtrack was composed in a similar manner). Maurer's pupil, András Wolsky, determines the compositions of his Mondrian-like paintings by dicing. A joint work by film director Gábor Bódy and physicist Sándor Szalay was an early computer animation (the medium was film at first), which was based on the mathematical model of a 'game of life' (see Christa Sommerer's similar activity). In the field of poetical object art, Miklós Erdély has elaborated the principles of so-called "self-constructing poetry," whose essence is the discovery of meaningful connections hidden in groups made up of individual, ordinary, found objects. (We may consider Daniel Spoerri's documentation of left-over food analogous.) Erdély paid special attention to the problem of twins in his "Theses of Repetition Theories" and the "Theses of Identity Theories." I believe this problem is closely connected to the research of alter ego. At the end of his life, in the first half of the 1980s, Erdély also involved chance in his painting. Doing something similar to what Robert Motherwell did, Erdély interpreted the process of composition as the correction of an incidental mistake on the canvas or paper. One of his paintings, *Koestler*, refers to an anecdote by Arthur Koestler, a Hungarian writer who moved to England and became a citizen of that country. Koestler's anecdote deals with coincidences. The author of the present article took courage in the 1970s from Koestler's book, *The Roots of Coincidences*, as well as from Gustav Jung's *Synchronicity*. The difference is that, while Koestler and Jung try to set up scientific hypotheses (the latter even attempted astrological constructions) concerning the origin of coincidences, I am satisfied to register the coincidences revealed in everyday life (with the help of what I call a "chance diary," kept for more than twenty years), interpreting them as a source of humor or as aesthetic phenomena. In the course of this activity I have discovered close relationships with Lipót Szondi's "analysis of fate," or the surprising coincidental characteristics of the cases he discovered.

The demonstration of chance as luck (or better: anti-luck) can be observed in Tibor Csiky's conceptual work: the artist bought lottery tickets in the 1970s and filled them out, but did not send them, thus provoking chance and refusing the possibility of a big prize from the beginning.

The role of chance is totally different in the art of Béla Julesz. In the visual structures he discovered, the randomly distributed mass of dots serves to camouflage a latent picture and at the same time to allow it to be perceived as a three-dimensional form.



Tamás Lossonczy
Chain Reaction, 1946
Oil on canvas, 94.5 × 150 cm

László Beke, born 1944 in Szombathely. Studied art history from 1963 to 1968 at the University of Budapest. Worked from 1969 to 1986 as an assistant in the art history research group at the Hungarian academy of sciences. Editor at the University of Budapest since 1976. Guest professor at the University of Lyon, 1987-88. Department head at the Hungarian National Gallery, 1988 to 1995. Assistant at the University of Applied Arts, Budapest, from 1989 to 1996. Chair for interdisciplinary art from 1990 to 1994 at the University of Applied Arts, professor there since 1994. General Director of the Budapest Műcsarnok since 1995.

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L. Beke, Zsuzsa Varga, eds., *Kozma* Layos (Budapest: Akadémiai Kiadó, 1968).
L. Beke, *Schäar Erzsébet* (Budapest: Corvina, 1973).
L. Beke, *Moholy-Nagy* László munkássága (Budapest: Corvina, 1980).
L. Beke, *Caspar David Friedrich* (Budapest: Corvina, 1982).
L. Beke, *Mualkotások elemzése* (Budapest: Tankönyvkiadó, 1986).

Tamás Lossonczy
born 1904 in Budapest. Studied at the Academy of Applied Arts Budapest, 1923-26.

1941 Műteremkiállítás, Budapest (with his wife Ibolya)
1943 *Új romantika*, Budapest
1947 Salon des Réalités Nouvelles, Paris (with his wife)
1971 Fényes Adolf Terem, Budapest
1978 Műcsarnok, Budapest
1987/88 *Retrospective*, Szombathelyi Képtár (with his wife)
1996 *3x3 from Hungary*, Center for Curatorial Studies, Bard College, Annandale-on-Hudson, New York
2004 Kassák Múzeum, Budapest
Fészek Galéria, Budapest

References:
Gábor Pataki, *Lossonczy Tamás* (Budapest: Új művészet könyvek 8, 1996).

6

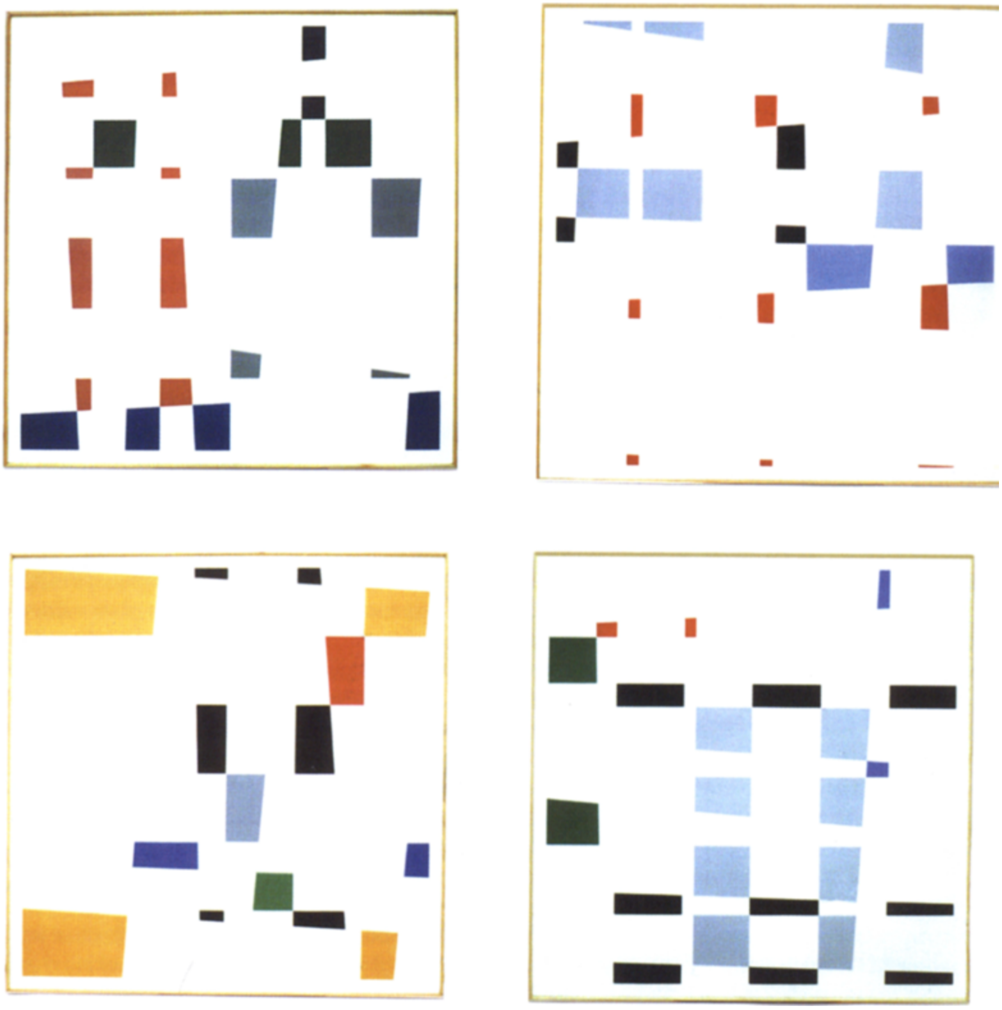
András Wolsky

Coincidence and Intention

András Wolsky
András Wolsky, born 1969 in Budapest. Studied with Dóra Maurer at the University of Applied Arts. Lives in Budapest.

1995 *Orientáció*, Rét Galéria, Budapest
1996 Haus Ungarn, Berlin
1999 Francia Intézet, Budapest

Exhibitions
1992 *Diákfotogrammok*, Goethe-Institut, Budapest
Tér-képzetek I, Budapest Galéria, Budapest
1993 Jövőgyűjtés, Liget Galéria, Budapest
1994 *Tondó*, Józsefvárosi Galéria, Budapest
1995 *Tanulmányraktár*, Budapest Art Museum
1996 *Der Budapester Künstlernachwuchs*, Albrecht Dürer Gesellschaft, Kunstverein, Nuremberg
Gesztus, Barcsayterem, Budapest
2000 Ludwig Múzeum, Budapest
2001 St. art Galéria, Budapest
2002 Vaduai Galéria, Budapest
2003 Városi Művészeti Múzeum Képtára, Győr



András Wolsky
Coincidence and Intention I, II, III, IV, 1996
Acrylic on canvas

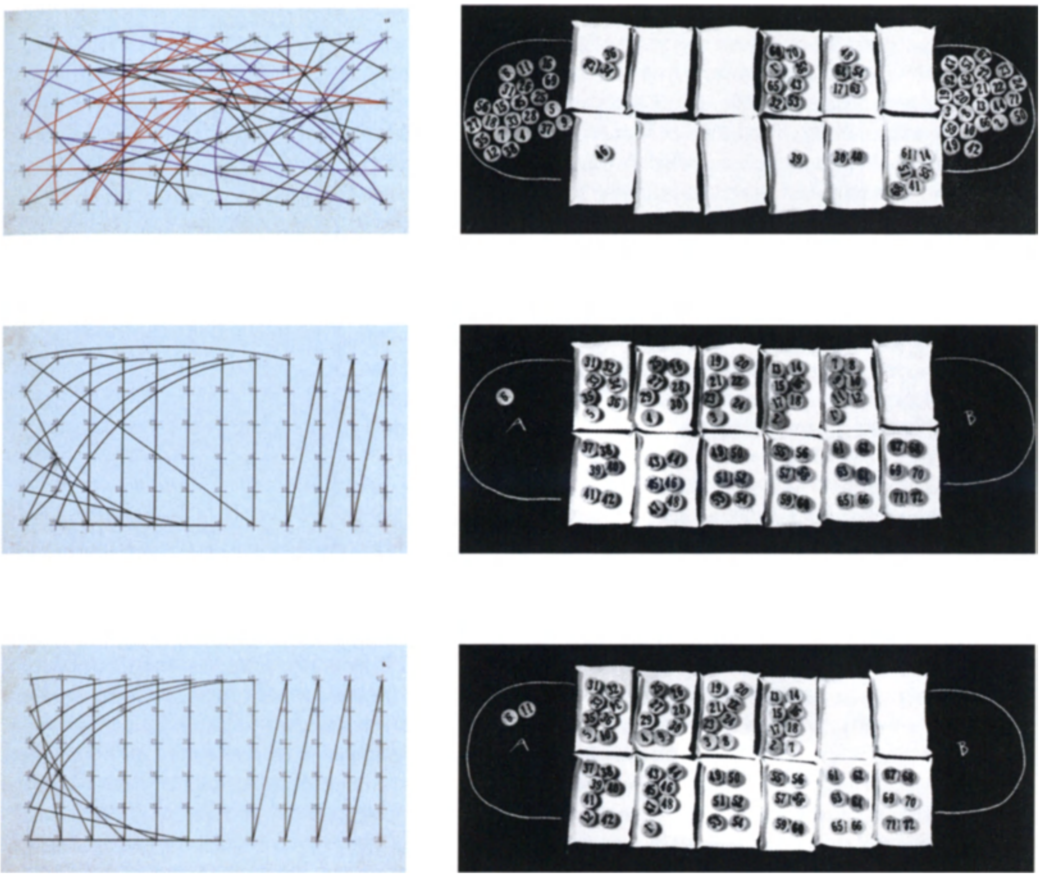
The four images represent what I am most interested in at the moment. The individual parts are not closely linked; rather, each constitutes a unified whole in itself. In this work, an additional element joins the system of thought: the possibility of coincidence, which further adds to the possible variations. The exciting thing for me is that a strict, rationally controlled order combines with the incalculable. Coincidence is the "hidden element" Malevich refers to, which represents a new quality and offers new possibilities.

I used die for a random generator, which offers six different possibilities in terms of size and colors, as well as variations in terms of direction and form.

The four sides of the image base are given. Since each die has six sides, six possible combinations were identified on all four sides, i.e., the sides were divided into six equal areas. The individual areas were in turn divided into six sub-areas, and the results of casting the die were applied to these areas. Each picture required twenty-four casts. The entries made on opposite sides as a result of the cast were then connected. The result was a network of squares. On (vertically) adjacent sides, the equal sub-areas that bring out the form of the network were picked out. The colors were determined as follows: the smallest unit is the most intense color, which gradually loses its intensity toward the edges. (The sequence of colors is not the same in all pictures.) The color scale was selected arbitrarily.

As a result of this methodology, the work does not have a fixed viewing angle and can be hung from any side, up or down, thus creating new variations.

Dóra Maurer
Kalah



Dóra Maurer, *Kalah*, 1980

Kalah, 1980
35 mm, color, audio-visual, 10 min
Music: Zoltán Jeney

The film is based on a well-known, ancient Arabic mathematical game. The number and order of its color and sound elements, as well as their changes (movements), follow the rules of a game of Kalah that ended in a draw. A visual artist and a composer played this particular game in order to find a way to balance the images and sound in a film. The rules of the Kalah functioned as a found generative system.

In accordance with the starting position of the game, the film begins by simply running through the elements from 1 to 72, with the sound rising on a musical scale made up of equal intervals. The oblong color scale starts with red and increases by groups of six, pulsating toward the spectator from the middle of the screen. Corresponding to the course of the game, it is easy to perceive the arrangement of the elements, as at first, they are even rhythmical. However, in the later cycles, the elements, struggling through apparently chaotic situations, gradually create two blocks of color and melody, which communicate with each other: these represent the banks of the Kalah game, which gradually fill with elements.

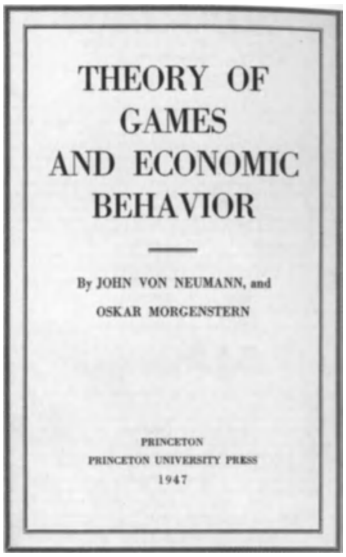
The film is not suitable for the traditional cinema: it becomes incomprehensible after the first twelve to eighteen seconds, as the rapidly changing images bombard the viewer. Therefore it should be projected onto a hemispherical screen as a visual environment. Viewers can lie down in front of it and watch the film from there.

6

Werner Leinfellner

A Short History of Game Theory

Oskar Morgenstern, born 1902 in Vienna, national economist. Studied social sciences in Vienna; PhD in 1925. In 1931, succeeded Friedrich von Hayek at the Austrian Institut für Konjunkturforschung. 1935, professor at the University of Vienna. Immigrated to the United States in 1938, where he became a professor at Princeton University. Director of the Economic Research Program from 1955 to 1970. Returned to Vienna in 1960, founded the Institut für Höhere Studien and remained its director until 1970. Professor at New York University from 1970 to 1976. White House advisor. His game theory was used to solve the Korean Conflict. Died in 1977 in New York.


THEORY OF GAMES AND ECONOMIC BEHAVIOR

By JOHN VON NEUMANN, and OSKAR MORGENSTERN

PRINCETON
PRINCETON UNIVERSITY PRESS
1947

What was it that made John von Neumann, a Hungarian emigrant, and Oscar Morgenstern, an Austrian emigrant, so famous? Neumann and Morgenstern invented a new theory intended to help people resolve their social and private conflicts more efficiently and more democratically than previously with the aid of scientific theories and models. Both men saw the game and its rules as the paradigm of conflict resolution. In a game of chess, one player's possible moves are dependent upon the pieces on the board and the opponent's moves. From the computer, we know how difficult it is to calculate a game of chess. Although life is a game, however, it is not a game of chess, but rather a far more complex game, for there is a third player in the game of life, a dice player: chance.

Game theory aims to show how to solve conflicts with others in an optimal, calculated manner. It is necessary to take into account not only the moves and assessments of the other players, but also, as mentioned above, chance. Coincidences such as the weather, the free will of others, etc. represent the throw of the dice. It is assumed that all players voluntarily adhere to democratic rules governing permissible moves, actions, and strategies (sequences of moves) for all participants.

To be precise, game theory seeks to calculate how (and how much) you can win or lose in a game as either a social or private conflict. Whether you win or lose depends on how you assess your moves or sequences of moves (strategies), how the other players assess them, the situation, the rules, and chance. Such conflicts are everywhere. Will I be safer traveling by plane, by car, or by train if I want to introduce myself at my new company? My whole life and my family's life can depend on it. So life itself creates conflicts whose solutions depend on a large number of participants: the family, society, and, to top it all — just as in a lottery — on coincidences, both disastrous and favorable. But that's not all. We can even compute the optimal solution. Optimal does not mean finding the best solution for myself alone, from an egoistic point of view, but rather the best solution for everyone in view of the given circumstances, coincidences, and accepted rules.


Oskar Morgenstern

The diagram presents an overview of models and subtheories of game theory, which can serve as recipes for how to solve socio-political conflicts in the best possible way. At the Institute for Advanced Study in Princeton, U.S.A., the two immigrants, Neumann and Morgenstern (with whom I worked on scientific projects for many years) succeeded in mathematicizing conflict resolution in the form of game theory. Their almost seven hundred-page book, *Theory of Games and Economic Behavior*, was published in 1944. It was soon a bestseller all over the world. Gradually, game theory was augmented by loosely connected mathematical models and theories meant to resolve competitive and cooperative conflicts in the best possible way for everyone involved.

Interestingly, communists immediately saw game theory as a theory supporting capitalist exploitation and thus condemned it as a capitalist invention. They did not understand that optimal solutions in democracies are fair, democratic compromises, balanced solutions (see saddle point in the diagram) between the poor and rich. Such solutions are acceptable to everyone; game theory, then, was the first non-ideological, scientific self-critique of capitalism. The fact that communists were unsympathetic to the idea of cooperative social solutions — which, in western democracies, led to the construction of modern welfare states — is astonishing (Schumpeter, Dahrendorf, Leinfellner).


Oskar Morgenstern, Kurt Gödel in Princeton

The things that are optimal in today's democratic welfare states can, for the first time, be computed as fair solutions for social conflicts in mathematical reconstructions of real conflicts. The fair solutions establish a balance between individual, often egoistic and cooperative, altruistic common interests, such as Harsanyi's mathematical solution of socio-ethnic conflicts between individual, egoistic, extremely altruistic collective interests (benefits). Optimal solutions in democratic states calculate socially compatible distributions of the social gross domestic product and reveal the boundless egoistic maximization of self-benefit and the discrimination against some by others (prohibited by the Pareto principle). The fact that optimal social solutions in democracies, as computed by new welfare economics and game theory, can be acceptable for all and nevertheless promote growth, has today become a far more explosive social issue than any past ideologies. Today, with politicians plunging the social welfare state into debt, we are becoming aware of the significance of modern welfare economics and game theory. Incidentally, the subscribers to these disciplines (most recently Nash, Harsanyi, and Selten) have been awarded more Nobel prizes than any other representatives of any other economic discipline. They have contributed more to establishing democratic welfare states than any other discipline or ideology. "Social" is defined beyond the realm of Marx, Jesus, and party politics. "Life is solving problems," Popper says. Game theory allows a permanent readiness to resolve social conflicts according to democratically accepted rules in an optimal manner and explains the evolutionary motor powering the social dynamism of modern democratic welfare states. But Neumann and Morgenstern wanted more. Their new theory was planned to revolutionize social science. "At least we've got our foot in the door," Morgenstern said to me in Vienna in 1964. The task of this new discipline of social science would no longer be concentrated on economic forecasts, which usually don't come true anyway, but rather on models that would serve as recipes or instructions for resolving potential future conflicts in the best possible way, even when information is unreliable and in the event of risk. The attached diagram presents an overview. The lower half contains the Neumann-Morgenstern models (theories), which still account for a large part of all models of conflict resolution. Once, when I remarked to Morgenstern that his theory was a true Austro-Hungarian cooperation, although carried out in the United States, he replied that it could have been done cheaper in Austria and Hungary, but it was too late for that now.

Even today, Neumann and Morgenstern's benefit or value theory and their value matrix method are still the foundation, the hard mathematical core of what has become an extensive, coherent complex of subtheories (boxes in the diagram).

A practical example of the game theory solution of an international military (meaning competitive) conflict, which could have escalated into World War III, is the Korean Conflict. The American government commissioned a team of specialists, including Neumann and Morgenstern, to find the best possible solution for the Korean Conflict. The game theory solution for this conflict — the impending war between China and the United States — was based on a 3000×3000 matrix containing all military moves (strategies) of both adversaries in the event of war, as well as the respective assessments. The optimal solution produced by the matrix was a saddle-point solution (see diagram), i.e., to end the war as quickly as possible. The solution was calculated on an ENIAC computer — a prehistoric apparatus, from today's point of view. The result was that the president of the United States, Harry Truman, ordered the army not to cross the Yalu River, the border between China and Korea, and that he fired General Douglas MacArthur, albeit with full military honors.

In order to successfully resolve internal democratic conflicts, new welfare economics (see diagram) not only employs special game rules but also the socially compatible principles and rules established by democratic constitutions and legislations, such as social justice, equality, free vote, etc. (Nash, Sen, Leinfellner). Socio-ethical decision theory (Harsanyi, Leinfellner), a sub-discipline of game theory, is based upon this. In modern social or welfare states, ethically optimal solutions can be founded precisely on social ethics, if it is proven that they are based on socially fair distribution and can stabilize societies that have become unstable. They establish a balance between extreme egoism, which often gets out of hand, and extreme collectivist altruism (Leinfellner). Ethically optimal solutions in democratic welfare states also increase individual security: for instance, by means of a socially fair distribution of income, labor, etc. (Rawls, Sen, Dahrendorf, Leinfellner). Thus, according to the ideas of the game theorists, welfare economists, and social moral philosophers, optimal solutions cannot maximize egoistic benefit, but should rather optimize the individual security of all and thus the relative stability of democratic societies. The question is whether politicians and managers have understood this condition of modern welfare states, and, if so, have they reacted accordingly. According to Tuchmann, they evidently have not, as illustrated by the crisis of the modern democratic welfare state.

The models (theories) indicated in the diagram calculate how, for example, to solve competitive conflicts between opponents (zero-sum games) or cooperative conflicts between friends (cooperative theory) in an optimal fashion. However, they also can solve conflicts between individuals, groups, or committees, be it for the purpose of collective democratic decisions, such as elections, or in democratic negotiations (negotiation theory, developed by Nobel Prize winner Nash). The diagram outside the lower section indicates the modern extensions (Machina, Munier, Allais, Hagen), new welfare economics (Arrow, Harsanyi), and cooperation theory (Axelrod). The bordered box at the top also gives an overview of the trends in game theory research for the next century.

Game theory trends include:

1. Chance is incorporated as a 'player' in the process of conflict resolution, in the form of the expected damage and possible benefit (as a risk).
2. Conflict-resolving game theories replace traditional social theories.
3. Principles of social ethics are successfully employed to resolve ethical conflicts between extremely egoistic and extremely collective/altruistic interests (Harsanyi, Leinfellner).

Johann von Neumann, born 1903 in Budapest. All-round scholar. Instructor at various European universities. Immigrated to the United States in 1933. Instructor at the Institute for Advanced Study, Princeton. As the inventor of Neumann algebra, he wrote the first Axiomatics of Quantum Mechanics in 1926. In the 1944 book Theory of Games and Economic Behavior, he and Oscar Morgenstern created game theory by employing axiomatic methods. His ideas about artificial intelligence and his theory of self-reproducing automata remain influential to this day. His political views ultimately led him to work against the Nazis by helping to produce the atom bomb in Los Alamos. Died in 1957.

References:
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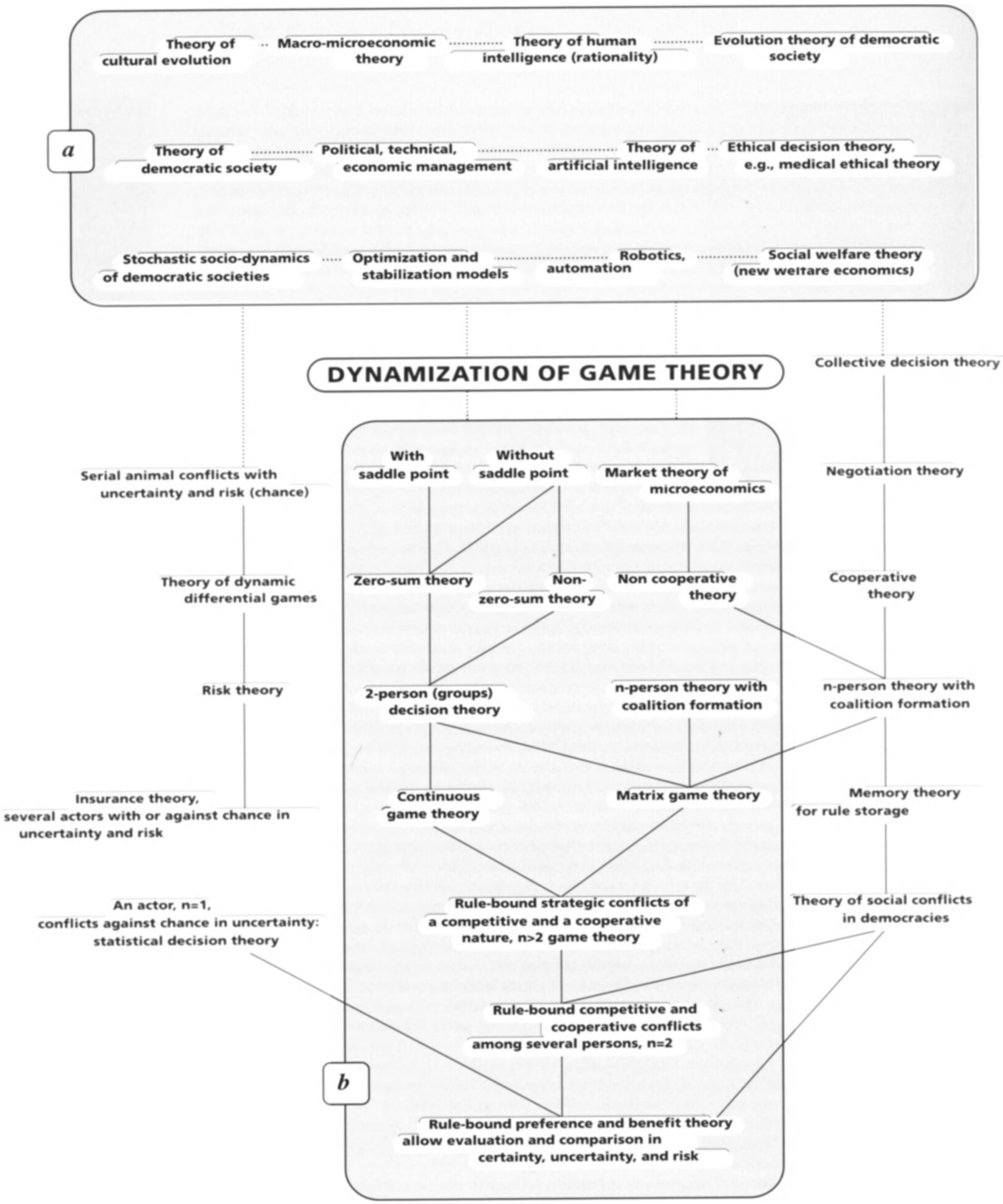
John von Neumann and his second wife, Klara Dan, and his dog, Inverz

OVERVIEW OF GAME THEORY



a) **Von Neumann-Morgenstern theory**

b) **Trends for the next century**

4. The theory of dynamic differential games evolves to become the first mathematical theory of evolution that stochastically covers sequential conflict solutions (evolutionary trajectories). Completely new evolution equations, on the order of Einstein's or Schrödinger's equations, are used to mathematicize Darwinian theory without resulting in social Darwinism (Eigen, Schuster, Sigmund, Helbing, Leinfellner, Maynard-Smith).

5. By including cognitive factors such as the storage of rules, the theory of conflict resolutions blends with the theory of artificial and biological intelligence (Simon, Holland, Tulving, Leinfellner). Their finite mathematical methods and framework of rules become the ideal foundation for computerizing decision-making processes and simulating evolutionary processes with the aid of genetic algorithms.

6. Today, serially arranged social conflict resolutions, where the later resolutions are dependent on the previous and the previous are stored, explain evolutionary learning processes and socio-cultural evolution. The mathematical apparatus employed here allows us to solve time-dependent differential equations, and to describe and compute the possible trajectories of the process (of the "evolution of conflict resolutions"). Their mathematical complexity always reminds me of Morgenstern, who said, "Why should mathematics that deals with our social, economic, and political behavior not be more complicated and more complex than the mathematics of physical microparticles?"

W. Leinfellner / 1996

Example 1: Egotism verso cooperative altruism

Experimental iteration of 25 decisions of the conflict; egotism verso altruism under democratic conditions DC

1. Value matrix

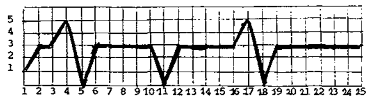
		Player 2: Co-operation	Player 2: No co-operation
Player 1	Co-operation	K, K (3, 3)	A, NK (0, 5)
	No co-operation	NK, A (5, 0)	B, B (1, 1)

2. Democratic conditions DC

2.1 Iterated value of cooperation w(1 v 2) > w(1) + W (2)
Super-additivity of the common group benefit

2. 2
$$K > (K + A)/n$$
$$NK > K > B > A$$

3. Experimental results of 25 repetitions (iterations)



3-5 and 16-18 are so-called "tit for tat"-strategies (A. Rapaport). They are democratic and social-ethical allowed counter measures and means of defence against moderate egotistical actions of others. The democratic right to protest, to demonstrate.

The main thing is that mathematics helps us solve our social conflicts of tomorrow in the best possible way, so that we will not lose everything we have won so far. We must be prepared, then, to repair our boat on the open sea, and the conflict-resolving models of game theory will help us do so.

6

Chikako Nakayama

The Concept of Equilibrium: John von Neumann and Karl Menger

Karl Menger, born in Vienna in 1902 as the son of the famous economist, Carl Menger, Studied mathematics. Afterward, assistant for two years in Amsterdam, later worked at the University of Vienna. After Germany invaded Austria in 1938, he went to Notre Dame University in the United States, where he later became a professor. From 1946 to 1971 he worked at the Illinois Institute for Technology in Chicago. Died in 1985.

Karl Menger

1. Introduction

Equilibrium originally comes from physics and is a dynamic concept explaining a balance of two or more powers that have opposite or different directions. Von Neumann and Menger were the first to introduce this concept to the field of social science.

Both scholars spent their younger days in various centers for the natural sciences. They immigrated to the U.S.A., not only because of severe repression in Europe, but also because the research conditions, including the financial ones, were definitely better. There were many immigrants like them at the time, so it is important to show the significance of this phenomenon for modern history. They had certainly reached a scientific and rational apex in Europe, but at the same time, they also had to fight against a certain disillusionment, since Gödel had proved the general incompleteness of scientific systems in 1931. Crises arose, not only in politics and economics, but also in the whole of modern science. Therefore, we cannot simply say that the "free intelligentsia" (K. Mannheim) of the time were the victims of the madness of modernity. Rather, they were its apologists, sharing the same ideals that in the end led to a fatal hubris.

After the World War, as they began work again in America, it was as if they continued to dream the same old dream of modernity that existed before in the Old World. Von Neumann and Menger were typical for this kind of scholar.

2. Equilibrium: The Historical Field of Powers

The historical origin of the concept of equilibrium can be found in the intellectual milieu around von Neumann and Menger. There seems to have been a historical *Kraftfeld*, or field of powers (Theodor W. Adorno), which led to its emergence. After World War II, the center of development shifted to America, and the paradigm of the market economy, which is centered on equilibrium, turned out to be the most important subject for economics in the 1950s and 1960s. It is still valid today. From that point on, there were three visible directions to be investigated: the existence, uniqueness, and stability of a potential equilibrium.

Von Neumann's and Menger's chief contributions were made before the war, when they were engaged in the theoretical formulation of so-called game situations. They continued in this direction after the war. The concept of equilibrium stems from their analysis of games, which was based on their work at the beginning of the 1950s[1] and still remains current. A point of equilibrium is a state of behavior involving the way individuals make decisions, where the general welfare cannot be improved any more, assuming that everyone has the same knowledge and no one deviates from it. For this reason, this point can indicate optimal allocation of resources, economically speaking. Furthermore, in sociological terms, it can be interpreted as either a kind of convention for behavior or as a social institution.

As early as 1928, von Neumann proved the existence of equilibrium in the special case of a game with two persons. It was a proof for the saddle-point of two mutually conflicting powers in a two-person, zero-sum game. The proof can be outlined as follows: each player wants to get as much as possible at the cost of the other. The more profit the one gets, the less the other can afford. Therefore, both behave in a way to avoid the worst case scenario. Ultimately, the result is that both have the best of the worst as well as the worst of the best. This outcome is called the minimax solution. Later, von Neumann applied this result to his theory of balanced growth economy. This result, which he reported in a lecture in one of Menger's colloquies, was von Neumann's contribution to the concept of equilibrium.

In the 1920s there was a general tendency in the German-speaking academic world to re-think the meaning of equilibrium — which in those days was simply equated with the solution to a comparative system — in order to find a new definition. Vienna was the center of this current, and starting in 1928, Menger was the head of mathematical colloquy held there.[2] Several important concepts and the foundation of mathematics were discussed, and the protocol was published as Ergebnisse eines mathematischen Kolloquiums (Results of a mathematical colloquy). Sometimes the discussion went beyond the narrow boundary of mathematics, crossing over into the field of economics. This kind of openness can be ascribed to Menger, who, as head, played a catalytic role. It was in this interdisciplinary atmosphere that the range of the concept of equilibrium was widened in the middle of the 1930s. K. Schlesinger, a banker from Hungary who also had a profound knowledge of theoretical economics, posed an important question about the solution and its meaning for a system of equilibrium in 1934. A. Wald, a mathematician from Romania, continued the investigation of this problem and proved that a solution existed. Von Neumann's aforementioned balanced growth theory can therefore be seen as the dynamic version of this problem.

Another issue to be mentioned is the elaboration of the concept of individual utility as a basis for general equilibrium, which is related to the consideration of social welfare. Menger himself also contributed to it. He wrote an article about uncertainty and time elements, maintaining that these elements should be formulated

1. J.F. Nash first defined it in 1951, which is why it is called the Nash equilibrium. After that, Arrow and Debreu, two economic theorists, worked it out further.
2. Menger led the first series of colloquies between 1928 and 1936. After immigrating, he continued the second series at Notre Dame.

with the help of subjective probability. It explained people's tendency to deviate from the rational calculation of objective, mathematical probability and to come close to irrational decision-making. Morgenstern was strongly influenced by Menger's investigation. With perfect foresight, he wrote an article about the incompatibility of the element of time in the equilibrium concept. Though they did not actually formulate a theoretical model, they did ultimately help to establish precise conditions for an equilibrium.

3. Science as Art?

Since Gödel refuted the completeness of an "architecture of words" or a system of axioms in general, the matter of science as art began to be dealt with. Von Neumann and Menger were at the center of this issue. On the one hand, they strove to construct a system, but on the other hand, were also conscious of its fragility. That was why they turned their interest from the abstract concept of equilibrium to the analysis of concrete games. Menger wrote an article about Occam's razor in 1960. This famous fourteenth-century principle says that nothing should be expanded beyond necessity. It is thus called the "law of thriftiness." The razor cuts off the superfluous. In contrast, Menger claimed that "nothing could be repressed by necessity."

The architecture of axiomatic systems consists of minimal symbols and their mutual relationship. There cannot be any contradiction between them. Such a system is abstract as well as incomplete: the castle is built on the sand, so to speak. But it is good to know that this architecture can never be finished. In this way, science can be understood as art, and only an aesthetic ideal exists. And it is in this way that we can understand why Gödel constantly emphasized the creative role of mathematical intuition. His and Menger's thoughts were important products of the same milieu.

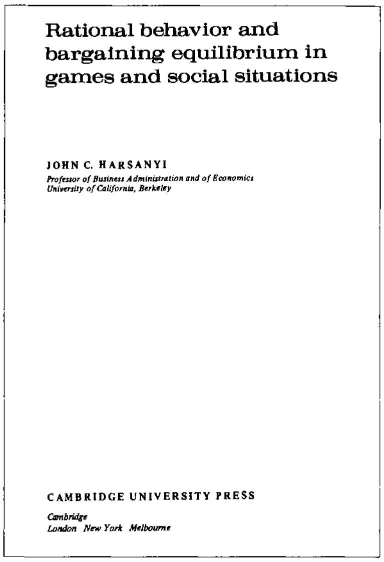
Chikako Nakayama, born 1964 in Yokohama, Japan. Studied economics and sociology from 1983 to 1989 at the Waseda University in Tokyo. Assistant at the University of Tokyo from 1989 to 1992. Master's thesis on "Continuity and Discontinuity in the Marginal Revolution: the Case of Carl Menger." PhD studies at the University of Vienna, 1992-95; dissertation on "The Theory of Games and Economic Behavior in the Context of the Austrian School of Economics and Contemporary Game Theory Problems." 1995-99 Lecturer, and 1999-2000 Associate Professor at Kumamoto Gakuen University. Since 2004 Associate Professor at Tokyo University of Foreign Studies.

6

Eckehart Köhler

John C. Harsanyi as the Master of Social Theory

John C. Harsanyi, born in Budapest in 1920. Studied at the University of Budapest, at Sydney University and at Stanford University. Professor at Wayne State University and at the University of California, Berkeley. Guest professor at the Universities of Bielefeld, Bonn, Paris, and Sydney. Professor at UCLA, 1964-90. His fields of research were: game theory, the selection theory, mathematical economy, the use of rational selection models in political science and sociology, utilitarian ethics and epistemology. In 1994, together with John Forbes Nash Jr. and Reinhard Selten, Nobel Prize for Business Studies for research in the field of the non-cooperative game theory. Died in 2000 in Berkely, Calif.



Rational behavior and bargaining equilibrium in games and social situations

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John C. Harsanyi is the most outstanding figure in the revolutionary development of the social sciences in the last fifty years. Philosophers, including Leibniz and Hume, have always dreamed of the genesis of a truly comprehensive theory of human behavior comparable with the natural sciences, although this dream has remained unfulfilled until recently. Two great Hungarian scientists, John von Neumann and John C. Harsanyi, have contributed significantly to its fulfillment.

The central theory of interpersonal behavior is the theory of games, or game theory. It is concerned with the exact strategic plan of all participants in a group interaction (chain of behaviors), the exact determination of the respective quality of knowledge (through individual possibilities in the sense of Bayesianism) and the respective ideas of value (pay-off: the value a player attaches to an outcome). The name is perhaps ill chosen, as it sounds frivolous and at first does not indicate how serious the theory really is. Two comments should adequately clear up the situation. First, people dealing in bonds, currency, and commodity exchange are called "players" in technical jargon, although only old-fashioned socialists consider their activity nonserious; and second, it is well known that the highly serious science of statistics and probability theory derive from Pascal's seventeenth-century mathematical concepts, which arose from thoroughly frivolous card games.

Game theory has been recognized as fundamental, especially in the business sciences, although there was resistance in this area for years; otherwise, it is tolerated, ignored, or even simply rejected in other social sciences such as sociology or political science. Although there are nonetheless redoubtable supporters of game theory in the latter field, it is scarcely used (not to mention understood) by the majority of professionals, as they continue to foster an exclusively humanist (meaning anti-mathematical) methodology. Game theory provides a suitable framework for a truly general theory of human behavior because it demonstrably allows for the conceptually strongest representation of behavior, in such a manner that all weaker theories can also be represented in it. Because game theory typically makes very strong assumptions about rationality and appears to be a rationality theory, some therefore believe it unsuitable for representing the actual behavior of humans and other collectives. That is, however, incorrect: game theory is a framework for expounding regular relations of a descriptive as well as normative character.

Game theory is not only applicable to humans, but to all intelligent beings in general, and in the meantime, a potpourri of applications have been carried out in evolutionary theory, robotics, and even theology.[1] Game theory is a general theory of all types of intelligence that appear in groups.

The founder of game theory, John von Neumann, told his colleague Oskar Morgenstern in the 1940s that the social sciences, including national economics, were still functioning at the comparatively primitive level of the natural sciences before Newton. When we continue to weave this image, we can claim that von Neumann himself was the Archimedes of the new social sciences, in that he created game theory, which, so to speak, contained the "law of leverage." Soon thereafter, in 1950, while von Neumann was still alive, there came a Galileo who discovered still more important laws (like the law of falling bodies) with the help of deep mathematical insights (which join with Newton's celestial mechanics). This was John F. Nash, Jr., of Princeton University, who founded the theory of behavior as a part of game theory; and finally, there was John C. Harsanyi who discovered, in the same decade, a wonderful synoptic theory that united and formed a base for all significant previous knowledge, so that (just like Newton who could equally explain all celestial as well as earthbound phenomena using the same laws) all types of games involving interpersonal behavior could now be handled within the same scheme. In later works, Harsanyi received important support from Reinhard Selten, which is why the Nobel Prize for science did not go to Harsanyi alone, but deservedly to Nash and Selten as well.

Naturally, one can question the use of thoroughly understanding organizational structures and interactive mechanisms of behavior without any expectation of particular and immediate breakthroughs in politics, economics, or society. Firm scientific knowledge has, for one, a great value in and of itself, and, for another, we cannot completely exclude the hope that future generations will be able to apply this knowledge with unanticipated success.

How important is Harsanyi's contribution today and of what does it consist? This question is not so easy to answer. Harsanyi's contribution exists on a complex theoretical level so that, at best, we can outline it in a

1. Steven Brams, a leading proponent of game theory in political science at New York University, did some excellent game theory analyses of the God of the Old Testament, somewhat in the style of the Pascalian bet! See for instance his book *Superior Beings. If They Exist, How Would We Know?*, New York, Springer Verlag, 1983. Another example: once, I explained to Oskar Morgenstern, a co-founder of game theory, the speculative natural science studies of life outside of the solar system, and he was immediately fascinated and asked for a list of books.

manner comparable with the popularization of Einstein's theory of relativity. We will attempt to do this in a few paragraphs. On the other hand, many contributions from Harsanyi, particularly on methodological and ethical themes, are compiled in a notably clear and approachable way, as the Scottish-English role models of empiricism and utilitarianism did before.

Harsanyi's most important contribution is considered a neuralgic point in a branch of game theory, which is considered remarkable for various reasons. It is concerned with a theory of behavior that had been previously developed by Danish economist Frederik Zeuthen[2] in 1930, without help from the von Neumann game theory, which was likewise published in 1928, but dedicated to quite different problems. Zeuthen's attention was directed toward leaders who negotiated collective contracts between firms and unions, a problem which both von Neumann as well as Morgenstern considered unapproachable from a game theory stance until the late 1950s. In 1928 von Neumann dealt at first with the simple case of purely competitive games, the so-called "zero-sum games" like chess or checkers, for example. Later, with the appearance of his major work,[3] he and Morgenstern additionally took on the radically opposing case of pure coalition games as they occur in legislative bodies. The entirely significant case of cooperative behavior was excluded. Belonging to this are, in particular, trade negotiations in markets (partly competitive and partly made up of coalitions), which are among the most commonly occurring interpersonal activities; and the many interactions within families and firms that cannot correctly be treated as ethical problems — e.g., the famous "battle of the sexes," which supposedly decides whether a married couple goes to the ballet or to a boxing match. Nash's solution[4] from 1950 and 1953 was immediately recognized as highly meaningful, even more so as it made significant use of one of the most famous mathematical theorems of the twentieth century, the Browerian "fixed point theorem;" which immediately gave Nash respect among mathematicians (almost the only people participating in the early development of game theory were trained mathematicians). Nonetheless, the situation remained dissatisfactory. First, Nash's prerequisites were very abstract and somewhat unfathomable; second, and still more seriously, they contained a relevant limitation in those cases in which participants in bargaining are sure of the strategies, values, and the respective level of knowledge of all negotiation partners. Harsanyi[5] crowned the development with an approach that at once pushed this lack aside. He let the participants' choice of strategy depend on uncertain knowledge (the only possible knowledge in the sense of Bayesianism). Apart from that, and what is possibly even more important, he was simultaneously able to prove that the Nash solution is the only correct, enlightening one. To do so, he presented a "behaviorist model" at the highest level of theory, which explicated the preparatory work done by Zeuthen but had been practically ignored by economists up to that point, so that the actual psychological motivation of the actors was clearly revealed. Harsanyi's contribution is important for social theory and especially for the various disciplines dealing with business, since the total theory of the market (the "free" as well as the less free oligopolistic) can — and actually should be — reduced to behavioral theory. Economists avoid this by normally beginning somewhat higher up the definitional ladder, namely with the macro-economic variables of supply and demand. If one begins instead with individual behavior, then there is the theoretical advantage that the influence of variations at the "micro-level" can be taken into consideration, even be pertinent. A parallel would be the extension of classical physics in the sense of early quantum physics as practiced by Bohr and Sommerfeld (whose radical transformation through Heisenberg and Schrödinger can no longer be understood as mere expansion — yet something analogous could contradict the classical market theory).

Harsanyi's achievements as a social theoretician were perfected primarily through his work in ethics. It is possible to see ethics as related to (rational) social theory, and Harsanyi does this. However, in this case it is a bit more classical, as his role models this time are not from five or ten years previous but rather a hundred or a hundred and fifty years. Indeed, they include first and foremost the Scottish-English utilitarians Smith, Bentham, and John Stuart Mill, as well as Immanuel Kant, although to a lesser extent. A fellow Nobel Prize recipient praised his achievement as "one of the few quantum leaps" in this field.[6]

Harsanyi's main contribution[7] is proof that the sum of social welfare is an additive function of the welfare (advantage) of every single person in society. For that, Harsanyi reaches back to themes that were very non-contemporary in the 1950s and practically fell victim on all sides to the highly influential behaviorism. He assumed that it makes sense to speak of interpersonal knowledge and the comparability of everyone's welfare (in technical jargon, interpersonal comparative advantage); moreover in his 1977 book, he expressly used a symmetry postulate that embodies the ethical equality of all participants in a society. This assumption was rejected in both ethics as well by economists of the time. His proof, however, achieved a kind of classical status, maybe precisely because of it was out of step with the times. Finally, no economist could deny that welfare economics belongs to the discipline — although very influential proponents (the Austrian school, of all schools!), who were otherwise kindly disposed to utilitarianism, namely Friedrich von Hayek and Ludwig von Mises, denied just this point.

2. Frederik Zeuthen, *"Economic Warfare," Problems of Monopoly and Economic Warfare* (London: Routledge & Paul Kegan [1930] 2nd ed., 1968) pp. 104-135.
3. John von Neumann, *Oskar Morgenstern, Theory of Games and Economic Behavior* (Princeton, NJ: Princeton UP [1944] 2nd ed., 1947).
4. John F. Nash, Jr., "The Bargaining Problem," Econometrica (XVII: 1950) 155-162; "Two-Person Cooperative Games," Econometrica (XXI: 1953) 128-140.
5. John C. Harsanyi, *Rational Behavior and Bargaining Equilibrium in Games and Social Situations* (Cambridge: Cambridge UP, 1977). John C. Harsanyi and Reinhard Selten, *A General Theory of Equilibrium Selection in Games* (Cambridge, MA: The MIT Press, 1988). Harsanyi's original essay on this theme was "Approaches to the Bargaining Problem before and after the Theory of Games," Econometrica (XXIV: 1956) 144-157.
6. Paul A. Samuelson, "Complementarity. An Essay on the 40th Anniversary of the Hicks-Allen Revolution in Demand Theory," Journal of Economic Literature (12: 1974).
7. John C. Harsanyi, "Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility," Journal of Political Economy (63: 1955) 309-321; "Ethics in Terms of Hypothetical Imperatives," Mind (47: 1958) 305-316. All essays mentioned here and others are collected in J.C. Harsanyi, *Essays on Ethics, Social Behavior, and Scientific Explanation* (Dordrecht: D. Reidel Publishing Co. [now Kluwer] 1976); see also his later collection, *Papers in Game Theory* (Dordrecht: D. Reidel Publishing Co. [now Kluwer] 1982).

Eckehart Köhler, born 1939 in Darmstadt. Studied psychology and scientific theory. In 1962 diploma at the Lehigh University, Bethlehem, Penn. (with A. Grünbaum, N. Rescher, W. Stegmüller). In 1976 Ph.D. with W. Leinfellner at the University of Nebraska. 1972-1976 managing editor of *Theory and Decision*. 1978-1979 organization of the Wittgenstein-Symposiums in Kirchberg am Wechsel. Founding member of the Kurt-Gödel-Society and the Vienna Circle Institute. Professor at the Institute of Business Management at the University of Vienna. Research on Kurt Gödel, the Vienna Circle, social history, and ethics. Lives in Vienna.

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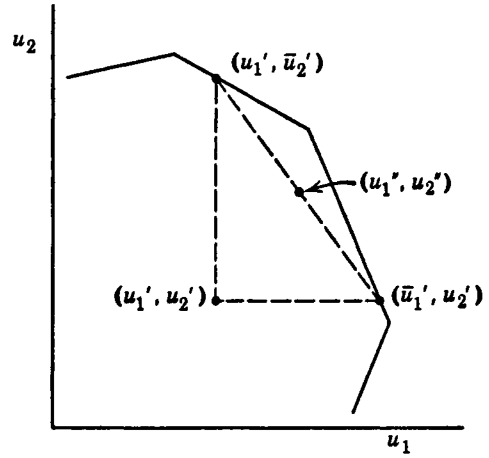
Eckehart Köhler, Ian Wolenski (eds.), *Alfred Traski and the Vienna Circle: Austro-Polish Connections in Logical Empiricism* (Dordrecht-Boston-London: Kluwer, 1999.

Harsanyi thus most cleverly connected classical utilitarianism with positions that had been hostile until then: on the one side, the Kantian (categorical imperative) and on the other, the representatives of rights and duties (de-ontologists). For Harsanyi remembered, just as these two positions emphasize, that the simple utilitarianism of the individual ("act utilitarianism") leads to highly objectionable results, which disappear, however, at the moment when we make rules using ethical decisions as the goal, instead of individual negotiations. To substantiate this, Harsanyi made employed a convincing argument from the currently widespread methodological approach to market theory, the school of "rational expectations." The mutual knowledge or the public expectation that generally valid societal regulations, not individual negotiations, are used as guidelines, necessarily results in much higher social welfare than when everyone is organized completely around themselves (as in Hobbes' "state of nature"). This argument is still largely unknown among professional philosophers teaching in the field of ethics. However Harsanyi's significance is still continuously recognized in this area. For example, in June 1996, he and worldwide renowned ethicist John Rawls of Harvard were co-recipients of an honorary doctorate in Caen.



Behavioral theory according to Zeuthen and Harsanyi:

Every act begins with the condition of the gain which each participant can achieve without interaction with the partner, which goes back to John von Neumann's minimax-solution (the players receive u_1' or u_2'). If we are not dealing with a zero-sum-game, in which the advantage of one is the direct disadvantage of the other, then both players can achieve a greater gain through cooperation than through the minimax-solution. The two dimensional amount of all possible use-values forms the bargaining-set. For that, all points right and above the drawn lines ($u_2 > u_3'$ or $u_2 > u_2'$) are reachable negotiation results, whereas the other points are only relevant as threats. Let's assume that player 1, based on the minimax-solution, has offered his partner the distribution (u_1,"u_2"). Should 2 accept? Harsanyi found a simple criteria for that, namely: $u_1'u_2' >= u_1''u_2''$.

8. Kenneth J. Arrow, *Social Choice and Individual Values* (New York: Wiley Science Publishers, 1951).

Harsanyi's achievement takes on additional meaning in light of his difficult biography. Born before World War II in Budapest as the son of a Jew converted to Christianity, Harsanyi saw no chance of realizing his philosophical and scientific goals in communist Hungary after 1945 and therefore immigrated to Australia. Through hard work, he finally gained a position at the University of Queensland, where several of his most important early works were done. In the 1960s the already widely known social theorist practically started all over again by beginning a doctoral program at Stanford University, with the support of the future Nobel Prize recipient, Kenneth Arrow, (whose work, especially the Arrowsian Paradox,[8] is today sometimes compared with Haransyi's in terms of importance). Arrow's suggestion was: a lot of mathematics and a little philosophy! (Stanford, at the time, lead the world in philosophy, with Patrick Suppes, Jaakko Hintikka, Ian Hacking, Dana Scott, Solomon Feferman, etc. as proponents, and therefore Harsanyi found it very inviting). After completing his new doctorate, Harsanyi was able to establish himself in Detroit at Wayne State University. Finally, he was called up to the great center of teaching and research, the University of California, Berkeley, where he became a Professor Emeritus in 1992. (His son also became a professor in the field of the political history of European social democracies).

In his last few years, Harsanyi enjoyed traveling to Hungary, with which he felt a special bond. He also occasionally held lecture series at the Eötvös University in Budapest.

The MIT Press, 1988.

Werner Leinfellner

Evolutionary Game Theory

1. The Revolution of Evolution in the 1980s

In the first half of the twentieth century, the major theories of natural science shook the very base of our traditional physical worldview, especially the theory of relativity and quantum theory. But the outward appearance of our society seemed to remain completely untouched by this. Even today, the public has not realized that a new theory — game theory — was invented in the latter half of the century, has grown rapidly, and merged with newer theories to form an extensive theory of all evolutionary processes. From 1945 to 1970, the development went from game theory to a social, conflict-resolving dynamic theory: evolutionary game theory. Then, in the 1980s, it blended with new welfare economics, an economically oriented social theory founded on democratic principles. It later successfully employed the evolutionary equations of population genetics. By joining up with other, newer theories, it grew to become the first comprehensive scientific theory of all evolutionary processes, including social evolution in modern democracies. Like all major theories mentioned above, its first step was to dismantle the theories that preceded it — in this case, the Darwinian theory of evolution.

To put it in a nutshell, Darwin's theory of evolution has, on the one hand, a hard, non-mathematical, biologically oriented core, which was able to describe biological evolution as the dynamic interplay of selective and adaptive factors. Thus it was able to explain the changing characteristics of organisms and the transmission of characteristics favorable to offspring, which takes place over generations, with a great deal of accuracy. However, on the other hand, Darwin based his evolutionary dynamics on what was, according to D. Dennett, an extremely dangerous, undemocratic social foundation, which has been far more successful over the past one hundred years in the social and cultural sciences under the name of "social Darwinism" than the hard biological core of his concept of evolution has ever been. According to Darwin, overproduction of offspring will force us into a merciless struggle for existence in which only the rule of the strongest will ensure the survival of the fittest.

Just one hundred years after publication of his main work, game theorists successfully rebelled against this social explanation of evolution that has led to the greatest moral disasters of our culture.

2. The Discovery of Cooperation in Evolution

Quite simply put, game theorists such as Morgenstern, Luce, Rapoport, Axelrod, and Leinfellner, as well as game theory scientists such as Eigen and Schuster, Maynard Smith, Sigmund, et al., proved that social and cultural evolution in democracies is primarily based upon cooperation and mutually accepted democratic rule aimed at solving social conflicts to the greatest benefit of all those involved. By increasing cooperation and employing democratic laws (rules) to resolve social, although not necessarily private conflicts, dog-eat-dog competition, such as Manchester capitalism, is steadily being driven back.

3. The "Revolution of Evolution" Game Theory

This change was supported by new welfare economics, which mainly contributed to the development of modern social welfare states, and by the mathematization of biological evolution using evolutionary equations (differential equations). Interestingly enough, the subscribers to welfare economics have been awarded the most Nobel Prizes: for example, the game theorists J. Harsanyi, J.F. Nash, and R. Selten in 1994. Supporters of this approach convinced game theorists that optimal solutions to social conflicts are based on rules that can be derived from democratic principles, or rather, major socio-ethical rules such as human rights, for instance, which, however, also require continuous evolutionary improvement. It was a great success for democracy when game theory proved that the special game theory rules are not sufficient to obtain optimal solutions to social conflicts. Rather, it is necessary to give precedence to major democratic, socio-ethical rules such as equality, liberty, Pareto optimality (solidarity), and so forth over the rules of game theory.

Game theorists, who recognized that solutions to successive conflicts are of an evolutionary nature, provided the mathematical and practical proof that socio-cultural evolution is primarily founded on cooperation was produced in the 1980s. This not only turned Darwin's explanation of evolution upside-down, but also shelved the traditional static, competitive social Darwinist, as well as extremely capitalist images of society. This is best expressed by the shift in paradigm from "game" to "conflict" and from "egoistic maximization of benefit in single games" to the new paradigm of dynamic game theory. "The attractor of social evolution for all individuals in democracies is to solve their social conflicts for all those involved in a socially compatible manner." Optimal solutions are solutions to series of conflicts, which optimize both the security of each individual and the stability of a democratic society, meaning that they that do not maximize egoistic, individual benefit. The Pareto principle, borrowed from welfare economics, acts as a main democratic rule, demanding that optimal conflict solutions should not permanently harm anyone unless she or he accepts any possible damage.

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J. Maynard Smith, *Evolution and the Theory of Games* (Oxford, 1982).

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A. Rapoport, *Mathematische Methoden in den Sozialwissen-schaften* (Würzburg 1980); *Fights, Games, and Debates* (University of Michigan Press, 1997).

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In the social evolution of democracies, we are no longer passive onlookers, but have instead become active "players" as we solve, for example, conflicts between old and new forms of society, albeit without the "struggle for personal survival." In this way we influence, at least to some extent (partially causally), the development of socio-cultural evolution. What is more, we democratically heed the fact that the others, too, and social and environmental coincidences have a causal effect as "selective factors" on optimal or "adaptive" conflict solutions.

The models of evolutionary game theory explain, then, why and how individual social forms created by mankind, such as customs, artifacts (artworks, for example), and technifacts, as well as mentefacts like opinions, concepts, models, theories, and ideas change over generations. The models of social conflict solutions are scientific, mathematical reconstructions of our empirical conflict solutions.

The evolutionary attractors represent motivating forces of social evolution and can be used to compute the possible course of evolutionary paths. It is not natural laws, but rather evolutionary attractors that statistically determine the course or the "channeling" of evolutionary paths.

The mathematical formulation of evolutionary attractors becomes the criterion for computing optimal conflict solutions, which are, however, not only the best solutions for individuals, but also optimal solutions for all involved that can also take into consideration changes in the environment and chance. Optimal solutions may have one disadvantage: they can also be of a cyclical, periodical nature, such as when good and bad solutions alternate and thus offset each other in the long run, when economic cycles involving heavy losses follow profitable periods, when various contrary styles of art follow each other, or when sexual behavior undergoes permissive and then puritanical periods.

This gave rise to a totally new theory of evolution, a modern type of socio-dynamics founded on cooperation, teamwork, and democratic collaboration among individuals — quite unlike social Darwinism. Eigen and Schuster proved in 1979 that even in the prebiotic evolution of living molecules and cells and lower biological organisms, cooperation and symbiosis are fundamental, constructive, creative principles of evolution valid for even the most primitive social existence. The more civilized and democratic the society, the better able we are to influence the course of social evolution by means of cooperative solutions to social conflicts, and thus avert possible disasters.

The winners of the 1994 Nobel Prize for economics, game theorists J.F. Nash, J. Harsanyi, and R. Selten, even succeeded in proving that, under more or less fair rules, every optimal, stable solution (even those for competitive conflicts formerly regarded as "Darwinian struggles") leads to a fair compromise: an evolutionary balance (even among enemies) that could have been attained by means of cooperation.

Axelrod, Leinfellner, and Rapoport have proven that under minimal democratic rules, competitive egoists often tend to turn into cooperative altruists, meaning, they become "socially ethical," simply because this puts them in a much better position, for one. Leinfellner concludes from this that socio-ethical conflict solutions between egoism and altruism can emerge through evolution, with or without an authoritarian moral prescription. At his American university, the author of this paper carried out three hundred experimental games consisting of successive social conflict solutions between two people. Under minimal democratic rules, they showed that "egotists" really can become "statistical altruists." "Statistical" means the same as "coopetitive." This new word, in turn, means that, while conflicts are generally solved in a cooperative, altruistic manner, in some cases the players seek to exploit each other egoistically, just as we all occasionally become slaves to egotism, compensating for this by means of cooperation. In the experimental games, after each egoistic relapse, the egoistic players were set right by the democratic rules, which allowed their partners to defend themselves against egotistic exploitation, and after their egotistic relapses, they once again returned to the path of cooperative solutions. This socio-ethical strategy, which Rapoport termed "TIT FOR TAT," is, interestingly, midway between the extremely egoistic "eye for an eye" and the extremely altruistic "turn the other cheek," or "love thy neighbor as thyself."

4. The Mathematization of Evolution in a Theory

The theory of differential dynamic games, also called "evolutionary game theory," grew rapidly in the 1970s; today, in addition to the methods of game theory, it draws on evolutionary equations. These differential equations permit a mathematical calculation of possible developments of biological and individual social paths of evolution. Whereas previously it was mostly the biological path that was analyzed, science has only started to tackle social evolution in the past ten years.

Evolutionary game theory is not yet able to supply an overall explanation of the various kinds of evolution, nor can it stochastically compute their possible aim. Here, "stochastically" means including chance, be it as an adversary or as a carrier of good fortune. According to Leinfellner, future evolutionary trajectories are particularly akin to lotteries, where, in extreme cases, you either lose everything or hit the jackpot. Modern theories of evolution can only calculate the individual evolutionary trajectories (paths) that consist of successive, interdependent conflict solutions. They are the real fields of empirical research of the theory of social evolution. According to Leinfellner, the course of evolutionary trajectories demonstrates the changes of a social form, e.g., a change of habit or fashion, caused by the multicausal influences on the conflict solutions of individuals. Similar to the way a river runs from its source to the sea, here, too, we can observe relatively or evolutionarily stable intermediate stages, such as lakes, which resemble the optimal, relatively stable intermediate solutions of evolutionary paths. Mathematical fixed point analysis uses these relatively stable intermediate solutions to compute optimal solutions to evolutionary equations when, for example, a particular social form remains relatively or, as we say, evolutionarily stable over the course of years, decades, or centuries. Interestingly, evolutionary game theory resembles quantum theory in that it possesses a matrix method and evolutionary equations to compute evolutionary or optimal solutions. The latter resemble the genetic algorithms of biology.

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K. Sigmund, *Games of Life. Explorations in Ecology, Evolution, and Behavior* (Oxford, 1993).

5. The Role of Empirical Memorization in the Theory of Evolution

Like simple game theory, the theory of evolution is founded on the fact that all players not only have to learn, use, and accept the same rules to solve similar conflicts (except if they are cheats), but above all, that they have to store these rules in their memories. It follows from this that without memorizing their "history," every evolution would soon dissolve into chaos. However, social evolution differs empirically from biological evolution in that it requires far more rules, coded in genes, which are additionally stored in our brains and passed on through language. The brain has a remarkable storage capacity of 1014 bits and could thus store one rule for every second of our lives. And as if that weren't enough, social evolution requires additional cultural, supra-individual storage, such as books, libraries (Popper's *Third World*), and technical forms of storage. New memory theories have been successfully incorporated into the modern theory of evolution of democratic societies. The result is a reassessment of history. Evolution is only possible by means of storing both the good and the bad, as well as the new experiences and decisions necessary to solve future social conflicts.

6. Another Empirical Foundation: the Role of Preferences and Evaluations in Conflict Resolution

Solving conflicts is empirically based on the fact that we have and use preferences in order to empirically evaluate and compare social forms so as to be able to opt for the highest-rated or optimal forms. Today it is possible to measure these in specific cases with the aid of empirical benefit and value theory, the new empirical basis of evolution theories. But everyone's collective preferences can also be empirically ascertained and gauged by measuring how frequently the social forms preferred by individuals in a section of the population appear. The more people as a collective prefer a particular form, the greater its frequency and value. The fewer people prefer this form, the more its collective value will drop. The fundamental empirical assumption of social evolution, then, is that evolutionary attractors have a causal effect precisely on individuals and collective preferences, and that the degree of their affect can be empirically, directly ascertained on the basis of the frequency of their use by individuals. Individual and collective preferences — not just fictitious historical laws — are thus the empirically measurable partial causes of social evolution.

7. Further Empirical Foundations: the Role of Subcultures in Social Evolution

Culture takes place in subcultures or micro-evolutions. According to Leinfellner and Schwendtner, evolutionary paths emerge only in subcultures. They are the germ cells where social conflict solutions between old and new social forms are decided, resolved, continue to exist, or fade away via small groups, teams, and communes — and not by any cult of genius.

In these germ cells, groups of artists and teams of scientists begin new cultural, evolutionary paths and trends. New habits, customs, trends in art, scientific discoveries, and inventions emerge often literally as a result of conflicts involving chance, often through close cooperation. Creative trial and error and learning play the greatest role in this respect. If necessary, new rules are devised, combined, and immediately tested on a small scale, and finally, it is ascertained whether they are compatible with the fundamental democratic rules or not. For, as more and more members of mini-groups, teams, and communes begin to prefer them, or as lucky chances increase their value, they will initially "survive" in the group, or they will vanish as quickly as they appeared.

Once they have successfully begun, they can be continued by means of aggregation, media, and chance in the macro-evolution of whole populations that accept them, which they will dominate for a short or long time, or where they will be rejected again later.

8. A Forgotten Intelligent Condition of Social Evolution: Participation with Others

The most important socio-psychological empirical condition for evolutionary social development is as follows: all social conflict solutions are exclusively founded on a social intelligence of Homo sapiens that has not yet been investigated to any great extent: the ability to place oneself in the mental conflict situations of the other partners and discover their motives for solving their social conflicts. Millions of years of experience in observing and empathizing with the motives and preferences of social existence and the behavior of other individuals, which is far more complex than nature, have shaped our intelligence far more than our knowledge of nature, according to N. Humphry and A.R. Damasio. We possess an inner view, an intelligent empathy with the possible preferences, evaluations, and conflict solutions of others, be they adversaries or cooperating partners. Of course, we do not know exactly which conflict solutions she or he will actually choose in a given conflict, but by putting ourselves in her or his position, we gain a very probable assessment of what strategy she or he will opt for. Recent research has shown that Homo sapiens obtained intelligence primarily by solving extremely complex social conflicts — thereby not only surviving in societies, but also developing democratic social forms through evolution. Thus, we are not only aware of our own preferences, assessments, and decisions in all social and ethical conflict solutions, but can also take those of others into account, which can of course be augmented with the aid of linguistic communication and scientific modeling. Astonishingly, this can all be reconstructed in the mathematical models of game theory and plays a major role in the game theory ethics of Harsanyi and Leinfellner, the welfare economics of A. Sens, and in Rawls's foundation of democratic society based on justice.

6

Peter Schuster

Molecular Evolution and Game Theory

1. Introduction

Contemporary science often uses metaphors to illustrate and explain complex matters. Many of these analogies lack substance; sometimes they even lead to wrong conclusions. We speak, for example, of "colored quarks," "intelligent molecules," "learning viruses," "selfish genes" or "individual strategies in populations of animal societies." Are such phrases only modes of scientific expression and unfounded terminology, or can we learn something about complex systems from the metaphorical allusions used in the interdisciplinary transfer of knowledge about simple systems? It would be wrong to denigrate this effort as a whole, and we will try to show in this article that we can learn the basic laws that are valid for both the highly complex behavior of our human societies and for the most primitive systems capable of evolution. This article deals with the "ways molecules learn" and the "strategies of adaptation" in the simplest systems capable of self-organization and reproduction, which lead to evolutionary optimization. Looking at the basis for the simplest evolutionary processes in nature as well as in the laboratory, we will try to find out if those processes have anything to do with "learning" or "strategic planning."

The scientific exploration of biological evolution encounters huge obstacles resulting from the great difficulty, if not the impossibility, of making appropriate experiments in the laboratory. Two problems become especially evident: (i) the natural evolutionary processes of higher species take place in periods of many thousands or up to millions of years and (ii) the number of possible "genotypes" is unimaginably high. (The concept of a "genotype" comprises all individuals with identical genetic information, for example, uniovular twins.) The first of these difficulties can be overcome by "quick-motion evolution." In order to achieve this, the periods between generations have to be reduced drastically from years to months. If the reproducing entities are reduced to nucleon acid molecules, replication times of less than a minute can be achieved. We will come back later to the problem of the high number of genotypes.

In the image created by Sewall Wright,[1] evolution can be regarded as a task of optimization in a landscape of fitness, as a specific kind of a function of cost. The landscape is produced by understanding all genotypes as a space with intervals measuring the degree of affinity between two genotypes, and assigning each genotype a value of fitness. In Wright's metaphor, the populations ascend in the fitness terrain until they reach optimum fitness. In Wright's time, the training terrain was an abstract notion that could not be quantitatively measured through theory or experiments. Since the beginning of the 1970s, physicists have dealt with extraordinarily complicated energy terrain in the theory of spin glasses. These terrains show a very high number of local optima with extreme differences in height, similar to rugged mountains. Model landscapes imitating the energy of spin glasses were used as examples for fitness terrains in biology. An essential characteristic of these complex landscapes is "frustration." This notion was used for the first time in the theory of spin glasses and expresses the fact that the effort to optimize (corresponding to the ambition to reach the highest peak by constantly "climbing the mountain") leads to conflict, and that therefore no simple solution to the problem exists. Finding the best solution in those landscapes is thus a very difficult task of optimizing. The strategy of reaching the highest point in the landscape by continuously "climbing the mountain" is limited by the next local elevation, no matter how low it is, and is therefore doomed to fail. Here we can see a similarity to problems in game theory, where the question is also how to choose the best strategy to optimize a highly complex profit function.

We will limit ourselves to the evolutionary optimizing mechanism, as Darwin saw it. It results from the separate reproduction of entities capable of evolution. For the sake of completeness, we want to mention that there is a range of other relations between evolution and game theory, which concern complex mechanisms of reproduction.[2]

2. Evolution of Molecules

The concept of simplifying and accelerating evolutionary processes by omitting all non-essential aspects in order to study them in experiments goes back to the two pioneers of molecular evolution, Manfred Eigen[3] and Sol Spiegelman.[4] In the late 1960s and early 1970s, Eigen developed a theory of molecular evolution based on the methods of chemical kinetics. By isolating the effective principles of bacteria cells that were infected with ribonucleic acid (RNA) viruses, Spiegelman discovered a laboratory essay that makes the reproduction of appropriate RNA-molecules possible and is thus fit for experimenting with evolution in vitro. Like organisms, variations of genes are produced by (unavoidable) mistakes in copying during the evolution of molecules, which biologists describe as "mutations." Out of the number of variations in the molecular populations, the Darwinian process of selection picks out the "master molecules" that are best adapted to each respective situation. In the Spiegelman experiments, these are the molecules that reproduce fastest. Nevertheless, new variations are constantly produced, and they are kept in the population if they are closely related to them,

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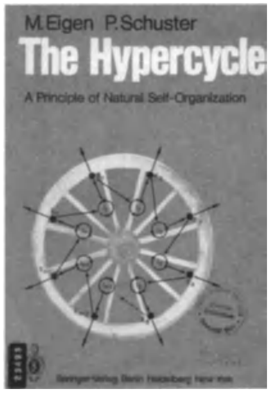

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2. J. Hofbauer, P. Schuster, K. Sigmund, "A Note on Evolutionarily Stable Strategies and Game Dynamics," J. Theor. Biol. (81: 1979) 609-612.
3. M. Eigen, "Self-organization of Matter and the Evolution of Biological Macromolecules," Naturwissenschaften (58: 1971) 465-523.
4. S. Spiegelman, "An Approach to the Experimental Analysis of Precellular Evolution," Quart. Rev. Biophys (4: 1971) 213-253.

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even if they are only equally or less "fit" than the master molecules. Continuous, partially incorrect copying results in populations of related molecules that are characterized as "quasi-species."[5] Quasi-species (fig. 2) form a genetic pool for structures, behavior, or strategies of molecules in the laboratory, just as viruses and bacteria do in nature.

The production of new variations in nature is at the core of natural optimization strategy. Three kinds of mutations are divided into three groups: (i) "spot" mutations, where the sequence of elements in the genetic information is changed at only one place; (ii) insertions, which represent a prolongation of the sequence by repeating a section of a sequence, and (iii), deletions, which shorten a sequence by omitting part of it. Mutations leading to changes in the genotype do not correlate with fitness, since advantageous mutations are not formed more often than disadvantageous ones. Nevertheless, the production of mutations is not completely random, for they are created by small changes in predecessors that have already undergone a selective process. The process in nature corresponds to the method of the player who creates new strategies by slightly modifying those that have already proven themselves. The second method of variation used by nature, the recombination, is only of secondary importance for molecular evolution and will therefore not be discussed in detail. Recombination means that entire sections of genotypes are replaced with others. Since its early beginnings in the 1970s, molecular evolution has become an independent discipline. Many examples of processes of in vitro adaptation of RNA-molecules have been reported. Through variation and selection, RNA-molecules resistant to RNA-splitting enzymes were produced (or "bred," to express the use of the principles of biological evolution in order to create molecules with the desired attributes). In other selection experiments, the catalytic qualities of RNA-molecules were changed so that that they split deoxyribonucleic acid (DNA) instead of the natural RNA extract. The so-called breeding of molecules firmly linked to given structures was especially successful. Most recently those studies were applied in "evolutionary biotechnology," using Darwinian principles to produce new biomolecules with determinable qualities. Molecules naturally cannot learn (not even in a non-literal sense), because once they are formed, they do not change during their lifetime. Yet "learning" in molecular evolution can also be found in primitive natural organisms on the level of populations by adapting to the environment according to the principle of "trial and error"; i.e., by constantly producing new variations and choosing the best adapted ones by the natural process of selection. In terms of the metaphor used by Wright, the difficulty of biological optimization is to beg the question. We have already mentioned the tremendously high number of possible genotypes. But the landscapes that describe the structures of RNA-molecules and thus determine all the qualities important for reproduction — including fitness — turn out to be highly complex, even with regard to the very high number of local optima with very different heights.[6] Evolutionary optimization therefore presents itself as a very difficult problem even at the experimental stage.

3. Evolutionary Dynamics

The dynamics of the very complex evolutionary process is easier to analyze if it is separated into conceptually simpler single processes. Fig. 1 shows such a partition in three processes: (i) dynamics of the population, (ii) dynamics of the carriers of population, (iii) genotype/phenotype projection. The dynamics of the population can be called universal because it can be described with the same mathematical methods used for many things, from autocatalytic chemical processes to models of societies, without increasing in complexity. Population dynamics describes the temporary development of populations and the way they are determined by given reactions, for example reproduction, mutation, and selection (for sexual reproduction and diploid organisms, the dynamics of population is identical to the conventional genetics of the population). Some genotypes increase, some occur less frequently; mutations or recombination form new genotypes, and already existing genotypes can die out. The quasi-species mentioned earlier is an example of a long-term result of population dynamics.

The difference between chemistry and biology becomes obvious when looking at the dynamics of population carriers — the second process referred to above. For this purpose, we look at the actually existing molecules, along with all those that could potentially be produced through the reactions observed. In chemical kinetics, we regularly deal with a few species, all of which have a very high number of particles — at least 1015 or more. The essential difference between evolutionary biology and conventional chemistry lies in the tremendously high number of possible genotypes and those basically accessible through mutations. Out of a single RNA molecule, an unimaginable number of variations can be formed. There are, for example, already 1060 different RNA sequences with a length of one hundred — or 102400 different RNA molecules with the length of the simplest virus genome. All populations, including the biggest virus populations, are diminutive compared to these "super-astronomic" numbers of possible genotypes. Populations are made up of molecules closely related to each other and can be represented by an area — the carrier of the population, the space of genotypes, or the so-called sequence space (fig. 2). Through mutation, the selection of better variations,

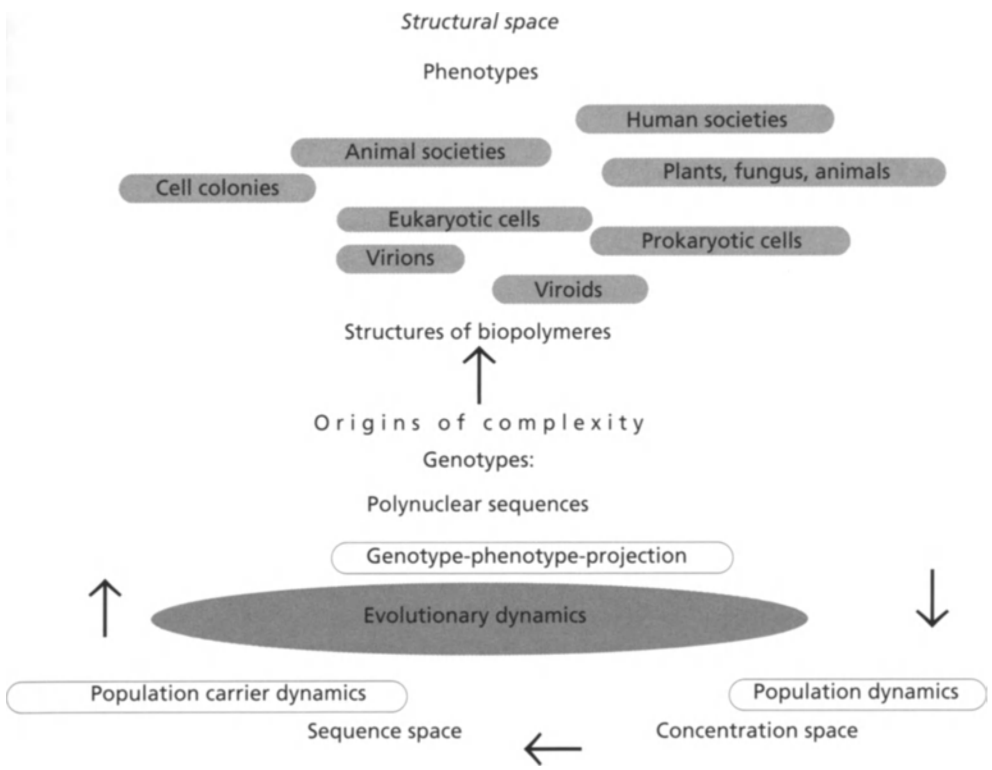

Fig. 1: Dynamics of molecular evolutionary processes. The complex process of evolution is divided into three sub-processes: (i) population dynamics, (ii) population carrier dynamics, and (iii) genotype/phenotype replication. Population dynamics completely corresponds to the chemical kinetic reactions of replication, mutation, and selection. Population carrier dynamics describes how populations move in the space or all genotypes, or sequence spaces. The replication of genotypes onto phenotypes is the origin of complexity in biology. Only in the most simple cases of evolution in RNA molecules, where the phenotypes are on an equal level with the (three-dimensional) molecular structures, can the genotype/phenotype replication be analyzed. All other cases are too complex to be studied with today's biophysical methods.

and the extinction of the losers, the population carrier is shifted in the sequence space. Correspondingly, evolutionary optimization can be understood as a migration of the population through the sequence space.

The third process illustrated in fig. 1, the projection of genotypes onto phenotypes, represents the actual source of complexity in evolution. Phenotypes are the visible appearances of entities capable of evolution: molecules, viruses, organisms, or societies. They are produced by processing the genetic information saved in DNA or RNA, and they determine the fitness of their genotype. In almost all cases, the connection between genotype and phenotype is so complex that it cannot be accessed through either mathematical analysis or computer simulations. The only currently known exception is the evolution of RNA molecules under laboratory conditions. Here, the phenotype is identical to the spatial structure of the molecule. Genotype and phenotype are two characteristics of one single molecule: the genotype is the sequence, and the phenotype is the spatial structure that is formed out of the sequence through a folding process. The genotype/phenotype projection thus becomes a sequence/structure projection, whose analysis is currently a crucial issue in the biophysics of biopolymers.

As has been outlined, the three separate processes shown in fig. 1 are cyclically linked with each other so that each process prepares the input for the process following it in the cycle. The projection of genotype onto phenotype determines the qualities of the molecules and thus specifies the values forming the parameters of the equation for the population dynamics. Essentially, population dynamics causes the emergence of new genotypes through mutation and the disappearance of existing genotypes via extinction. The dynamics of the population carrier originate in both of these processes. Ultimately, the dynamics of the population carrier decides in which areas of the sequence space new genotypes will appear, thus providing the input for the genotype/phenotype projection and thereby completing the circle.

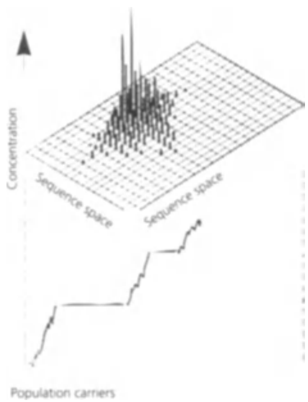

Fig. 2: The molecular quasi-species and its carrier in the sequence space. Continuous incorrect replication of RNA or DNA molecules create distributions of mutants, which can become stationary in a constant environment, meaning that they become independent of time, if the rate of mistakes is not too high. Each population corresponds to an area in the sequence space, which is called the "carrier." The process of evolution can be illustrated as the movement of a population carrier through a sequence space.

4. The RNA System and the Exploration of the Structural Space

It is possible to conduct of how RNA molecules fold into somewhat simplified spatial structures, using mathematical methods and computer simulations in particular. This simplified structure is called a "secondary structure." Right now the RNA system is the only model of evolution whose details can be studied with theoretical as well as experimental methods. We will look at two results that are important for evolution: the "exploration of the structural space" through a small sector of the sequence space, and the existence of extended "neutral networks," which were obtained through a systematic analysis of the genotype/phenotype projection of the RNA system.

The numbers of the various RNA systems are much smaller than those of the possible RNA sequences. This necessarily entails that many sequences form the same structures. Systematic computer analyses of the relations among all sequences of a specific chain length, including all of the sequences they had formed, have shown that the structures can be divided into two classes: frequent and rare structures. Rare structures are often formed by one or just a few sequences. Almost all sequences form frequent structures for sufficiently long sequences (all natural RNA molecules fall into that category). Therefore, rare structures cannot be found in either a natural process of selection or through experiment and so have no evolutionary significance.

Frequent structures fulfill a fundamental requirement: they appear in all parts of the sequence space. In order to find a sequence that produces a frequent structure, it is not necessary to search the entire sequence space. As suggested in fig. 3, the circular area in the sequence space already contains the sequences for all (frequent) structures. This principle of "exploring the structural space" through a small section of the sequence space has important consequences for an understanding of biological evolution, as well as for the planning of evolutionary experiments. (i) Evolutionary optimization is easier than initially thought, because only a tiny part of the sequence space has to be searched in order to find an appropriate solution; (ii) it does not matter in which part of the sequence space the optimization is carried out, because every randomly chosen starter sequence offers the same probability of success (this also explains the excellent results produced by working with random starter sequences in biotechnology); (iii) when carrying out evolutionary experiments, it is important to set the probabilities of mutation so that the area of the sequence space necessary for exploring the structural space can actually be probed.

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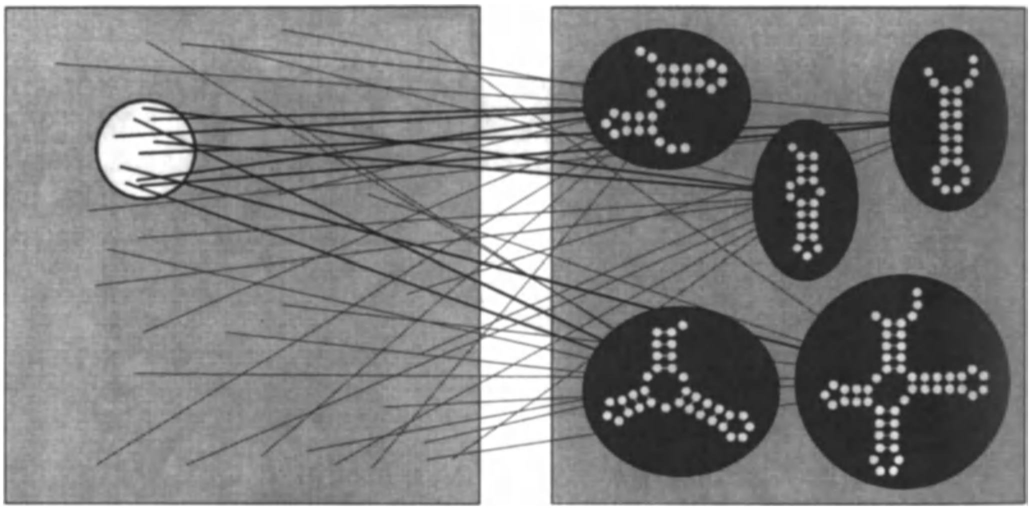

Fig. 3: Outline of the structure space using a small section of the sequence space. Only a (relatively) small space of a randomly selected RNA reference sequence must be investigated in order to find at least one sequence, which is formed by folding, for each frequent structure. In other words, evolution in vivo or in vitro can remain limited to a small section of the sequence space, yet all frequent structures can nevertheless be tested.

5. Neutral Networks and Evolutionary Optimization

The fact that many sequences immediately form the same structure raises the question of the precise positions of these sequences in the sequence space. In terms of the "theory of neutral evolution" developed by Motoo Kimura,[7] such sequences are neutral with regard to selection. They form a so-called "neutral network." The neutral networks of frequent sequences cover the entire sequence space and are connected. This means that, as a consequence of step-by-step mutations, one can roam the entire sequence space without having to leave the neutral net. Quite in accordance with Kimura's theory, populations in neutral networks migrate via a random process analogous to the physical diffusion of molecules. This has been shown in extensive computer simulations.[8] This random process, also called "random drifting," is a result of the independent replication and mutation of the individual members of the population. The population as a whole drifts along the neutral net without any apparent directional preference. If the net is connected, each point of the net will be visited if one only waits long enough.

The existence of neutral networks offers a new basis for understanding the mechanism of evolutionary optimization (fig. 4). Every time a population reaches a local peak, the random drifting inside the corresponding network will set in. This carries the population into other regions of the sequence space. If there are higher fitness levels in the vicinity, another phase of "climbing the mountain" starts, which then leads to the next accessible local optimum. The evolutionary optimization of biopolymer structures turns out to consist of a combination of periods of "climbing the mountain" and random drifting through the sequence space, which eventually can lead to the peak of absolute fitness in the sequence space. In terms of temporary development, the optimization proceeds in steps: between the individual periods of fitness increase there are (sometimes long) constant periods during which nothing seems to change. The structures and level of fitness remain the same, yet continually new sequences are produced. Whether the approximation of the evolutionary process to the optimum happens in a continuum or in steps has frequently been a contested issue in evolutionary theory. Molecular evolution offers, as shown here, a simple explanation for the phenomenon of steps.

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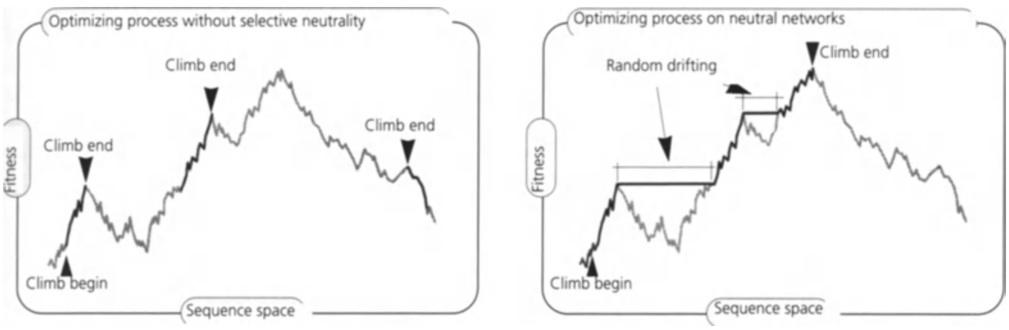

Fig. 4: Evolutionary optimizing in sequence space. The sketch shows the significance of neutral networks for evolution. By continually "climbing the mountain," populations can only reach the highest point closest to the start. However, they can bridge narrow gaps in the fitness landscape, since they can cover a couple of mutation steps at once, depending upon their breadth of the variation. They are not capable of bridging wider gaps and so they wind up on one of the nearby fitness peaks (see left section). Accordingly, just a few optimization processes attain various final stages. The existence of expanded neutral networks in the sequence space alters the optimization process in an impressive way. Whenever the population reaches a local high point, this element is a neutral network. Thus, the population immediately begins to drift across this network. The "accidental drift" continues until it once again reaches another nearby point with a higher fitness level. Then a new phase of "climbing the mountain" begins. By combining these phases of "climbing the mountain" and accidental "drifting," the population can finally attain the global optimum, the highest peak in the fitness landscape (right section). This final stage is unambiguous, meaning independent of the starting point.

6. Conclusions

The analysis of the in vitro evolution of molecules allows for detailed insights into the events during evolution, which cannot currently be gained by looking at more complex natural systems. Three discoveries are important: (i) the formation of quasi-species; (ii) the exploration of the structural space; and (iii) the existence of local networks. Using a mode of expression derived from game theory, we can say that evolution does not rely on a single strategy, but pursues optimization with a number of related strategies corresponding to the different genotypes in a population of quasi-species. The individual genotypes are assessed according to their fitness: genotypes with higher values are more likely to appear in the next generation than their less-successful relatives. The problem of the immeasurably high number of genotypes is dramatically reduced by the distinct redundancy of the relations between molecular genotypes and phenotypes. This is reflected in the exploration of the structural space through a small section of the sequence space. Up to now, only biologists have given due attention to the question of neutrality with regard to selection and its consequences. Every time a selective process cannot distinguish among different variations, a process involving the random succession of dominant genotypes sets in. The extent of the selective neutrality is of key importance for the structure of neutral networks that strongly influence the course and success of the process of evolution. Whether the neutrality of strategies is also important for game theory is a question that future analyses will perhaps address.

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6

Karl Sigmund

Game Theory and Artificial Life

Mathematical abstraction unquestionably represents the non plus ultra of technology transfer. Therefore it is not surprising that the most radically diverse thinker of the twentieth century was a mathematician: the Hungarian John von Neumann. He quite consciously cultivated this diversity, which led him apparently effortlessly from mathematical logic to quantum physics or from hydrodynamics to meteorology. At times it seems that he directed his interests toward a new field precisely because it was different than anything he had ever done before. For this reason, it would have greatly fascinated him that two completely separate fields, which he created, have grown together in a surprisingly natural way. First, there is game theory, which he (and his Austrian friend, Oskar Morgenstern) created as a tool for economics. Second, there are the models for artificial life, which his Polish friend, Stanislav Ulam, suggested and which von Neumann designed, using cellular automatons.

This method of combining abstract biology and theoretical economics only became viable with the development of computers, which, as is well known, von Neumann influenced more than anybody else. This rounds off the portrait of a universal genius comparable only to Leonardo and Leibniz.

One of the few activities in which von Neumann remained relatively unsuccessful was playing poker. His friends and biographers are unanimous in that his talent did not match his enthusiasm for this game. But he used poker and other party games to create a grand framework for the mathematical analysis of all social interactions, including economic and military ones. Game theory is actually firmly established in the institutes of economic sciences all over the world, although it did not fulfill some of the great expectations raised by the book published in the 1940s by von Neumann and Oskar Morgenstern. From today's perspective, the authors concentrated too much on zero-sum-games such as with poker, where one player wins what the other loses. Their assumption that all players maximize their profit in a completely rational way has proven to be the Achilles' heel of game theory, in theory as well as practice.

Perhaps the two most significant developments after von Neumann's occurred in the early 1950s, when John Nash developed his non-cooperative game theory, and in the 1970s, with John Maynard Keynes's evolutionary game theory: These theories overcame the limitations of earlier game theory.

These aspects play a role in the so-called prisoner's dilemma, a mental experiment where the most important aspects of economic life, the problems of social cooperation, are worked out in minimalist manner almost like the composition of a haiku. In the prisoner's dilemma, there are two players who both have only two strategies: they can either offer support to their co-player or refuse it. If both support each other, the profit is higher than if they do not. Let us say that in the first case, the profit will be one, and in the second case, it will be zero. If one of the players supports the other, and the other refuses to return the service, the latter gets more than one point and the first one less than zero, because he let himself be exploited — he loses out. It is obvious that a rational player who wants to maximize his points will not cooperate: this is his best strategy, no matter what the other player does. Therefore both players will refuse to cooperate and both will get zero points. Cooperation would have been better, but was rejected according to the rational principle of profit maximization.

This game is not a zero-sum-game. Neither are most economic relationships. The principle of rationality fails totally. This becomes particularly clear in the case of evolutionary game theory. The point of this approach is to observe a large population of players in which some play one strategy, and some play the other. The individuals play the game against randomly selected adversaries. Their profit determines their reproductive success, and their descendants inherit their strategy. The frequency with which the more successful strategy is used increases with each new generation. As this is the strategy that refuses any cooperation, the willingness of the population to cooperate will be extinguished. Personal profit undermines the profit of the community. "Public profit overrides personal profit" is a popular slogan in totalitarian dictatorships. Do we need a higher authority to coerce public-spirited behavior and protect it from exploitative individuals? The evolutionary struggle for survival is about the success of individual reproduction. Why is it then that — apart from quite a bit of exploitation — the natural selection in simple human and animal communities allows so many examples of apparently spontaneous, naturally developed cooperation?

One answer came from a quite unexpected area: the theory of cellular automatons. In the late 1940s, von Neumann started to develop models of artificial life — that is, robots that were able to reproduce themselves. At the time, the molecular basis of genetics was not yet known, and the idea of an "élan vital" necessary for all processes of life was very tenacious. Von Neumann planned self-reproducing robots on an electromechanical basis. But the physical laws behind the familiar, electromechanical equipment are not completely transparent, so that skeptics can continue to argue that the "secret of life" is hidden behind unknown natural laws. In order to exclude this possibility, von Neumann had to show that self-reproducing robots are also possible in a world whose laws are completely known to us. Such a world has to be an artificial one: this is the only way

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to be sure that we have not overlooked an unknown aspect. One of von Neumann's colleagues, mathematician Stanislav Ulam, suggested using a cellular automaton as an artificial world. Such a "world" consists of an unlimited chessboard: each field can have one of a finite number of states, and it change its state at a given point, according to precise rules of transformation. The next state is unambiguously determined by the current states of the chess field and the states of its eight neighboring fields (the ones the king can reach in one move).

It was in such a "game world," with its completely predetermined time intervals explicitly defined by the mathematician, that von Neumann constructed a self-reproducing robot. In this context, it is a configuration of chessboard fields in specific states, which produce copies of themselves. The robot was extraordinarily complex: von Neumann needed a game world, where each field can take on one of twenty-nine different states and the rules of transition are very complicated. The self-reproducing configuration consists of approximately two hundred thousand fields! Later, other considerably simpler ,living' configurations were invented. John Conway's computer game, "Life," a game world with fields that can take on only two different states, is particularly well known.

The connection of this game world with game theory originates from the work of evolution theorist Martin Novak, a young Austrian scientist working in Oxford. He analyzed a hypothetical population living all over the chessboard. An individual sits on each field, playing prisoner's dilemma with each of eight neighbors. The strategy of the individual is predetermined once and for all: either it always cooperates or it always refuses cooperation. After eight games against each of its neighbors, this individual receives a specific number of points, which are dependent upon its strategy and the strategies of its neighbors. Then the individual dies. In the next generation, the field is again occupied with a descendant of the most successful individual chosen from the former occupants of this field and its and neighbors. Of course, the descendant inherits the strategy of its parent: it will either cooperate or refuse cooperation every time it plays. Thus the chessboard population evolves from one generation to the next. The rules of transition are unequivocally determined and allow us to observe the composition of the population indefinitely. Again, we are dealing with a cellular automaton: the state of a field represents the strategy of the individuals living on it.

Naturally, refusal still results in better pay-offs than does cooperation. One single non-cooperator can exploit his/her neighbors; in the next generation, she or he will be surrounded by eight non-cooperators. But at this point, the picture changes: each of the new non-cooperators has at least three neighbors who likewise refuse and thus do not provide any points; at the most, there are five neighbors to exploit. Each of these neighbors has at least five neighbors who are cooperative, providing her or him with one point each — and not more than three exploitative neighbors. If the cost of being exploited is relatively low, the cooperative neighbor will get more points and be able to occupy the field of a non-cooperator with a descendant. If the game starts with a population in which cooperators and non-cooperators are randomly thrown together, the generations oscillate with regard to the frequency of strategies, which prevents the elimination of cooperation, although exploitation also does not disappear.

Why can a cellular automaton maintain cooperation? It is because the individuals do not play against everyone else, but only against their immediate neighbors. In this case, it obviously pays for the neighbors to remain cooperative — which is impossible if they are exploited too much, since they will consequently be replaced by non-cooperators. The ,moral' is fairly illustrative: cooperation is much harder to obtain in an anonymous, continuously changing population than in a spatially structured population. These results have been given a great deal of attention and have been complemented and corroborated by many other studies. Even in a completely different context, it turns out that a spatially structured population can display surprisingly stable diversity and will protect minorities. In the same way, ecosystems of predators and prey can survive much longer if they form a spatial patchwork than if they live in a homogenous environment.

Computer simulations also suggest that the spatial structure (not a chessboard, but perhaps the surface of a crystal) must have played an essential role in the delicate initial phase of life on earth when, for the first time, replicating RNA molecules gave each other catalytic support. This corresponds to the concept of a pre-biotic world of RNA, as proposed by Manfred Eigen and Peter Schuster. Molecular cooperation becomes more robust thanks to a solid, crystalline grid of neighborhood relationships. Hungarian evolution theorist Erős Szathmany already speaks of a pre-biotic pizza instead of a pre-biotic soup to describe the scenario of the origin of life. Computer simulations of the spatial prisoner's dilemma show that the incessantly changing, totally unpredictable patterns of the cooperating fields on the game board (that is, the pixels on the computer screen) are aesthetically very attractive. If you start with a symmetrical situation (e.g., a single field that is not occupied by a cooperator) the symmetry will be sustained and, together with the spatial, temporal chaos of strategic development, leads to fascinating kaleidoscopes of cooperation.

Karl Sigmund, born 1945 in Gars am Kamp. Professor since 1974 at the Institute for Mathematics at the University of Vienna; Head of this institute, 1983-85. Managing Editor of *Monatshefte für Mathematik*, 1991-2001. His first works dealt with ergodic theory (the mathematical side of statistical mechanics). Later, he turned to biomathematics (mathematical ecology and genetics), contributing to the theory of dynamic systems and evolutionary game theory. He is interested in the history of the Vienna Circle. Lives in Vienna.

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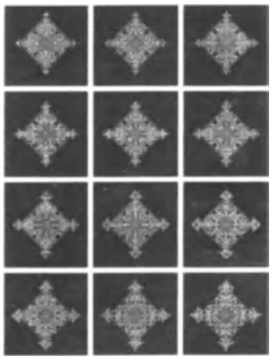

Computer simulations of spatial prisoner's dilemmas. Color code: the blue fields are occupied by cooperators, as they were in previous generations. The red fields are occupied by non-cooperators, as they were in previous generations. Yellow fields are the spaces where a non-cooperator replaced a cooperator, and the green fields show where a cooperator replaced a non-cooperator. They form patterns resembling fractals, which are in continual fluctuation. Cooperation is not eliminated. For more, see A.L. Lloyd, "Computing Bouts of the Prisoner's Dilemma," Scientific American (June 1995) 110-115.

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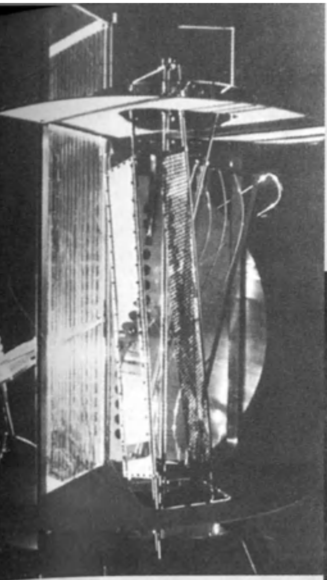
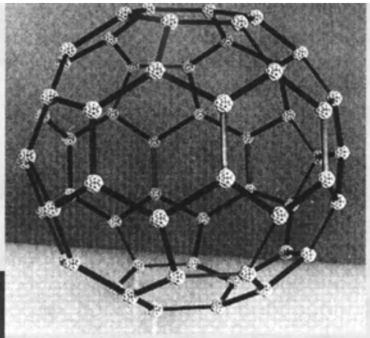
Austria and Hungary both cultivated philosophical traditions oriented toward analytical, social, and scientific concepts: the Galilei and the Sunday Circles in Budapest, and the Vienna Circle. These informal institutions and their discussions produced mathematicians, philosophers, sociologists, and art theorists whose ideas were influential well into the 1960s, went far beyond Europe, and have direct relevance to the present time. György Lukács, Karl Mannheim, Károly and Mihaly Polányi, György Pólya, and Béla Balázs are some who have felt this influence, as well as Ludwig Wittgenstein, Kurt Gödel, Rudolf Carnap, Otto Neurath, Karl Popper, and Ernst H. Gombrich — just to name the most well known. There were also those less well known, such as Leo Popper, who had propagated the term "open art works" as early as 1906, and the precursor of systems theory, Béla Zalai. In particular, the influence of Ludwig Wittgenstein and Ernst Mach can scarcely be overestimated. John Blackmore demonstrates the effect that Mach had on Hungarian scientists (Tódor von Kármán, György von Békésy, György von Hevesy, John von Neumann, Jenö Pál Wigner, Leo Szilárd, and Ede Teller). E. Leinfellner convincingly shows, however, that Fritz Mauthner influenced Wittgenstein. C.J. Nyiri analyzes the specificities of Hungarian and Austrian philosophy from the perspective of the humanities.

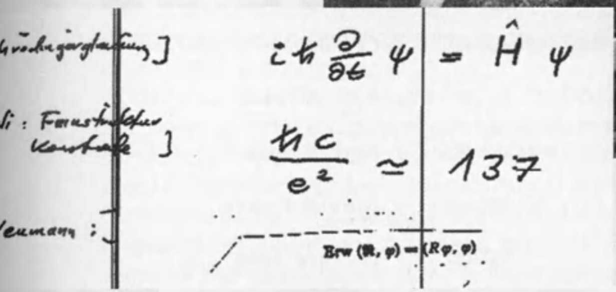
In viewing both art and science as social activities, a new connection between the two developed. This approach was evident in the Galilei Circle (Péter Szegedi), in György Lukács's Sunday Circle (László Ropolyi), in the thoughts of Arnold Hauser (Katharina Scherke), and finally, most radically, in the work of Paul K. Feyerabend (Peter Weibel). Contemporary science and art theory relies on de-emphasizing individual expressive powers and elements in art production. Instead, the social aspect becomes more apparent. Only up to a point is art a pure medium of subjective expression. Rather, it is primarily the product of a social construction formed by the institutions of the art community (artists, collectors, critics, curators, galleries, art societies, and museums).

The tradition of the Vienna Circle, which was shaken by emigration, revolutionized philosophical concepts in close association with the natural sciences. It was fundamental for modern scientific theory in the U.S.A. after 1945. Friedrich Stadler provides here a complete typology of the Vienna Circle; Eckehart Köhler focuses on its philosophical concepts. Arthur Koestler also tried to convey scientific theory to the general public, as the Vienna Circle did (György Kampis). Through Karl Popper, the Vienna Circle also affected the currently most well-known scientific theorist from Hungary, Imre Lakatos (György Kampis).

The use of critical scientific theory to demythologize science — as practiced by Ernst Mach and the Vienna Circle and later continued by Popper, Feyerabend, Lakatos, and Koestler — was a reply to the demythologizing of art as well, which was carried out by critical art history from Ernst H. Gombrich, Ernst Kris, Otto Kurz, and Edgar Zilsel (Nadja Rottner), social critique from Arnold Hauser and Ernst Fischer, and the theoretical and artistic practices of Oswald Oberhuber, Oswald Wiener, and Peter Weibel. This chapter outlines for the first time the stations of a critical, rational, and social understanding of art. This understanding has been subordinated and marginalized in Austria, but has had allies in Hungary. In Austria and Hungary, therefore, there is a living tradition that does not allow for the phenomenological, conservative separation between the aesthetic or the social experience and the technical/scientific one. The linguistic, socio-critical, visual, and active work of the Vienna Group (H.C. Artmann, Friedrich Achleitner, Konrad Bayer, Gerhard Rühm, and Oswald Wiener) anticipated the trends of Happening and Fluxus (see the use of the word "Begebenheit" in the "Literary Cabarets" manifesto from 1959: translated into English, it means "happening"). However, thanks to a change in paradigm — from the perceptual model to the linguistic model as the source for explanations of the world regarding art production — the Vienna Circle's work also anticipated some essential directions in concept art. Here, we will see both Austrian contributions (Heinz Gappmayr, Peter Weibel, Valie Export, Richard Kriesche, Gottfried Bechtold, Wolfgang Ernst, Dominik Steiger), as well as Hungarian (György Kepes, Lászlo Lakner, Balász Beöthy, András Halász, Miklós Erdely).







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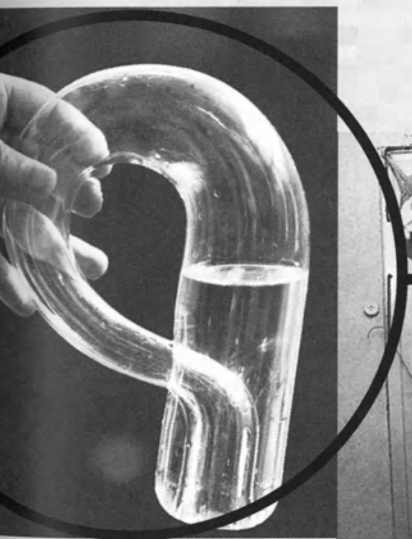

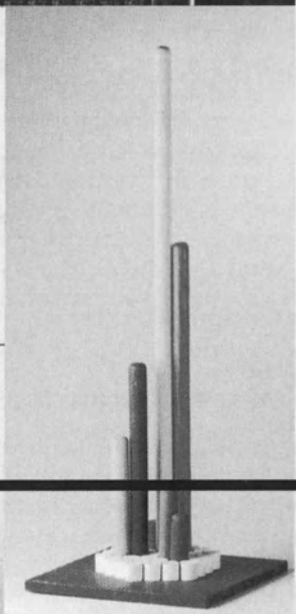

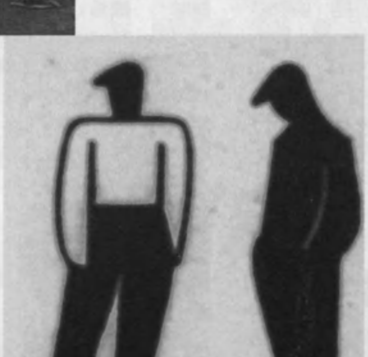

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C.J. Nyíri

The Austrian Element in the Philosophy of Science

Seen from the perspective of its basic convictions and methods, Austrian scientific philosophy does not seem to possess any uniformity at all. The realism of Bolzano or Boltzmann contrasts with the conventionalism and phenomenalism of Mach; the elementism of Mach contrasts with the holism of Wittgenstein; the fallibilism of Mach or Popper stands against the fundamentalism of Schlick; Popper's or Stegmüller's flair for technical terms presents a glaring contrast to the later Wittgenstein's or Feyerabend's preference for colloquial language; the anarchism of Feyerabend is opposed to the traditionalism of the later Wittgenstein or the later Musil; the sociological point of view of Wittgenstein or Fleck is alien to the mainstream attitude of the Vienna Circle. In fact, one could further diversify the picture by pointing out, for example, that there is a difference between the realism or logical objectivism of Bolzano, which postulates a realm of abstract logical entities, and the more commonsense, realist position taken for granted by Boltzmann;[1] or by pointing to the differences that arise between, say, Wittgenstein's romantic, Spenglerian-like traditionalism on the one hand and Musil's somewhat more future-oriented conservatism on the other;[2] or by pointing to the fact that, even within the Vienna Circle, radically divergent trends made themselves felt. Neurath's ideas in particular, and even, increasingly, Carnap's[3] were characterized by a measure of fallibilism and holism, as well as by an awareness of the sociological dimensions of truth and knowledge, as opposed to what was referred to above as the mainstream attitude of the logical positivists.

One can indeed discern a rather strong undercurrent in the history of Austrian thought: the idea that there is a proper place for sociological considerations in scientific philosophy — in the sense that some normative questions, at least, regarding truth or falsity should really be considered factual questions about what is and is not accepted by the scientific community, or about what is handed down through successive generations of this community. Thus, although in Mach's philosophy, for instance, the role of tradition as regards society in general and science in particular is depicted in an overwhelmingly negative manner, he nevertheless concedes that what is handed down fulfils indispensable functions. In his 1883 inaugural address, Mach refers to the "fixed habits of thought,"[4] without which new problems will not become perceivable as such, and to the "importance and utility" of "habitual judgment" and of "prejudice." "No one could exist intellectually," he writes, "if he had to form judgments on every passing experience, instead of allowing himself to be controlled by the judgments he has already formed... On prejudices — that is, on habitual judgments not tested in every case to which they are applied — reposes a goodly portion of the thought and work of the natural scientist. On prejudices reposes most of the conduct of society. With the sudden disappearance of prejudice, society would hopelessly dissolve."[5]

In a similar spirit, Karl Popper writes:

> *What we call social life can exist only if we can know and have confidence that there are things and events that must be so and cannot be otherwise. It is here that the part played by tradition in our lives becomes understandable. We should be anxious, terrified, and frustrated, and we could not live in the social world, did it not contain a considerable amount of order, a great number of regularities, to which we can adjust ourselves. The mere existence of these regularities is perhaps more important than their peculiar merits or demerits. They are needed as regularities, and therefore handed on as traditions, whether or not they are in other respects rational or necessary or good or beautiful or what you will. There is a need for tradition in social life.*[6]

And even Feyerabend, having once more made his peace with Wittgenstein, writes of "standards or rules" that we could not use were they not "well integrated parts of a rather complex and, in places, quite opaque practice or tradition."[7] Indeed rationality is here regarded by Feyerabend as "one tradition among many, rather than a standard to which traditions must conform."[8]

The list of Austrian philosophers of science more or less affected by the idea of the traditional and indeed necessarily authoritarian character of knowledge is, then, quite impressive, including as it does Ernst Mach and Carl Menger, whose *Untersuchungen über die Methode der Socialwissenschaften* (Investigations of social scientific methods), written in 1883, extols the "subconscious wisdom" inherent in what has developed historically and organically. There was also Robert Musil, whose essays written in the 1920s amount to a devastating criticism of his own earlier views on Mach;[9] Ludwig Wittgenstein;[10] Karl Popper; Ludwig Fleck, author of *Entstehung und Entwicklung einer wissenschaftlichen Tatsache: Einführung in die Lehre vom Denkstil und Denkkollektiv* (Genesis and development of a scientific fact: introduction to the study of styles of thought and thought collectives), 1935.[11] Another was F.A. von Hayek, whose *Counter-revolution of Science*, written during the 1940s, and numerous later papers collected most notably in his volume *Studies in Philosophy, Politics, and Economics* (1967) plead for a view of scientific rationality uncontaminated by utopian individualism. Others

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1. "I believe," wrote Boltzmann, "that the task of theory consists of the construction of a pure image of the world which exists in all of us ... it is a possessive drive of human spirit to create such an image and to adjust it more and more to the outer world." Ludwig Boltzmann, *Populäre Schriften*, (Leipzig, 1905) p. 77.
2. See, for example, my papers "Musil und der Begriff der Tradition," *Robert Musil – Theater, Bildung, Kritik*, Josef and Johann Strutz, eds. (Munich/Salzburg, 1985) pp. 143-152; and "Musil und Wittgenstein," Literatur und Kritik 113 (1977: 4) 167-179.
3. As Rudolf Haller points out, Neurath stressed as early as 1913 that all statements of observation are laden with theory, and in fact by the mid-1930s, he had arrived at views strikingly parallel to those of Kuhn and Feyerabend. See Haller, "Die Arten der Erfahrungsbegründung," *Schlick und Neurath – Ein Symposium*, R. Haller, ed. (Amsterdam, 1982), pp. 26 and 33.
4. Ernst Mach, *Popular Scientific Lectures* [1895] reprint, La Salle Ill (1943) p. 227.
5. Mach (1943), p. 232.
6. Karl R. Popper, *Conjectures and Refutations* (London, 1972) pp. 130f. From a paper titled "Toward a Rational Theory of Tradition" (1948).
7. Paul Feyerabend, *Science in a Free Society* [1978] reprint (London, 1982) p. 26.
8. Feyerabend (1982), p. 7.
9. Musil's doctoral dissertation of 1908, "Beitrag zur Beurteilung der Lehren Machs," is now available in English under the title "On Mach's Theories"(Munich, 1982).

were Paul Feyerabend and Michael Polányi, according to whom science is actually "operated by the skill of the scientist,"[12] a skill that can only be passed on by example, even though to learn by example is to submit to authority. By watching the master and emulating his efforts in the presence of his example, the apprentice unconsciously picks up the rules of the art, including those which are not explicitly known to the master. Only a person who surrenders himself that far, uncritically, to the imitation of another can assimilate these hidden rules; this is the person who will "submit to tradition."[13]

One could in fact formulate a thesis to the effect that behind all the apparent diversity there is a core of traditionalism in Austrian scientific philosophy, or at least a continuous line of traditionalist thinking. One could even experiment with a comparison between the Austrian notion of "tradition" and the English notion of "consensus," as explicated in John Ziman's *Public Knowledge*.[14] This, however, is not the line I wish to pursue in this essay. Instead of searching for unifying traits with regard to content and basic outlook in scientific philosophy as practiced by Austrians, I would like to concentrate on the peculiar place of scientific philosophy as a whole, when set against the Austrian background. For there is indeed an Austrian element in the philosophy of science, in the sense that the dimensions of Austrian philosophy of science — as compared to the dimensions of science proper, the predominance of this discipline within Austrian philosophy, and the presence of Austrians in this discipline worldwide — are no less than staggering.

The inventory of Austrian philosophers of science, even if only the leading representatives are listed, is remarkably large. In rough chronological order, one could enumerate Bernard Bolzano, Ernst Mach, Carl Menger, Ludwig Boltzmann, Alois Höfler, Edmund Husserl,[15] Robert Musil, Ludwig Wittgenstein, Hans Hahn, Otto Neurath, Herbert Feigl, Philipp Frank, Karl Popper, Ludwik Fleck,[16] F.A. von Hayek, Richard von Mises, Michael Polányi, and Paul Feyerabend. Not counted here are Brentano, Schlick, and Carnap because of their German origin; Meinong because his interest in the philosophy of science was perhaps merely tangential; Zilsel, Waismann, V. Kraft, B. von Juhos, and W. Stegmüller because the significance of their contributions is still in doubt. By comparison, a list of German philosophers of science would include at best no more than five to eight names: Ostwald, Hertz, Dingler, Reichenbach, Hempel, and possibly the three elective Austrians mentioned above. This contrast becomes especially intriguing if one recalls that in science proper, Germany always had an absolute lead over Austria. Comparing, for instance, the numbers of Nobel Prize-winning scientists, one finds that by 1906-07 — the time when Philipp Frank, Hans Hahn, and Otto Neurath started their fateful routine of meeting weekly in a Viennese coffee house — the number of Germans was seven, and that of Austrians zero. By 1921, the year Einstein won his Nobel Prize, and the year he gave his celebrated public lecture in Vienna, "in an enormous concert hall before an audience of some three thousand people,"[17] the figures were twenty for Germany and one for Austria, Viennese-born Hungarian Robert Bárány having won the Nobel Prize for medicine in 1914.[18]

Philosophy of science very soon became the dominant branch of philosophy in Austria, a state of affairs having no parallel in Germany, England, or France. There is no really first-rate Austrian philosopher who did not contribute to this discipline, and the major figures in Austrian philosophy are practically all major figures in the philosophy of science, too. Or, as Rudolf Haller has put it, Austrian philosophy "appears...as a hidden branch of English empiricism, with the eventual reduction of philosophy to one of its disciplines: the theory of science."[19]

Philosophy of science was not, of course, created by Austrians. From Whewell, J. S. Mill, Poincaré, Duhem, and Russell to Toulmin and Kuhn, the discipline has a distinguished English, French, and American history. But the Austrian presence and, indeed, influence has become enormous. There is the school of Popper. There is Feyerabend. And there is, most importantly, the impact of Wittgenstein. This latter is obvious in Toulmin's case; conspicuous in Hansen's;[20] very important in that of Sellars's,[21] and essential in Kuhn's, whose other main source of inspiration was, of course, Ludwik Fleck.[22]

Now, in attempting to offer an explanation for the preeminence of the philosophy of science in Austria, one must be conscious of the fact that, as with all historical hypotheses, the suggestions made here are of a necessarily tentative character. They are designed merely to open up what may be plausible perspectives and do not amount to propositions capable of definite verification. Three such complementary perspectives will be put forward.

The main characteristics of Austrian philosophy as such bear striking testimony to the fact that the emergence of an autonomous middle class within the Habsburg Monarchy was belated and incomplete. The middle-class values of individual rationality and the sovereign, self-determining personal subject were neither taken for granted in Austrian thought, nor made the object of conscious hypostatization. Hence, both the isolated epistemological subject of Descartes and Locke and the pure ego of Kant failed to play a role within the borders of the Empire. And the Austrian aversion to the notion of a metaphysical self helped from the

10. On the traditionalist elements of Wittgenstein's later epistemology see my papers "Wittgenstein's New Traditionalism," Acta Philosophica Fennica 28/1-3 (1976) 503-512, and "Wittgenstein 1929-1931: Die Rückkehr," KODIKAS/CODE - Ars Semeiotica 4-5/2 (1982) 115-136.
11. Transl. into English under the title *Genesis and Development of a Scientific Fact* (Chicago, 1979).
12. Michael Polányi, *Personal Knowledge: Towards a Post-Critical Philosophy* [1958] reprint (London, 1983) p. 49. It was, of course, in England that Polányi wrote his philosophical works, but he was actually born in Budapest in 1891, and the milieu in which he grew up was so markedly Viennese that it does not seem improper to regard him in the present context as an Austrian philosopher of science. His father, whose name was still Pollacsek, came from the Carpathian region, and his mother, Cecile Wohl, from a Lithuanian rabbinical family. During the 1880s they lived in Vienna. Michael's brother, Karl, was born there, and the family's ties with the culture of that city remained strong for decades thereafter.
13. Polányi (1983), p. 53
14. Cambridge, 1968.
15. Husserl's early work, *Philosophie der Arithmetik* (1891), should doubtlessly be regarded as an Austrian contribution to the philosophy of science, and the *Logische Untersuchungen* of 1900/01 still contain characteristically Austrian elements.
16. Fleck was born into a Lemberg Jewish family in 1896. To see in him a Pole sans phrase, as the editors of the 1980 German reprint of his major work seem to do, is an utter misunderstanding of what Austria was, or of what it was to be an Austrian, at the turn of the century.
17. Ph., *Einstein: His Life and Times* (London, 1948) p. 214.
18. The margin narrowed later, the figures being 56 to 13 by 1970, and here one should, of course, take into account the differences in population. From our present point of view, however, it is only the earlier decades that are of interest, for it was then that the Austrian paradigm in the philosophy of science became established.
19. Rudolf Haller, "Österreichische Philosophie," Conceptus 11/28-30 (1977) 66.
20. Witness his *Patterns of Discovery*, Cambridge, 1959.

very start to direct epistemological attention toward intersubjective cognitive processes, and not least toward the phenomenon of science.

In peripheral Austria, the development of natural science necessarily lagged behind that of the more advanced countries in the West — in particular that of imperial Germany — creating a vacuum, which the theory of a practice so attractively pursued elsewhere could then fill. The early career of Ernst Mach, whose example for, and influence upon, subsequent generations of Austrians can hardly be overestimated, is itself paradigmatic. He entered the University of Vienna in 1855 and was not at all happy there. As he wrote to Hugo Dingler in retrospect:

I never had a teacher of importance outside of the great dead classical authors, for my student days preceded almost all of the reforms of the Austrian universities, which had been allowed by Emperor Franz to go to the dogs. [But] I had no money to attend a German university.[23]

After having received his doctorate in 1860, he wanted to study at Königsberg under Franz Neumann, who had done work on the dynamic theory of light and mathematical research relating to the induction of electric currents. But Mach, as Blackmore puts it, "simply lacked the financial means, nor could he even afford to buy the equipment necessary to carry out satisfactory physical experiments in Vienna. Thus financial pressure drove him in two directions: first, to introduce popular, remunerative lectures, and second, to find a way to carry out inexpensive laboratory experiments."[24]

Such experiments, Mach found, were possible in the application of physics to physiology and psychology. Here, to quote Blackmore again, "he was able to make some progress, even with the most primitive instruments and apparatus or with none at all."[25] And if psychophysics was cheap, philosophy was of course even cheaper. Mach's 1871 lecture on history and roots of the principle of the conservation of work,[26] already contains all the main, radical but facile, philosophical ideas of his later years. "There is one thing we want to maintain," Mach stressed, "that for scientific research, all that is important is recognizing connections. What we imagine behind the appearance only exists in our minds and for us only has the value of a memory or formula whose form, because it is random and neutral, changes easily with our cultural standpoint."[27]

Karl Popper never shared Mach's conventionalism; but he did share with him the experience of finding himself in the close vicinity of science at its greatest and of being caught up in wonder at its possibilities, without, however, really being able to partake in it. He was awestruck by lectures in mathematics and theoretical physics at the University of Vienna,[28] but what absolutely dazzled him was the aura of Einstein's work. Here, Popper felt, was the true scientific attitude:

Einstein was looking for crucial experiments whose agreement with his predictions would by no means establish his theory; while a disagreement, as he was the first to stress, would show his theory to be untenable.[29]

When, in 1921, Einstein gave his public lecture in Vienna referred to above, Popper, too, went to listen to him; but, as he stated in retrospect, "This thing was quite beyond my understanding...I remember only that I was dazed."[30] He was not the only one. "The public was," as Phillip Frank describes the lecture, "in a remarkably excited state, the kind of mental state in which it no longer matters what one understands as long as one is in the immediate neighborhood of a place where miracles are happening."[31]

Philosophy of science has an ideological character that science lacks. The picture of scientific detachment drawn by Max Weber in his *Wissenschaft als Beruf* (Science as a profession, 1919)[32] is surely an idealization. Yet it would still be unheard-of within science proper to attach political labels to this or that position, whereas such labeling has always been widespread in the philosophy of science. To cite some current examples: Wittgenstein's philosophy has been called "conservative" by Prague-educated Ernest Gellner.[33] Both Wittgenstein and T. S. Kuhn have been labeled "undemocratic," "authoritarian," and "elitist" by the Hungarian Imre Lakatos, who maintains, on the other hand, that his own philosophy of science, like Popper's, is "democratic," whereas that of Feyerabend is of course "anarchistic."[34] Some of these labels might be unhappily chosen. But the strong connection between political arguments, on one side, and arguments pertaining to the theory of science on the other, is clear: it was already conspicuous in the writings of Mach and was indeed there even earlier, in the work of Bolzano. This ideological character of the philosophy of science must have clearly had special appeal in a society facing the political dilemmas of relative backwardness.

Introductory chapter to C.J. Nyíri, *A Monarchia szellemi életérő. Filozófiatörténeti tanulmányok* (Budapest: Gondolat, 1980).

21. This becomes especially clear from his early essay, "Some Reflections on Language Games," Philosophy of Science 21 (1954).
22. See Kuhn's "Preface" to his *The Structure of Scientific Revolutions* (Chicago, 1964), p. viii; and his "Foreword" to Fleck (1979).
23. From a letter dated 16 March 1911. cit. J. T. Blackmore, *Ernst Mach: His Work, Life, and Influence* (Berkeley, 1972) p. 13.
24. Blackmore (1972), p. 14. Reflecting upon the achievements of science in Germany after World War I and upon the "abominable economic conditions" there, W. Fischer wrote, "that highest standards could be kept in spite of such relative poverty throws some doubts on the hypothesis that there is a necessary direct link between ample funding of basic research and its quality" in *Science, Technology and Economic Development*, W. Beranek, Jr. and G. Ranis, eds. (New York, 1978) p. 100. But as Fischer himself writes, the German situation was peculiar, since from the time of the Prussian university reforms promulgated mainly by W. von Humboldt there had existed a powerful, established tradition of research and teaching — a tradition destroyed by the Nazis.
25. Blackmore (1972) p. 15.
26. First published Prague, 1872, 2nd ed. Leipzig, 1909.
27. Mach (1909) pp. 25f.
28. K. Popper, *Unended Quest*, op.cit., pp. 39, 54.
29. Ibid., 38.
30. Ibid., 37.
31. Frank (1948) p. 214. By 1945, Nobel Prizes had been given to Austrian physicists Schrödinger, Hess, and W. Pauli. But one can still hear an undertone of frustration when, for example, the essayist Paul Kruntorad writes, "Nuclear fusion, which the German physicist Otto Hahn was the first to carry out in an experiment, was described by Lise Meitner and her cousin Otto Robert Frisch, who coined the term." *A.E.I.O.U.*, P. Kruntorad, ed. (Vienna, 1985) p. 9.
32. See his *Gesammelte Aufsätze zur Wissenschaftslehre* (Tübingen, 1968).
33. See his *Words and Things: A Critical Account of Linguistic Philosophy and a Study in Ideology* (London, 1959) esp. pp. 196, 214.
34. See Imre Lakatos, "Understanding Toulmin," *Philosophical Papers, vol. 2* (Cambridge, 1978) p. 225.

7

György Kampis

Béla Zalai: An Original Hungarian Thinker

Béla Zalai, 1882-1915. Studied mathematics and physics at the University of Klausenburg, philosophy at the universities of Budapest, Paris, and Leipzig. He was influenced by Wundt and Meinong. During this time, his later philosophy, which was anti-psychology and anti-positivism, developed its early characteristics. Between 1911 and 1914, he wrote the key works of his legacy, *On the Types of Reality Concepts, Das Problem der philosophischen Systematisierung, Untersuchungen zur Gegenstandstheorie, Allemeine Theorie der Systeme*, and *Wille der Logik* (incomplete).

Béla Zalai is one of the great, yet little known, personalities from the turn of the nineteenth century and an important figure in Hungarian philosophy, which was just beginning to develop its own character in that period. The neglect of his work can be explained by the unfortunate circumstances: his — especially for a philosopher — very early death in World War I (he was 33), and the subsequent troubles with, and distribution of, his most important manuscripts that hadn't been published during his life. Despite these facts, his influence on Georg Lukács and other members of the Sunday Circle (Vasárnapi Kör) can be pointed out in many respects: Karl Mannheim, Arnold Hauser, and Béla Fogarasi considered themselves as much as students and followers of Zalai as they did of Lukács. Zalai's main work, *Allgemeine Theorie der Systeme* (General theory of systems), which was considered lost for a long while, was published for the first time in 1982.

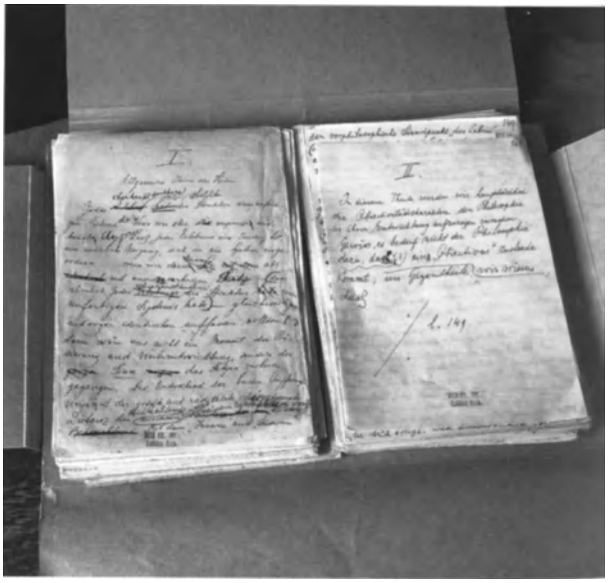
Zalai was born exactly a hundred years earlier, in 1882, in Debrecen. He finished secondary school at the local secondary school (Református Gimnázium) and studied mathematics and physics at the University of Klausenburg (Kolozsvár, today Cluj, Romania). He later studied philosophy at the Universities of Budapest, Paris, and Leipzig. He was soon influenced by Wundt and Meinong. The basic directions of Zalai's later philosophy began manifesting themselves at this time: anti-psychologism and, simultaneously, anti-positivism. He received a Ph.D. in philosophy in 1906. During his short life, Zalai lived under continual financial stress. Working on his own philosophy with an iron will, he earned a living by teaching during the day. Between 1911 and 1914 he wrote all the key works of his œuvre: *A realitás-fogalom typusairól* (On the types of reality concepts), *Untersuchungen über die Gegenstandstheorie* (Studies concerning the theory of objects), and the unfinished *Wille der Logik* (The will of logic). He died in 1915 in a POW camp in Omsk, Russia.

Béla Zalai

Most of his works were left behind in the German original, except for a few, such as *On the types of reality concepts* and *A filozófiai rendszerezés problémája* (The problem of philosophical systematization), which were published in Hungarian. These works appeared in the columns of Athenaeum (the periodical published by the Hungarian Philosophical Society) and *A Szellem* (Mind), a very short-lived philosophical journal (1911-1912) oriented toward French and German metaphysical thinking, edited by Georg Lukács, Lajos Fülep, Arnold Hauser, and (following Lukács' recommendation) Zalai himself. Lukács thought very highly of Zalai: upon his death, he was reported to have said, "he was the most talented of us."

Zalai's most important contributions concern the issues of symbol, thought, logic, experience, sign, and meaning. In these endeavors, he moves (following Husserl's and Cassirer's ideas) toward a version of neo-Kantianism and transcendental phenomenology. The key concept of his main work, the system, should also be understood in this context:

> *There is no isolated scientific fact: each requires an encompassing, general and necessary relation, which is brought forth by a complex of definitions, axioms, hypotheses, and principles. This requirement, or need for expansion, is not merely constructive, or even chiefly so — meaning, it does not exist for the sake of completeness itself. The deepest sense of this requirement is a critical one: a fact, or a process, etc. cannot be understood in and of itself, therefore — in the ideal sense — it cannot exist (if it is not part of a whole). It is the whole that makes it understandable. This critical side of the requirement is the content of our statement: everything that is conceivable has the structure of an incomplete system.*[1]



Béla Zalai, *Allgemeine Theorie der Systeme*, written between 1911 and 1914, first published in 1982 in a volume edited by Béla Bacsó (Budapest, MTA Filozófiai Intézet).

1. Béla Zalai, *General Theory of Systems*, Béla Bacsó, ed. (Budapest: MTA Filozófiai Intézet, 1982) p. 17.

Rudolf Haller

Poetic Imagination and Economy – Ernst Mach as Scientific Theorist

Mach's epistemological phenomenalism — the magnificent idea of constructing the world from those elements that are supposed to be nothing but sensory impressions — seems to have quit the scene of philosophical discussion as a loser.

After Carnap, and later, Goodman,[1] attempted to set up a constitutive system as a rational reconstruction of the structure of the world based on subjective psychology and thereby revealed the unforeseeable difficulty of reducing physical to psychological phenomena, many people immediately sought to abandon the foundation of empiricism, along with the epistemological foundation of the subjective psyche.

It is therefore not surprising that Mach's philosophy, always a philosophy of empirical science, lost the attraction and even the fascination it possessed not only during the great scientist and philosopher's lifetime, but also within the Vienna Circle. With the verdict that positivism was finished and the historical judgment that logical positivism had been killed off,[2] the relevance of Mach's philosophy seemed to recede into the misty and ancient realm of the classics. Only in this way can the judgment of the last occupant of Mach's Vienna chair for the history and philosophy of the inductive sciences, Victor Kraft, be understood. In the postscript to the beautiful volume, *Ernst Mach: Wegbereiter der modernen Physik* (Pioneer of modern physics) by K.D. Heller,[3] Kraft wrote in 1964 that Mach surely was "a historical figure of far-reaching importance," but that his attitude toward epistemology has to be viewed as "outdated." This is a misjudgment, a mistake, even though it comes from a logical positivist. This is not to say that a now-outdated point of view was originally wrong. On the contrary, it is typical for all of scientific research and categorization to be improved, perfected, and surpassed by further, new research. This is how the researcher contributes to decreasing the number of open, contemporary scientific questions in his field, or to raising new questions — research that will broaden or at least promote knowledge. Yet even here the scientist has no guarantee. On the contrary, it is not uncommon to look back and see that his assumptions and convictions did not amount to anything, but were instead unfruitful and even misleading.

If we listen to how contemporary philosophers and scientific theorists judge Mach, the assertion that he is merely outdated comes close to being a euphemism. According to this one-sided judgment, his work would have to be counted instead among the philosophically misleading and unfruitful teachings. There are three assertions about Mach's philosophy of science, which are designed to support the accusation of obsoleteness. The first is, that it is phenomenalistic; second, it is narrowly instrumentalist/inductivist, and third, it is not adequate for science and its theories.

Before we form a judgment in this vague territory of philosophical rumors and second-hand hearsay, it may be appropriate to call to mind Mach's basic ideas about the construction and change of scientific ideas, and to examine them in light of the controversy about philosophical theories of our day.

"Science Emanates from Life"[4]

In contemplating scientific activity there is an advantage in starting with the world in which we live, our environment, in order to examine the continuity of and differences in familiar behavior in a familiar environment from this vantage point. In our environment, the experiential sphere in which we grow up, we learn just like other creatures. Yet we are privileged, because we have the chance to receive all at once, so to speak, the experiences of other individuals — indeed, the experiences of past generations — and of adapting them to our needs. This process is analogous to the process that transfers experiences gathered over the course of millions of years to living beings, so that these experiences are available to future generations as inherited dispositions. Some people have viewed and characterized this very process as "producing knowledge," in which one generation genetically passes on to the next all information that is vitally necessary, promoting selection.

Man, however, belongs to two worlds insofar as he is given not only natural information, but also that of the mind, or more precisely, language. "We are the same sort of thing as others in our physical surroundings, and it is through ourselves that we become acquainted with them."[5] The process of acquiring this conceptual apparatus is highly complicated and initially takes place without reflection and consciousness. If we become conscious at this stage of our learning process (which, moreover, is always a practical stage), then what we find "within us is already a fairly complete world picture."[6] But this conception of the world is, of course, not a priori, as might be suggested by our so-called instinctive knowledge, which inspires a great deal of confidence.[7] This world picture is nothing other than the treasure of experiences, which — as is the case with material worth — concentrates the work of many individuals in one individual. "Not magic therefore," says Mach, "but economy." In science, too, the situation is basically the same. It is just that here the work of many is collected and unified without the necessity of exploiting anyone else's energy — or, as Mach himself says, "without robbing others of anything."[8]

Ernst Mach, born 1838 in Chirlitz, near Brno. Studied mathematics and physics at the University of Vienna, 1855-1860. In 1864, he became a professor for mathematics and later, physics, at the University of Graz. Professor for experimental physics from 1867 to 1895 at the University of Prague. In 1895, he accepted the newly created chair for philosophy, especially the history and theory of inductive sciences. He had a stroke in 1898, which forced him to retire from teaching, but he continued to publish scientific works. Died in 1916 in Vaterstetten, near Munich.

1. R. Carnap, *Der logische Aufbau der Welt* (Berlin, 1928); N. Goodman, *The Structure of Appearance* (Dordrecht, 1977); Philip Frank, "Ernst Mach – The Centenary of his Birth," Erkenntnis (7: 1938) 247.
2. K. Popper, "Der logische Positivismus ist tot: Wer ist der Täter?," *Ausgangspunkte*, K. Popper, ed. (Hamburg, 1979) p. 120-121. See R. Haller, "New Light on the Vienna Circle," The Monist (65: 1982) 25.
3. K.D. Heller, *Ernst Mach. Wegbereiter der modernen Physik* (Vienna/New York, 1964) p. 168.
4. E. Mach, "Notebook, April 1882," *Die Grundgedanken der Machschen Philosophie*, H. Dingler, ed. (Leipzig, 1924).
5. E. Mach, *Erkenntnis und Irrtum* (Leipzig, 1905) p. 135 (abbreviation: EuI); cf. *Knowledge and Error*, B. McGuiness, ed. (Kluwer: 1975).
6. Mach, EuI, p. 162.
7. See Mach's notebook entry dated 1 January 1881, Dingler, p. 15.
8. Mach's notebook, February 1882, Dingler, p. 86.

Mach's inexhaustible and often praised gift for reducing complex or opaque relationships to simple concepts found, in the concept of economy expressed here (the notion of rational cunning, as it would have been called elsewhere), a fruitful start for a concept of the history of the progress of knowledge. The value and extent of this concept are only now fully appreciated.[9]

Mach does not tire of emphasizing the principle of economy, the economical nature of science, as the chief characteristic of all investigations and achievements of knowledge. Again and again, he refers to Austrian political economist Emanuel Herrmann, whom he met during his time at Graz, as the person who inspired this idea.[10] Mach wanted to solve the problem of the dynamics of theories — that is, the question of which principle determines change as well as the progress of hypotheses and theories — with the aid of Herrmann's central concept of economic theory, namely the concept of economy. However, Herrmann himself strove to examine economic problems resulting from the principle of economy using methodology borrowed from the natural sciences. Both scientists were convinced that a separation of man and nature can only be achieved artificially.

> *The petty lines of division drawn between man and the rest of creation by superstition and false beliefs must dissolve in the light of science like fog in the sun; we know only one nature in which man finds a small and certainly quite insignificant place as a participating, cooperatively creative being. It is the very economy of nature (in the old and rotten sense of extra-human existence) that constitutes the most beautiful, most magnificent part of economic doctrine. What is the saving in human labor, buildings, or machines, compared to the economy apparent in the operation and creation of the vital organs of plants and the same organs and mental organs of animals?*[11]

Mach's theory of elements, however, grew out of the idea of the unity of the physical and the psychological: a theory that was so often and readily dismissed as a kind of sensualism that would lead to solipsism. Such an interpretation, however obvious, only too easily obscures the fact that Mach himself wanted to and did take a much more subtle view. Mach argues that a coin appears large and round or large and elliptical if viewed up close, and small and round or small and oval if viewed from a distance. This is to say that the effects an object has are imparted via perception, and thus an object does not seem to be anything but a bundle of perceptions, a complex of perceptions. Taken at face value, Mach's position would seem nothing but a new version of Bishop Berkeley's epistemological idealism or idealistic empiricism. But only the superficial cliché of a positivist specter could overlook the fundamental differences.[12] According to Berkeley, the fact that it is perceived constitutes an entity and the esse est percipi represents a metaphysical determination of what is. In Mach's opinion, however, the question of whether something is an object depends only on the way the elements (which are ontologically neutral) are observed. "It depends on the definite purpose of the observation whether we view A (i.e., an element) as sensation or object."[13] Here, Feyerabend, who is not always dependable because of his hedonistic tendency to reinterpret, is quite right when he states that Mach's "elements are not sensations."[14] Mach's appropriate and independent safeguard against metaphysics is rather the very concept of an element introduced not only as an irreducible part of the complex of sensations but also as an irreducible part of a physical complex.

In his confrontation with Max Planck, in one of his few polemical writings, Mach clearly formulates his point of view, which follows the natural world beyond idealism and realism. Here, he asserts that experience teaches us that what at first sight appears to be directly given is, in fact, not directly and unconditionally given. Even ordinary people are aware of the influence of external circumstances, as well as of subjective psychological and physiological conditions, on our impressions of the world. This is even more true of scientific observations, which, if they appear hallucinatory, must be corrected by the other senses or other persons if they "are to have scientific and therefore social value... Overestimating the exceptional situation [meaning the deception caused by hallucination] easily leads to monstrously idealistic or even solipsistic systems."

Mach also tells us which consequence his interpretation seeks to avoid:

> *It would be strange if the experience of the world were to become so refined that it would be abolished and leave nothing of the world itself but unattainable phantoms.*[15]

Here, Mach contrasts the hypothesis of a shared world as the sum of the objects of experience to the hypothesis that this world itself cannot be experienced without sensory perception and the physiology of the living being. These, he believes, are the facts with which any theory of knowledge must begin. Of course, this is not yet the solution to the fundamental problem of epistemology. It is, nevertheless, a beginning whose

9. See also P.K. Feyerabend, "Philosophy of Science: A Subject with a Great Past," *Historical and Philosophical Perspectives of Science*, R.H. Stuewer, ed., Minnesota Studies in the Philosophy of Science V (Minneapolis; 1970) p. 174; A. Gargani, *Wittgenstein tra Austria e Inghilterra* (Torino: 1979).

10. See E. Mach, *Populär-wissenschaftliche Vorlesungen* (Leipzig, 1896) p. 209; "Die Leitgedanken meiner natur-wissenschaftlichen Erkenntnis-lehre und ihre Aufnahme durch die Zeitgenossen," Scientia (7: 1910) 225.

11. E. Herrmann, *Allgemeine Wirtschaftslehre, vol. 1* (Graz, 1868) p. 21.

12. See K. Popper, "A Note on Berkeley as Precursor of Mach and Einstein," *Conjectures and Refutations*, K. Popper, ed. (London, 1965) pp. 172-173.

13. Mach, notebook entry 1880, Dingler, p. 16.

14. Feyerabend, p. 176. See also R.S. Cohen, "Ernst Mach: Physics, Perception and the Philosophy of Science," Synthese (18: 1968) 132.

15. Mach, Scientia article, p. 235. See note 10.

clarity is convincing, and which is not surpassed by the so-called realists. Similar to Hertz and Boltzmann, Mach views the models that we create from our experiences — namely thoughts — as building blocks of a world whose epistemological value is to be perfected by means of continuous and increasing adjustment. "We seek pictures of facts," Wittgenstein writes in his *Tractatus Logico-Philosophicus*, and the picture is composed of elements that represent the objects. This picture is itself a fact and the "reproductive relation" belongs to it, to a certain extent, as a feeler reaching out toward reality.[16]

Due to its similarity to Mach's concept and the identification of the elements with sense impressions, the Vienna Circle and Carnap's early work in particular were bound to produce a phenomenalist program, picking up where Mach left off, and the *Tractatus* was also interpreted in this vein. Additionally, according to Mach, the goal at first was "the presentation of facts in thought."[17] However, while ordinary cognitive interest — or, as Mach puts it in the manner of his time, "vulgar thinking" — pursues the conceptual completion of observations for the sake of practical cognitive purposes and is therefore wanting, scientific investigation is free from such considerations and hence not only moves away from ordinary views, but constitutes one of them.

The representation of facts in thoughts and the adjustment of thoughts to facts by no means guarantee that the thoughts agree with each other. To put it differently: when constructing a scientific theory, it is not only a necessary to use theoretical concepts, but the concepts also have to "fit" each other and be adjusted to each other. In working out the logical connections, which can be represented in their purest form in axiomatics, Mach sees the essential difference between everyday thought and scientific investigation.

However, "the facts are not compelled to conform to our thoughts..." "It is of course not possible to achieve perfect adaptation to every individual and incalculable future fact."[18] How do we then adapt our thoughts?

The answer to this question, if properly understood, shows once again the fruitfulness of a principle of economy. If we did not have the means to connect the objects of the observable and the unobservable world with the help of simplification and analogy, to reduce the pluralities to unities, we would senselessly stumble about in a disconnected realm of set pieces belonging to all kinds of possible worlds. If, on the other hand, we divide the complexes of facts into theoretical elements, or elements of thoughts, then we simplify, schematize, idealize. "The aim of research is to discover the equations that subsist among the elements of phenomena."[19] We must, of course, not expect Mach to be in a position to present a semantically clarified definition of these concepts. Brentano pointed out in a sharp and penetrating critique of Mach's *Erkenntnis und Irrtum* (Knowledge and error) that both Mach's concept of similarity as partial identity and his concept of analogy were not sufficiently and satisfactorily analyzed.[20] And the physical equations express here "indeed, a mathematically conceivable relation," but the logical scope of these relations is limited by experience. Those who so readily advocate and propagate the total theory dependency of empirical concepts, such as observation, all too easily forget one of the pillars of their critical argumentation, namely, that "there is no inductive necessity other than a logical necessity, such as a physical necessity."[21] Even if we assume that the simplest law corresponding to our experience holds, there are nevertheless no grounds to assume that the simplest case will occur. Wittgenstein's formulation in the *Tractatus* is a clear echo of the Hume/Mach position:

> *A necessity for one thing to happen because another has already happened does not exist. There is only logical necessity. At the basis of the whole modern view of the world lies the illusion that the so-called laws of nature are the explanation of natural phenomena.*[22]

Therefore, there is no explanation. The logic of inquiry shows us that the adaptation of thoughts to facts is nothing other than their description. It was a credo of Mach's philosophy that the act of description meant the concentration, the condensation of all experience, and that theories are nothing but the systematic summary and categorization of these experiences. But Mach did not characterize these descriptions as assertive (much less apodictic) judgments, propositions that are either true or false. Rather, he maintains[23] that all empirical statements can only be hypothetical:

> *A proposition of natural science always has a merely hypothetical sense: if fact A corresponds precisely to concept M, then consequence B corresponds precisely to concept N; the two correspondences have the same degree of accuracy. Absolute precision — the perfectly exact, unambiguous determination of the consequences of a presupposition — in natural science (as in geometry) does not exist in sensory reality, but only in theory.*

Mach is of the opinion that two main reasons compel us to regard descriptions not as assertive or apodictic, but as hypothetical judgments or statements. The first and most profound reason is that science provides an

16. L. Wittgenstein, *Tractatus logico-philosophicus*, 2.1. to 2.174; see also Wittgenstein's early journal entry dated 15 October 1914: "In the sentence, we put together things, which, in reality, don't need to behave that way, as a test, so to say," L. Wittgenstein, *Schriften 1*, (Frankfurt/Main, 1960) p. 101. Cf. *Tractatus Logico-Philosophicus* (London: Routledge, 2001) (abbreviated as T.L.Ph.); *Philosophical Investigations: The German Text, with a Revised English Translation* (London: Blackwell, 2002); and L. Wittgenstein, *Zettel*, G. H. von Wright, ed. (University of California Press, 1976).

17. Mach, Eul, p. 3.

18. Mach, Eul, p. 447. See also Mach, *Populärwissenschaftliche Vorlesungen*, p. 211 (note 10).

19. Mach, Eul, p. 221. See also Mach, "Über das Prinzip der Vergleichung in der Physik," *Populärwissenschaftliche Vorlesungen*, p. 264 (note 10).

20. See F. Brentano, "Bemerkungen zu Ernst Machs ‚Erkenntnis und Irrtum,'" unpublished manuscript, *Studien zur österreichischen Philosophie, vol.* 6, R. M. Chisholm, J. CH. Marek, eds. (Amsterdam).

21. Mach, *Die Principien der Wärmelehre* (Leipzig, 1896) p. 435. Translated into English as *Principles of the Theory of Heat* (D. Reidel, 1987).

22. Wittgenstein, T.L.Ph., 6.37 and 6.371 (see note 16).

23. Mach, Eul, p. 448.

adequate picture of the facts and their conceptual, real connections only as a goal. As an inquiry or, as Mach says, as "becoming science," it exists in the realm of conjecture. Each hypothetical or theoretical value, therefore, is at first related to a field of particular circumstances with the hope of extending it to corresponding, similar, and analogous cases. This "intended field of application" of a basic theoretical idea arises, so to speak, with the birth of the hypothesis or theory itself. From here, new problems emerge, which lead us to new hypotheses and so on. Viewed from the goal, or retrospectively, hypotheses have a "self-destructive function," as Mach characterizes their tendency to successfully adapt to facts.

The second reason lies in the temporal nature of events as well as in the temporal nature of opinions or notions of events and facts. Mach says in the introduction to his lecture, *The History and Roots of the Principle of the Conservation of Work* (1872), "history has made everything; history can change everything."[24] If a change in ideas were not expected, it would be enough to store the accomplishments of the past in one's memory, or even better, to relinquish this work to automatons. But just as there is no necessary sequence of events in nature itself, there is also none in the history of nature or human ideas. Mach reminds us that there are hypotheses that last only moments, as when we dismiss an idea at once. There are those, however, which persist for hundreds or thousands of years, such as Ptolemaic cosmology. "Absolute forecasts, consequently, have no significance in science."[25] But despite the realization that "history has made everything; history can change everything," Mach did not become a proponent of anarchic epistemology, as is common today among so-called anti-positivists. He is also not ailing from the semi-skepticism of critical rationalism, whose clichés he definitely opposes. Whoever reads Mach will easily discover how much even those who are so eager to attack him owe to him — even take from him.

I mentioned at the outset that Mach emphasizes the principle of economy as the characteristic principle for distinguishing scientific from non-scientific ways of knowing. Most importantly and primarily, history, methodological conjecture, investigation, and representation of an area of facts are to be preferred, since they are scientifically justified, as opposed to a merely accidental gain in knowledge. Thus the method of discovery as well as the systematics of representation are subjected to the principle of economy. Or, as Pierre Duhem states, in full agreement with and in the spirit of Mach, "the economy achieved by the substitution of the law for the concrete facts is redoubled by the mind when it condenses experimental laws into theories."[26]

I am surprised that something fundamental to this controversial principle has evidently been forgotten and is in a position to be rediscovered. Both interpreters and opponents of the principle of economy overlooked the fact that in the rational theory of decision-making, we of course proceed analogously to Mach. Someone who does not agree with the rules and norms of a rational theory of action or in the realization of desires and purposes cannot be refuted any more than a single theory in the history of science could be falsified by exceptions. We would have to say of such a person that he is acting unreasonably, just as an anomaly disturbs the rational order of concepts in a system. However, the concept of rationality itself has by no means been clarified, even to this day.[27] Furthermore, rationality is a relative concept that both considers and refers to the kind of knowledge (or basis of information) that people have at their disposal, as well as the goals they pursue. As everyone knows, there are well-developed theories in which the expected utility — the worst or the best result possible among possible alternatives — can be calculated.[28] These models and theories, as incomplete and irregular as they may be in the present state of investigation, seem to be splendid confirmation of Mach's initial attempt to investigate how the most useful, economical way can be found to attain a given goal: namely economy, which is nothing other than the basic hypothesis of scientific rationality — the rationality that makes understanding and comprehension possible.

Finally, at this point, the question arises of the role imagination (mentioned in the title) plays in this kind of process, which, after all, has its own genesis. Preference is not given to poetry, as contrasted with facts (the comprehensive knowledge of which is the aim of investigation).

To be sure, the conjunction "and" is patient, and with its help, even the greatest inconsistency can be connected. What, then, justifies placing poetic imagination next to the basic principle of rational scientific investigation, as if the structure of science rested on both of these pillars?

The view expressed here is, in accordance with Mach, precisely that only these two principles are needed in order to understand the genesis, dynamics, and the goal of scientific research. If the veil is removed from the birth of scientific hypotheses — a veil created primarily by relegating heuristics to the realm of the incomprehensible, to that which cannot be rationally reconstructed[29] — then we might be unimaginative enough to attempt to discern behind it again the discredited induction. And we are disappointed if we do not find it. In *The Principles of the Theory of Heat* we read:

24. Mach, *Die Geschichte und die Wurzel des Satzes der Erhaltung der Arbeit* (Leipzig: 1909). See also A. Höfler, "Zur Geschichte und Wurzel der Machschen Philosophie," Zeitschrift für den physikalischen und chemischen Unterricht (23: 1910) 1; and E.N. Hiebert, "Mach's Philosophical Use of the History of Science," *Historical and Philosophical Perspectives of Science*, R.H. Stuewer, ed., Minnesota Studies in the Philosophy of Science (Minneapolis, 1970) pp. 184-203.

25. Mach, *Die ökonomische Natur der physikalischen Forschung*, p. 223.

26. P. Duhem, *The Aim and Structure of Physical Theory* (reprint, Princeton UP, 1991); *Ziel und Struktur der physikalischen Theorien*, translated into German by F. Adler, with a foreword by E. Mach (Leipzig 1908).

27. See also R. Haller, "Wie vernünftig ist der Common Sense?", *Wandel des Vernunftbegriffs*, H. Poser, ed. (Freiburg, 1981).

28. See also, for example, R.D. Luce & H. Raiffa, *Games and Decisions* (New York, 1957); W. Stegmüller, *Normative Theorie des induktiven Räsonierens* (Berlin, 1977); C.G. Hempel, *Aspekte wissenschaftlicher Erklärung* (Berlin, 1977); W. Spohn, *Grundlagen der Entscheidungstheorie* (Kronberg, 1978).

29. See K. Popper, *Logik der Forschung* (Vienna, 1935).

Those who have dealt with research or the history of research will have difficulty believing that discoveries are made according to the Aristotelian or Baconian scheme of induction (by enumerating identical cases). If that were the case, discovery would be quite a cozy business.[30]

What misconceptions in the estimation of positivism had to occur, that such passages in Mach could be overlooked, missed, or not read? And how much propaganda is necessary to give such mistaken judgments a measure of credibility! In the conclusion, I intend to return to this point briefly — a point closely connected with the latest developments.

If, as we have heard, discovery cannot be a very cozy business because it is not possible to rely on past experiences in order to imagine new things, what, then, is it that enables us to see, or learn to see, facts in a new light?

It is the work and role of the imagination, which is, according to Mach, the only thing in a position to lead us away from what we habitually expect again and again. Those who begin to let their imagination roam, leaving the shackles of everyday life behind, plunge into the infinite realm of possibility to work on every possible world, regardless of whether they enjoy it or not. Ultimately, they even leave these worlds behind and cross the line of what is really possible to the objects that are logically impossible. If the concept of the perpetual motion machine is an example of the former, then every indirect mathematical and logical proof that shows the assumption of the opposite of what is proved to be absurd, is an example of the latter. This is also the place for associations, which lead us, without any effort on our part, to places we would not reach without their seductive, capricious charm.

Without going into detail, it may be appropriate to distinguish between two forms of imagination. One form continues the possibilities of actual events and thus makes it possible for us (afterward, as with dreams) to remain in the everyday world without wants and anxieties, even if the stream of events has long flowed past us. The other rises, so to speak, above the events and creates a separate structure of relations, where the intellect, unconscious of its actions, is quite capable of intervening and, from within the overlapping nets, spinning its own web, if I may use this image. Expressed less picturesquely, while the first mode follows the usual patterns or life and experience, substituting alternative courses of events for real ones, the latter mode constructs things, stories, and structures, whose nature was hitherto unknown; this really is poetic imagination.[31]

Mach himself does not distinguish between these two types, but simply assigns to the imagination the role of differentia specifica for the animal organism of the human being. For him, poetry is "the first step up from the everyday burden of life,"[32] and poetic dreaming is not only the very beginning of all mental development, but the source of the completion of hypotheses and theories. To remind ourselves, what, after all, are the constituents of those facts that we subsume under laws? "Simplification, schematization, idealization": every theoretical concept is also a product of this disposition.

Every alteration appears to upset stability, to dissolve what existed until then, abolishing the accustomed condition, and so disturbing us and posing a problem, which drives us to look for a new connection and inquire into the cause.[33]

Abstractions and imagination do the main work in the process of discovering new knowledge. The fact, emphasized by Whewell, that method can do little here, makes clear the mysterious feature that he believes is attached to so-called 'inductive' findings.[34]

First, the result helps us to understand what always seems to have been difficult for other interpreters, namely, why Mach assumes that the knowledge of facts, as well as the knowledge of error with respect to facts, have the same source. From a phenomenological point of view, our imagination is active in both instances, either following the event alternatively, or constructively and poetically. This makes it possible for us in the empirical sciences to add to the experimental methods the important method of mental experiment, which the scientist shares with those who build castles in the air — namely the novelists and science fiction writers (technical utopians). While it is hard to explain how to do mental experiments, Mach indicates a way: use paradoxes. "These [paradoxical situations] not only give us the best feeling for the nature of a problem, since paradox is what makes a problem, but contradictory elements will not allow thought to rest."[35]

If knowledge and error therefore cannot be distinguished by means of their genesis, how, then, can truth be separated from falsehood, if everything is not to sink into the unknowable realm of mere conjecture?

Mach's answer to this question once more connects the two principles with his biological, evolutionary basic outlook[36] and with the realistic attitude of a great physicist and natural scientist who himself frequently

30. Mach, *Principles of the Theory of Heat*, p. 443 (see note 21).
31. Mach, EuI, p. 154.
32. Mach, EuI, p. 97.
33. Mach, EuI, pp. 272-273.
34. Mach, EuI, pp. 313-314.
35. Mach, EuI, p. 193.
36. See M. Capek, "Ernst Mach's Biological Theory of Knowledge," Synthese (18: 1968) 171.

37. Mach, Eul, p. 237.
38. Mach, Eul, p. 210.
39. Mach, Eul, p. 448.
40. Compare Mach, Eul.

erred. His answer is simple: only experience provides this distinction. He talks about an "intellectual risk" that one takes, and he asserts that the intellect of a genius differs from the normal intellect precisely because of "the certain expectation of the success of an intellectual move." In other words (and expressed in theses), the following picture of the structure of scientific theories emerges:

1) "The essential function of a hypothesis is that it leads to new observations and experiments, which confirm, refute, or modify our surmise and so widen experience."[37]
2) The negative result of an experiment — that is, the falsification of a hypothesis — must, however, "never be regarded as decisive."[38]
3) An "unambiguous determination of the consequences of a presupposition in natural science...does not exist, but has to be checked by using deduction — not in reality, but only in theory."[39]
4) The result obtained through any quasi-inductive procedure has to be checked deductively.[40]
5) Science, like any other creation of man, is a product of history. History easily leads to prejudice and allows people to cling to old ways.
6) Not only is there an evolution of life, but also of knowledge; knowledge itself promotes life.
7) Only poetic imagination makes it possible to discover new methods and problems, the value of which always remains dependent on success, either by adjusting to the existing theoretical structure or, sometimes, by breaking with it.

Contemplating these seven theses, which could easily be supplemented with many other compatible ones from Mach's work, is like opening a work in the theory of science of our century: All these thoughts can be found again almost without modification as the living accepted treasure of knowledge. And this thought can also be found in those who elsewhere in their writings list Mach among those who contributed to a false understanding of science. Can there be greater, more vivid success for a concept than that it is used and recognized after a hundred years even by its alleged opponents?

Rudolf Haller, Friedrich Stadler, eds, *Ernst Mach – Werk und Wirkung* (Vienna: hpt, 1988) pp. 64-87.

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Rudolf Haller, *Facta und Ficta* (Stuttgart: 1986).
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7

John Blackmore

Mach's Influence on Six Great Hungarian Scientists

1. Introduction

It is time to acknowledge that Hungary was the birthplace of many great twentieth-century scientists and that secondary education in Hungary was so good that it made greatness not merely possible but likely. Furthermore, it is high time that we recognize that Ernst Mach, the great Austrian and Moravian physicist, had a significant influence on the direction or nature of the scientific work of several of these Hungarian scientists, and in some cases, on their philosophical outlook — at least early in life, and, upon occasion, for a much longer period.

What is perhaps most remarkable about these great Hungarians is the homogeneity of their backgrounds. They were mathematically inclined physicists or chemists with a knack for applied science. Most were educated at home first and then later in excellent high schools. They were taught a number of languages. Many knew each other well. Most worked in German universities during the 1920s, and all but one would eventually immigrate to England or America, where they became famous, but where the Hungarian nature of their background often tended to be overlooked. So much so, indeed, that in spite of many biographies, few have included much information about their formative years. On the other hand, the history of Hungary itself, with its political oscillations between extreme left and right, has not made it easy for most Hungarians themselves to fully appreciate these émigrés, so that the Hungarian-born scientists that Hungarians currently honor are usually not the ones the world honors most.

There are also some other hallmarks that are not assigned to all of these great men, perhaps due to incomplete information. All, or virtually all, were Jewish, came from Budapest, and had an amazing mathematical or research ability that enabled them to rise quickly to the top in foreign countries. And, in a perhaps completely unrelated sense, they all were (apart from Wigner) gregarious and enjoyed joking — and several quickly became friends of Albert Einstein.

Who are these great scientists, who, during periods of their life, were either scientific or philosophical followers of Mach? Our list includes four scientists whose last names included a "von," which may seem to be an odd title for a Hungarian, but is quite understandable when we realize that, in most cases, it was the fathers of these great scientists who received these titles from Franz Josef, the Austro-Hungarian Emperor himself. The famous four "vons" in our account are: von Kármán, von Hevesy, von Békésy, and perhaps the greatest genius of them all, von Neumann. Among the great twentieth-century Hungarian scientists without a title were the three famous atomic scientists, Szilárd, Teller, and Wigner, who not only combined to warn Albert Einstein (and, indirectly, President Franklin Roosevelt) of the danger of allowing the Nazis to build atomic weapons before the democratic nations had completed theirs, but who played important roles in the actual development of nuclear power. To this list, we could also add Mihály (Michael) Polányi, the physicist-philosopher who interacted with most of the great Hungarians during his scientific career in Germany.

Naturally, in a short article we cannot enumerate everything that made them great. The best we can do is to touch on their famous work while indicating Mach's influence on them. But even this can add to scholarship, since in several cases, Mach's influence is either unknown or little known.

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J. Blackmore, R. Itagaki, S. Tanaka (eds.), *Ernst Mach's Vienna 1895-1930: or Phenomalism as Philosophy of Science* (Dordrecht/Boston/London: Kluwer Academic Publishers, 2001).

2. Tódor von Kármán (1881-1963)

It is perhaps appropriate that the father of Tódor von Kármán was a famous humanist and educator who was highly instrumental in helping to establish the Hungarian secondary school system and its high standards. It was also he who established a special teacher-training school, called the Minta, the Trefort Street School, or, simply, the Model School. Von Tódor, who was born in 1881 as the third of five children, attended the Minta, which was often considered the best secondary school in Hungary.

Tódór von Kármán

His gift for mathematics and physics became conspicuous when he won the Eötvös Prize, the leading secondary school award in Hungary, named after Hungary's leading physicist, Loránd Eötvös, who is best-known today for his experimental investigation into the ratio between gravitational and inertial mass. His detailed work on surface tension also inspired an article by Albert Einstein. Eötvös dominated Hungarian physics for forty years.

Von Tódor attended Palatine Joseph Polytechnic school, where he discovered that his real ability was in solving engineering problems with the help of deep mathematical theory — that is, using methods other than trial and error or empirical laws on one hand, and trying to solve fully abstract or idealized problems on the other. He correctly believed that mathematics and theory could explain genuine, concrete problems — or at least real types of such difficulties — if one had enough background, insight, imagination, and feeling. After graduating and then completing his military service, he accepted a position in the Budapest Polytechnic as an assistant professor. But von Tódor's father felt that his son's potential could only be reached by further study abroad.[1] Thus in 1906, one year before his father was ennobled by Franz Josef, von Tódor moved to Göttingen in Germany, which was — thanks to the presence of Hilbert, Klein, and others — the mathematics capital of

1. Our information is taken primarily from Theodore von Kármán's and Lee Edson's *The Wind and Beyond – Theodore von Kármán. Pioneer in Aviation and Pathfinder in Space* (Boston/Toronto: Little Brown and Company, 1967).

2. John H. Lienhard, "Ludwig Prandtl," *Dictionary of Scientific Biography* (New York: Scribner, 1975) p. 124.
3. J.L. Heilbron, "Theodore von Kármán. Transcript of a Tape-recorded Interview, June 29, 1962" (College Park, Maryland: American Institute of Physics, Center for History of Physics) p. 4.

the world. Von Tódor enrolled as a student and then became a lecturer under Klein's follower, Ludwig Prandtl, a determined and very able scientist who obeyed Klein's desire to emphasize applied mathematics. Prandtl is sometimes called "the father of aeronautics." One of his biographers, John Lienhard, writes:

> *During his first years there [Göttingen], he made lasting contributions to the theory of supersonic flow. He combined Riemann's theories with Mach's Schlieren flow visualization apparatus to obtain the first explanation of the behavior of supersonic nozzle efflux.*[2]

But while Prandtl knew of Mach's work on shock waves, which he photographed to make them visible, he was determined to go beyond Mach's flow descriptions by attempting to discover explanations capable of being put into mathematical form. Von Kármán initially had other interests.

Theodor von Kármán, as he called himself in Germany, came to Göttingen intending to continue work on a project he had started in Budapest, namely, to understand more about the "buckling effects of non-compressible materials." Prandtl's stiff personality and (in Kármán's opinion) naïve, unworldly attitude made it hard for the cosmopolitan, fun-loving Hungarian to fully appreciate him. Nevertheless, he apparently learned much from Prandtl's lectures, despite his wooden style of delivery. But being unable to obtain a machine suitable for his buckling work, he soon left Göttingen. Prandtl finally got the machine needed from the Krupp Steel Works and von Kármán returned. But after receiving his doctorate, von Kármán left Göttingen again, this time for Paris, where it seems he hoped to enjoy life and have a good time.

In short, von Kármán's interests began to change, from an interest in engines and buckling effects to fluid mechanics, the science of flow, "which was to dominate my later life." But this was also Prandtl's field of primary interest.

For decades, Prandtl and von Kármán were the dual leaders of theoretical aeronautics. Von Kármán passed through many stages in his relationship with Prandtl — from student to assistant, to colleague, and finally to rival or competitor, and indeed they would often strive to improve upon or expand each other's work. For all of Von Kármán's brilliance — and he certainly had the greater imagination — Prandtl's experimental, mathematical, and applied work, as well as the work of his students, often advanced aeronautics just as much, at least until the late 1930s.

Let us now turn to von Kármán's contact with Mach's ideas and touch on his own contributions to aeronautics. Like Prandtl, von Kármán naturally became familiar with Mach's work on shock waves, and the two men contributed much more to our understanding of them, but he also had an interest in Mach's philosophy. Von Kármán's father, who was a self-acknowledged follower of the nineteenth-century educational philosopher, Johann Friedrich Herbart, had taught his son that the purpose of natural science is not to understand the real world, but to relate aspects of appearances in a consistent manner, which is surely a position Mach would have taken. Or, as von Kármán put it in an interview with John Heilbron on 29 June 1962, shortly before his death:

> *My general philosophy was perhaps very different from most of the physicists. Most of the physicists believe there is a truth that the world is made in a certain way. And I, following my father's philosophy, said, ‚It is a very funny point of view. Why is the good Lord hiding...why doesn't he just tell us?' So my father said that all science is only an organization of our observations. This is also Poincaré's standpoint, and Ernst Mach said that it had nothing to do with the truth, that we believe in an explanation that is the most economic as far as thinking is concerned. That everything depends on our senses is self-evident.*[3]

In those gracious days on the eve of World War I, an era without passports and long before Hitler, it was indeed still possible for a Hungarian Jew to become a full professor in Germany. In fact, von Kármán taught at Aachen from 1913 until 1930, when, after much soul-searching, he accepted a position at the California Institute of Technology in Pasadena, which he held until retirement. But von Kármán could not break his old habit, although in this case it was not his fault. Trapped in Budapest by the end of World War I and unable to return to Aachen, he accepted an offer from the liberal Károly government to become an undersecretary for universities, a position he kept under the Béla Kun communist dictatorship; however, the latter lasted only for a few months. Understandably, fearing retribution from the conservative Horthy regime, which replaced the Bolsheviks, he then scurried back to Aachen, a position which, fortunately, had remained open.

As for science, let us turn to a brief description of von Kármán's best-known discovery and its relation to Mach's work — a discovery that seems to have taken place in 1911 while von Kármán was still in Göttingen. Mach, with the help of his instrument-making son, Ludwig, had studied and photographed bullets during the 1880s, making waves both below and above the sound barrier or what we now call "Mach I." But Prandtl reversed matters with his wind tunnel, by making the atmosphere move and keeping the projectile stable. The clear advantage to the new approach was that all kinds of objects of any shape could be put in the wind tunnel for analysis, not just those that were bullet-shaped or those that seemed to have good aerodynamic qualities. He could also experiment with elements other than air.

During one experiment with water, Professor Prandtl had a student put a cylindrical object in the flow, hoping that the student would be able to measure pressures on different parts of the cylinder, but the student kept finding that the pressures he measured on the tube were continually fluctuating. According to the story (and few people could tell them better or more often than von Kármán), Prandtl blamed the failure on the student and the cylinder. Prandtl thought at first it might be due to roughness on the surface of the cylinder. So, with the famous German thoroughness, Hiemenz (the graduate student) made the cross sections of the cylinder exactly circular by grinding, measuring, and more grinding. He placed it carefully in the channel, turned the water on, and prepared to measure. With perfect perversity, the water continued to oscillate down past the cylinder, shaking the cylinder back and forth in the process.[4]

Many other suggestions were made, to no avail. Passing by, von Kármán would ask, "Mr. Hiemenz, is it still oscillating?" And he would reply sadly, "yes, always it oscillates."[5]

> *One Friday, I remember, I could stand the suspense no longer. That weekend, I decided to go after the reason for the untidy oscillation, not out of pity for Hiemenz, but out of curiosity. I had a strange hunch that the solution was mathematical. It would be exciting to prove the point.*[6]

Von Kármán went on, solved the problem, and, it is generally thought, had his work confirmed in spectacular fashion when the Tacoma Narrows Bridge collapsed in 1940 from a strong wind, which had created von Kármán vortices. His work in America consisted largely of teaching, advising, and helping to set up new institutes to further the development of aeronautics, not least in his role as co-founder of the NASA Jet Propulsion Laboratory in Pasadena. His emphasis on theory and his special ability to solve problems using the kind of applied mathematics that Felix Klein had considered so important set the tone for the future.[7] And in the New World during World War II, Theodore von Kármán's work and that of many other Americans would finally surpass that of Prandtl, his teacher and rival. He was not the first great Hungarian scientist, but his ability to work in many lands and become internationally well-known did set an apparently new pattern for many Hungarians who followed.

3. György von Békésy (1899-1972)

Mach's main contributions to experimental science were surely (1) his work on what are now called "Mach bands," which are inhibitory sensory phenomena, (2) "Mach shock waves," which differ from mere sound waves, as they can be accelerated to supersonic speed, and (3) his discovery of the equilibrium function in the inner ear, i.e., our sense of balance. György von Békésy was influenced significantly by all three of Mach's major experimental contributions, and he advanced our understanding of the human ear, as well as of the inhibition effects in the ear and in other sensory organs of the brain. He received a Nobel Prize in physiology and medicine for his work in 1961.


György von Békésy

Given his exposure to so much of Mach's scientific work, it would be reasonable to suppose that he may also have been influenced by Mach's philosophy, but unfortunately, our knowledge of Békésy's personal life and philosophy is far too meager to allow such a generalization, regardless of how plausible it may sound. He was not in Germany when most of the other great Hungarian scientists were studying or working there, and he seems not to have been as socially or intellectually active in this group. An apparent result of this and other factors is that much about his life and philosophy still remains an open question — which we hope future research will resolve.

What we do know is that he was the son of a Hungarian diplomat and was schooled in Munich, Zurich, Budapest, and Istanbul. He was gifted in music, interested in art, and attended the University of Bern in 1916, where he studied mathematics, physics, and chemistry.[8] After military service, he earned a doctorate in physics in Budapest in 1923. He was hired by the Hungarian Post Office to help solve the technical problems that plagued the newly installed telephone system.

Von Békésy was asked if the main problem lay in the microphone, the transmitting line, or the earphone. He decided that the major difficulties were in the membranes of the earphones, and this in turn got him interested in the human ear. Helmholtz's book on acoustics had been the main reference guide since the 1860s.[9] Ernst Mach, Crum Brown, and Josef Breuer had challenged Helmholtz during the 1870s about the function

4. Von Kárman, Edson, *The Wind and Beyond*, p. 62 (see note 1).
5. Ibid.
6. Ibid., p. 63.
7. For Von Kármán's extensive commentary on Mach's contributions, which helped lead the way to supersonic aerodynamics, see the chapter "Supersonic aerodynamics" in his book *Aerodynamics – Selected Topics in the Light of their Historical Development* (Ithaca: Cornell University Press, 1954) pp. 103-123, p. 141.
8. Anonymous, "Georg von Békésy," *Nobel Prize Winners*, Tylor Wasson, H.W. Wilson, eds. (New York: 1987) p. 76.
9. Hermann von Helmholtz, *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik*, 1863.

Robert Bárány

of the inner ear and discovered that, in addition to hearing, the equilibrium function was also important.[10] In Vienna in 1909, Robert Bárány, an Austrian with a Hungarian name, discovered a method for diagnosing a disease of the semi-circular canals in the inner ear and was awarded a Nobel prize in 1914. Thus, von Békésy chose to enter a field where illustrious predecessors had already begun investigations and where progress was rapidly being made.

Since the anatomy of the inner ear was rather well known by the 1920s, von Békésy asked the question of how the basilar membrane vibrates when the eardrum is exposed to sound pressure.[11] Von Békésy experimented largely on the cochlea of guinea pigs. It is said that four competing theories had been proposed to account for the ear's ability to distinguish different pitches of sound. Instead of simply selecting one theory, von Békésy tried to find what was common to all four, simulating them all by varying the thickness of the membrane. He concluded that the proper method was to measure the elasticity of volume. The measurements he carried out showed that the vibrations in the basilar membrane were what were called "traveling waves." An anonymous source on von Békésy's work continues as follows:

> *Although a traveling wave in the tiny cochlea moves the entire basilar membrane, one section moves more than the rest. The location of this peak seems to depend on the frequency of the stimulating vibration; for high sounds it is closer to the middle ear, and for low sounds it is closer to the apex. The brain receives information about the location of the peaks from nerve fibers in the cochlea and uses this message to differentiate high- and low-pitched sounds.*[12]

In 1928, von Békésy decided that inhibiting effects in the inner ear restricted what was consciously heard, an opinion that Mach had had regarding visual phenomena as early as the 1860s. Mach had discovered what are now called "Mach bands," which existed on both sides of the boundaries between different colors: scarcely visible bands of the other color help to enhance the boundary, to make it more noticeable. Such bands are most easily detectable when a color wheel with contrasting colors is rapidly revolving.[13] As Von Békésy did in the 1920s, Mach theorized in the 1860s that inhibition phenomena were largely responsible for the very selective character of what is perceived. It should be pointed out however, that Mach's work had to be rediscovered by Haga and Wind around 1900,[14] and that it was probably von Békésy's acquaintance with Mach's work on the inner ear and shock waves that somehow encouraged him to check neglected papers by Mach, Haga, and Wind on Mach bands.

Von Békésy became a professor at the University of Budapest in 1939 and remained in Hungary until the end of World War II. Realizing that he would not be able to find financial support for his research at home, he accepted an invitation from Stockholm. The following year he moved to the United States to work at Harvard University.[15] In 1966 George von Békésy became professor of sensory sciences at the University of Hawaii. He was a devoted art collector with a special interest in Oriental art. He eventually bequeathed his entire collection to the Nobel Foundation.

But there is more to the story. Extensive work on Mach bands has continued in subsequent years, highlighted by Floyd Ratliff's wonderful book titled *Mach Bands* (1965), which also includes English translations of Mach's articles and a discussion of Mach's life and philosophy. Yet the big news, of course, has been the realization (which began with von Békésy's work) that inhibition phenomena appear to affect all of the senses, not just vision, as Mach discovered, or hearing, which was probably von Békésy's original focus.[16]

Though von Békésy received his Nobel Prize in 1961 primarily for his work on the cochlea and inner ear, he continued working on other senses and their inhibitory aspects and apparatus. This work culminated in his book, *Sensory Inhibition*, published in 1967. George von Békésy died in 1972.

4. György von Hevesy (1885-1966)

Why would our story include a Hungarian scientist whose published papers do not seem to indicate that he was influenced by Ernst Mach in either science or philosophy? The reason is that publications do not tell the whole story. It seems that Georg von Hevesy (the name he used when writing in German, which he normally did during most of his life) had a dark secret. We do not know why he kept it private for so long, but possibly he was ashamed of certain 'unscientific' things he had believed when he was young. But before revealing his secret, which has a direct connection with Ernst Mach, let us outline his illustrious scientific career.

According to Gábor Palló and J.D. Cockcroft, von Hevesy was born in Budapest on 1 August 1885, the son of court councilor Louis de Hevesy and Baroness Eugeny Schosberger. The father was the general manager of a mining company and supervised the estates belonging to his mother.[17] Young von Hevesy attended a secondary school run by the Roman Catholic Piarist order. He began his university studies in Budapest, but in

10. John T. Blackmore, *Ernst Mach* (Berkeley: University of California Press) pp. 53-54.
11. Quotation from Georg von Békésy, *Nobel Prize Winners*, p. 77 (see note 8).
12. Ibid.
13. Floyd Ratliff, *Mach Bands – Quantitative Studies on Neural Networks in the Retina* (San Francisco: Holden-Day, 1965) pp. 37-76.
14. C.H. Wind, "Zur Demonstration einer von E. Mach entdeckten optischen Täuschung," Physikalische Zeitschrift (1:1899-1900) 112f.
15. Gyula Radnai, *Rezsö Kunfalvi, Physics in Budapest – A Survey*, Ildiko Csurgay, ed. (Amsterdam, Oxford etc.: North-Holland, 1988) p. 66.
16. Georg von Békésy, "Die Erweiterung der Existenz der Mach-Bänder auf andere Sinnesgebiete," symposium on the occasion of the 50th anniversary of the death of Ernst Mach, March 11/12, 1966, organized by the Ernst-Mach-Institut, W. Merezkirch, ed. (Freiburg im Breisgau 1967) pp. 161-170
17. Gábor Palló, "Why did George Békésy leave Hungary?," Periodica Polytechnica – Chemical Engineering (30: 1/2, 1986) 99. See also J.D. Cockcroft, "George de Hevesy," Biographical Memoirs of Fellows of the Royal Society, vol. 13 (1967) p. 125.

1904 he transferred to the Technical University of Berlin. He moved again in April 1905, this time to Freiburg, where he received his doctorate in 1908. His interests were in both chemistry and physics. Between 1908 and 1911 von Hevesy did physical chemistry in laboratories in Karlsruhe under Fritz Haber and in Zurich under Richard Lorenz, meeting Einstein in the latter in 1909.[18] From his own perspective, it seems his 'real' career began in Rutherford's laboratory in Manchester in 1911, where he met and became friends with Moseley, Bohr, and others.[19] Von Hevesy's most important contributions stemmed from the assumption in Rutherford's laboratory that atoms were real, and that they were divisible, that is, separable into parts. According to Soddy, they also had isotopes. Rutherford told him, "if you are worth your salt, then separate radium D from all that nuisance of lead." He failed, concluding that this isotope at least did not seem chemically divisible. But continuing his work at the Radium Institute in Vienna with Paneth, von Hevesy did discover in 1913 that lead can be "marked," that is, detected and traced by the radiation from radium D. Thus was born the use of radioactive tracers, which thirty years later brought a Nobel prize to von Hevesy. According to G. Palló, the long delay in recognizing the importance of his work was primarily due to the fact that, in those days, "few radiating isotopes were known;" nor was their use immediately understood.[20]

Von Hevesy's return to Budapest as a lecturer in 1913 was short-lived. While on vacation the following year, the Great War engulfed von Hevesy and he remained with the Austro-Hungarian army until 1918. But he resumed his modest position in Budapest and was even promoted on 3 March 1919, becoming a professor of physical chemistry — only to find, as did Von Kármán, that by retaining his position during Béla Kun's brief communist dictatorship, which started two weeks later on 19 March 1919, he had apparently compromised himself.[21] Although during the communist regime he was very active in trying to obtain new equipment for his laboratory, it seems that only four days before the fall of Bolshevik Hungary on 1 August 1919, he left the country to visit Bohr in Copenhagen.

In 1920 Hevesy's friendship with Niels Bohr helped him obtain a position at Bohr's Institute for Theoretical Physics in Copenhagen, which was still being built at the time. Even though Bohr decided to call it the Institute for Theoretical Physics, it included experimental scientists such as von Hevesy and, from time to time, other chemists. Bohr's kindness was soon rewarded by von Hevesy's role in the discovery in 1922 of a new element called Hafnium (element 72).

But rather than plow through von Hevesy's later contributions to science (and there were many), discuss how he obtained a position in Freiburg im Breisgau in the 1920s, had to leave for Copenhagen again in 1934 because of the Nazis, or fled in 1943, during World War II, from Denmark to Sweden, where he continued his work at the University of Stockholm, let us instead turn to Von Hevesy's secret and its connection with Mach. When Thomas Kuhn and E. Segré interviewed von Hevesy at Segré's home in Lafayette, California on 25 May 1962, four years before his death, we note at once two things. First, von Hevesy begins relating his life without first being asked a question, and second, he starts with Manchester in 1911, as if the period before this was of no importance.

But there is a second interview, conducted almost ten months later by John L. Heilbron, who skillfully begins to unravel the secret.[22] The interview begins as follows:

Heilbron: May I refer first to the earlier problems before you got to Manchester? I am curious whether such a question as the reality of atoms was a live issue?

Hevesy: The reality of atoms?

Heilbron: Yes, the sort of doubts which Ostwald and others had earlier shed on the question.

Hevesy: I've never heard anyone discuss the reality of atoms. No, the atom and the nucleus were so much in the foreground that nobody thought about the reality problem.

Heilbron: This was true even at the beginning of your education, say in Zurich, or –?

Hevesy: I never heard of anyone in Manchester who doubted the reality of the atom.

Heilbron: What about earlier?

Hevesy: Earlier?

18. Ferenc Szabadváry, "György Hevesy," *Dictionary of Scientific Biography*, vol. 6 (New York: Scribner, 1972) p. 365.
19. Thomas S. Kuhn, E.G. Segré, "Georg von Hevesy. Transcript of an Interview, May 25, 1962" (Niels Bohr Institute, Center for History of Physics, College Park, Maryland) p. 1.
20. Palló, pp. 98-99 (see note 17).
21. Ibid., pp. 102-103.
22. John Heilbron, Interview with G. von Hevesy in Hevesy's apartment, Stockholm, Sweden, 4 February 1963, tape #55, side 1 (Niels Bohr Library, Center for History of Physics, College Park, Maryland) p. 1.

György von Hevesy

Heilbron: Say, at Zurich or Freiburg, or somewhere.

Hevesy: Well, at Zurich, I really — I don't know. I met Einstein several times, but he didn't discuss the atom. So I had no opportunity to talk to anyone in Zurich who was interested in the reality of atoms. Oh, you mean the very old days [prior to 1908] — Ostwald's. Oh, well it's true. I myself learned from Ostwald's books; he had very good textbooks, [for example] "The Laws of Inorganic Chemistry" and "General and Analytic Chemistry," and he was very hostile toward the atom. I was quite influenced in those days by these ideas of Ostwald, but when I went to Manchester, of course, there they were so much occupied with the atom, the Wilson chamber, singular fields, and counting alpha particles that I soon forgot Ostwald's ideas.

But that was not all von Hevesy forgot. He was also interested in the philosophy of Ernst Mach.[23] In fact, he was so interested and seemed so much of a follower that, as a student at the Technical University of Berlin and later at Freiburg, he corresponded with Mach between 1904 and 1906. His part of the correspondence still exists. What was von Hevesy's dark secret? What was he so ashamed to admit? Apparently, prior to going to Manchester in the year 1911, he had accepted many of the philosophical ideas of men such as Ostwald and Mach, who had rejected the reality of atoms! But as an honest man, when pressed in later years, he seems to have finally been willing to admit that he had been interested in their anti-atomic philosophy. The extant correspondence consists of four rather lengthy letters from von Hevesy to Mach.[24] Letters from Mach to von Hevesy have not yet been located. The content of the letters shifts from a strong defense of Mach's philosophy to a gradually increasing appreciation for Jonas Cohn's Freiburg lectures. Cohn (1869-1947) was a philosopher of ethics and aesthetics who often used a dialectical method. We have translated von Hevesy's first letters as follows:

Georg von Hevesy to Ernst Mach — *Hotel Ronsard (?), Grado, 9 July 1904*

Highly Respected Herr Professor!
It is perhaps unusual, even improper, for a completely unknown person to burden Herr Professor with a letter. [But] the deep veneration I hold and the inextinguishable impression which Herr Professor's works have exercised upon me motivated my act [and] shall serve as my excuse.
Two years have passed since I first read your book, Popular Scientific Lectures.[25] *Herr Professor's other works followed, but unfortunately only in part (since the time had to be stolen from my studies).*
I am currently studying physics at the University of Budapest. I am also a beginner, but feel in spite of that a strong tendency on the one side toward physiology and, on the other, toward philosophy of natural science. Therefore, I enjoy Pop. Sci. Lec. twice as much because, next to the physical material, I can also draw understanding of the other mentioned fields as well.
I have occupied myself very thoroughly with the thoughts described. Only later did your Analysis of Sensations[26] *fall into my hands. It pleased me greatly to find ideas, which I had already crudely suspected, enlarged upon in your Analysis and put forward in the most logical manner possible.*
The knowledge [that we shared many opinions] embarrassed me at first, but I quickly realized that the reason for our agreement was to be found in the seeds of the thoughts I had already encountered in Pop. Sci. Lec., particularly in the treatise "On the Economic Nature of Physical Research," which is about transforming and adjusting scientific thoughts and so forth. Having become acquainted with these ideas, I reflected deeply upon them (though naturally only in a way that may seem less than significant) and have finally connected many of your ideas with mine. Naturally, agreement between my insignificant self and your work pleased me in an extraordinary way.
Your Analysis of Sensations, no, the 'Anti-Metaphysical Preamble' itself, is the most beautiful result of what must have been a long, intelligent life full of work. The great critical sense, the strong intelligence, the ,ability to acquire mind-broadening experiences' (as you have defined it) is shown at its most powerful; how — standing at the highest level of knowledge, from which standpoint Herr Professor contradicts attempts to justify the existence of the self — at the same time the boldness of science is put ahead of the philosophy of the common man.
I would like to be candid. My respect is even greater, Herr Professor, for what you have done on the fringes of your mighty works of physics and epistemology. I am referring to the asides that you often mention in your footnotes and elsewhere: for example, what you say about reading Kant's Prologemena when you were young, seeing yourself in a mirror, and thinking it was someone else; the observations on children and so forth, but especially your little story about the tiny sparrow.

23. This is briefly mentioned in the monograph by J.D. Cockcroft, "George de Hevesy 1885-1966," *Biographical Memoirs of Fellows of the Royal Society, vol. 13*, 1967, p. 125. Possibly aware that the secret was already slipping out in the discussion with Heilbron in 1963, von Hevesy apparently included a mention of Mach in the documents he gave to Cockcroft before his own death in 1967. Hilde Levi seems to have picked up on Cockcroft's one-line remark and included it in her biography of von Hevesy, which was published in 1985. Hence, his interest in Ernst Mach has become part of the lore, even without the following letters. But Cockcraft's lack of interest in philosophy (he spells Heidegger's name "Haideker") may mean that there is more to the documents von Hevesy gave to him than appears in his obituary. But the basic fact is that we still know very little about von Hevesy before he received his PhD in 1908. The first twenty-three years of his life still remain relatively undocumented.

24. The letters are located in the Ernst-Mach-Institut, Eckerstraße 4, Freiburg im Breisgau.

25. E. Mach, *Populär-wissenschaftliche Vorlesungen* (Leipzig, 1896).

26. E. Mach, *Beiträge zu einer Analyse der Empfindungen* (Jena, 1886). The second edition, minus the word "Beiträge (contributions)," was published in 1900. See the English translation, *Contributions to the Analysis of the Sensations* (Open Court Publishers, 2000).

Perhaps these are the most important parts of the Analysis; they still exercise a great impression upon me...I will not continue. Please accept my apology for disturbing you. My good intent apologizes for me. I remain respectfully your servant
Georg von Hevesy

5. János von Neumann (1903-1957) & Jenő Pál Wigner (1902-1995)

These two great Hungarian scientists are so important in terms of their accomplishments that they deserve not just separate articles, but separate books, yet our focus is primarily on their relation to the ideas of Ernst Mach, and their most important contributions will only be mentioned in passing. Hence, they will only receive a few pages, largely because Mach's influence on them, while real, appears to have been generally indirect and rather hard to assess, in terms of their work. In fact, most of our attention will be on the people who helped educate them, since the influence of Mach there is stronger.

János von Neumann

Both Jenő Pal and János were so talented in mathematics that they caught the eye of Lázló Rátz, the mathematics teacher at the Lutheran secondary school they attended in Budapest, Wigner being one year ahead of Neumann. Both pupils were given especially tough math questions to solve at the end of each semester, except when they were ill. Then Rátz, a noted reformer in how to teach mathematics, even visited Jenő Pal's family and lent mathematics books to him. But Rátz was especially impressed by János (or "Jáncsi" as he called himself, i.e., "Johnny"). He was so brilliant in mathematics that Rátz called in university professors to help him, and had him attend university math lectures.[27]

Just as von Kármán and von Hevesy had both completed their university education before the famous Galilei Circle (1908 to 1919) could inspire them to an even greater interest in science, so von Neumann and Wigner were too young to be more than peripherally influenced, although a pro-science atmosphere surely persisted. But while both families disliked the Béla Kun Soviet Republic of 1919, they found, to their distress, that the new conservative Horthy regime blamed Budapest Jews for weakening the war effort, losing territory to neighboring states, and supporting left-wing governments, and so intended to restrict Jewish presence at Hungarian universities. Thus, after the war, while both von Neumann and Wigner received their higher education in Budapest despite the restricted admittance of Jews, they also continued their education abroad. They were well aware that there were only a few opportunities in Hungary for mathematicians and, under the then-prevailing conditions, they were unlikely to go to Jews. It was here (as was the case earlier with von Kármán and von Hevesy) that their tutoring in German came in handy. Von Neumann attended the University of Berlin (chemistry) from 1921-1923 and then the Technical University of Zurich in 1923, graduating in chemical engineering in 1925, and, while he rarely actually attended the University of Budapest, he won a degree in mathematics there in 1926. He continued his studies in Göttingen (mathematics) in 1926/27. During his university studies, he published his first five papers.[28]

Jenő Pál Wigner

Wigner also studied in Budapest and Berlin, receiving a degree in chemistry at the Technical University in Berlin, where he began lecturing in 1928. It was during this period, when quantum theory was being significantly advanced, that expatriate Hungarian scientists both contributed to it and formed their own community. The group was partly helped and protected by Einstein and the two main Hungarians who held good positions in science departments at German universities, von Kármán in Aachen and Michael Polányi in Berlin. Yet it seems that Szilárd was most responsible for bringing the Hungarians together and linking them with leading scientists such as Einstein and Polányi. He was often, as Wigner says, "brash."[29] But sometimes foreigners have to behave like that to overcome their isolation. All of these Hungarians started to do important work in Germany before the rise of Hitler forced them to go to England and America.

It is not true that it was only in America that they became productive scientists, even if this "land of opportunity" is where they would become most famous. Von Neumann's mathematical attempt to put the new quantum mechanics of Bohr, Pauli, and Heisenberg beyond the possibility of serious challenge was influential for decades and still has defenders. Wigner's contributions to quantum mechanics would result in a Nobel prize many years later. In short, they and other Hungarians were already doing important work in Germany during the Weimar republic of the 1920s, some of them even as late as the early 1930s. Let us now turn to Mach before returning to science.

There is, of course, a difference between one's private philosophy and philosophy stemming from the most profound general assumptions. Neither von Neumann nor Wigner seemed to voice basic philosophy very often, but that does not exclude the fact that they had basic assumptions of a general nature. However, we should note that both von Neumann and Wigner, who rarely spoke about philosophy, had the same physics teacher at the Lutheran secondary school they attended in Budapest, and that that teacher was an admirer of Ernst Mach. We should also add that the Lutheran school was largely based on a "comprehensive philosophical

27. András Ádám, "John von Neumann," *Leben und Werk von John von Neumann*, Tamás Legendi, Tibor Szentiványi, eds. (Mannheim, 1979) pp. 14-15. (The following professors are reported to have helped von Neumann: Lipót Fejér, József Kürschák, and Mihály Fekete.)
28. William Asprey, *John von Neumann and the Origin of Modern Computing* (Cambridge: MIT Press, 1992) pp. 7-8; and Ádám, p. 12 (see note 27).
29. See Thomas Kuhn, "Interview with Eugene Paul Wigner," 3 December 1963, vol. 93a (Niels Bohr Library, College Park, Maryland) p. 2.

system built essentially on Comte's positivism."[30] Sándor Mikola (1871-1945) tried to combine the philosophies of Loránd Ëotvös and Ernst Mach[31] — an emphasis on mechanics from the former and an apparent denial of a physical world beyond sensations and consciousness from the latter — but, like many phenomenalists and followers of Mach (perhaps most notably Gustav Jaumann, Mach's long-time assistant), Mikola was very skeptical of both the atomic and relativity theories. Wigner related in 1992:

> *The physics teacher at the Gimnázium was Sándor Mikola. Mikola seemed at first a gruff, distant man. He came, imparted his wisdom, and left. But he had a good heart...I already loved physics, and I wished that Mikola taught with the vigor of Mr. Rátz. But Mikola knew physics well. He had written a fine physics text...Mikola [once] asked me bluntly why I believed in relativity theory...The physics text that Mikola had written was my first real physics book. It told us: atoms and molecules may exist, but the question is irrelevant to physics. Physics is entirely concerned with things that can be observed. That was a nineteenth-century view, but it still had a great many followers in 1919.*[32]

It would be unfair and probably wrong to consider Wigner a follower of Mach, regardless of how much he had learned from Mikola or had been influenced by the fundamental positivism of his secondary school, which may have presupposed a phenomenalist epistemology or ontology about nature. In much of Wigner's physics, there is an extreme concern for sensory "facts," as well as support for the Copenhagen interpretation of quantum theory, which suggests that Wigner did not think that physics required the traditional Galilean assumption that there is a physical world existing beyond what is sensory and conscious, and that it is the primary task of physical inquiry to understand that metaphysical, i.e., real world. As for von Neumann, his mathematical defense of the Copenhagen interpretation of quantum mechanics is an attempt to improve mathematical logic, and his alleged presence at some sessions of the Vienna Circle during the 1920s or 1930s are activities one would expect from a logical positivist. That movement rejected parts of Mach's philosophy, such as his reduction of mathematics to sensations and his theory of economy, but nevertheless, at least many members presupposed a phenomenalism or presentist epistemology underneath its linguistic façade.

Did Mach's ideas have any clear influence upon von Neumann? Yes, in later years, von Neumann became very interested in Mach shock waves, particularly in relation to the atomic bomb and the attempt to work out a successful implosion technique for triggering it. But this brings up the chief reason for the fame of all of the most famous Hungarian scientists: von Neumann, Wigner, Szilárd, and Teller all contributed to the Manhattan Project for developing the atomic bomb, and von Kármán had contributed much in his own brilliant theoretical way to the development of the aircraft that would deliver it. Teller would also be able to recruit von Neumann for the hydrogen bomb project.[33]

But before turning to this well-trodden topic, we should include at least a brief mention of the great work of Wigner and von Neumann with respect to other areas of mathematics and science. Wigner, for example, was one of Polányi's assistant in Berlin, as well as assistant to Hilbert in Göttingen, and von Neumann often helped him solve mathematical problems. Wigner is best-known in physics for introducing the notion of parity into the field in 1927, the Breit-Wigner formula for neutron absorption in the 1930s, and for reasoning that "the nuclear force binding neutrons and protons together must be short range and independent of any electric charge."[34] He shared a Nobel Prize in Stockholm with Maria Goeppert Mayer and J. Hans-Jenson in 1963 for "systematically improving and extending the methods of quantum mechanics and applying them widely."[35]

Because of Eugene Wigner's accomplishments, personality, and long life (he became the last of the great quantum scientists, even outliving his brother-in-law Dirac), he enjoyed his final years as a doyen of physics. Von Neumann, on the other hand, died relatively young.

However, von Neumann had the greater mathematical impact, contributing much to both pure and applied mathematics. In pure mathematics he was, like many others, highly impressed during the 1920s by Hilbert's axiomatic method, as well as the development of set theory and mathematical logic, and he contributed to their development[36] — that is, until Gödel showed that the latter could not be both complete and internally consistent. Other contributions to "pure" mathematics were made in the following areas: groups, measure theory, rings of operators, ergodic theory, Hilbert space, and Hilbert's fifth problem. As far as applied mathematics goes, the field in which he is perhaps best-known to the educated public, von Neumann is remembered for his minimax theorem in game theory (1928) and for a book on game theory, written during the 1940s,[37] Indeed, he virtually created the field, at least from a mathematical point of view. It was also soon realized that von Neumann's ideas could be applied to mathematical economics and other fields as well. He put his mathematical mind to work on digital computer theory during the 1940s, so that many theorists have treated him as instrumental in accelerating the development of the field to a revolutionary extent.

30. Katalin Demeter writes, "The director of this famous school (Lutheran secondary school) from 1873 to 1896 was Károly Böhm, who created a comprehensive philosophical system built essentially on Comte's Positivism." See her paper, "Natural Science and Positivism in Hungarian Culture." The article is a partial translation from a much longer Hungarian article printed in Magyar Filozöfia Szemlw Budapest (3:1987) 403-456.

31. Ibid., manuscript pages 18-20. See also Sándor Mikola, *Ernst Mach* (Urania, 1916) p. 124.

32. Andrew Szanton, *The Recollection of Eugene P. Wigner* (New York: Plenum Press, 1992) pp. 54-55. Earlier, Wigner had called Mikola's textbook "a semi-philosophical book that was very good." See Thomas Kuhn, "Interview with Eugene P. Wigner," 21 November 1963, tape 92b (Niels Bohr Library, College Park, Maryland) p. 7.

33. Robert Jungk, *Brighter than a Thousand Suns* (New York: Harcourt Brace, 1958) p. 299. "Teller had experienced no difficulty in winning over his compatriot von Neumann from the start to take part in the super project (the hydrogen bomb)... He had learned to hate it (communism) as a thirteen-year-old boy during its brief period of domination in Budapest after World War I."

34. See Thomas Kuhn, "Three Session Interview with Eugene P. Wigner," 21 November 1963, tape 92b; 3 December 1963, tape 93a, and 4 December 1963, tape 93, side b (Niels Bohr Library, College Park, Maryland).

35. Ibid.

36. J. Dieudonné, "Johann (John) von Neumann," *Dictionary of Scientific Biography*, C.C. Gillispie, ed., vol. 14 (New York, 1976) pp. 89-91.

37. Ibid., pp. 91-92.

6. Leo Szilárd (1898-1964) & Ede Teller (1908-2003)

If Jenő Pal Wigner and Jáncsi von Neumann could be considered lifelong friends and colleagues made of the same stuff, then Szilárd and Teller could be considered almost opposites. Szilárd was ten years older, left-wing, while Teller was right-wing in politics; Szilárd was considered sullen but personally fearful of danger, while Teller was optimistic and personally fearless. But they did share several powerful characteristics as well. Both were Hungarian, both from Budapest, both won academic prizes in their youth (Szilárd won second prize in physics in 1916, and Teller, first prize in physics and mathematics in 1925); both became brilliant and influential scientists, and both had very strong personalities. We will skip the earliest years of Szilárd and Teller, except to mention that both men, like the Hungarian giants previously discussed, came from upper middle-class Jewish families with a deep concern for education. Also, Szilárd, unlike Teller, did not attend the secondary school on Trefort Street in Budapest, as has been alleged by von Kármán in his autobiography and often since then, nor did he attend the Lutheran or Piarist secondary schools. Instead, he went to the junior high school at Rippl-Rónai and Szondi Streets in the sixth district,[38] which may help explain part of his apparent inferiority complex. Szilárd was not as broadly educated as his colleagues.

Leo Szilárd on the book cover of Bernard T. Feld, Gertrud Weiss Szilárd (eds.), *The Collected Works of Leo Szilárd. Scientific Papers*, The MIT Press, Cambridge 1972.

He was also not safely conservative in his political views. Like another gifted Hungarian, Arthur Koestler, who was not a scientist but often commented on science, he was even a radical socialist during his youth. Also, like Arthur Koestler, he was interested in the Galilei Circle, and probably like Koestler, he also was an admirer of Ernst Mach. But unlike Koestler, it is not certain whether he ever recanted his radical political notions. Also, like the other great Hungarian scientists and Koestler, he was Jewish, but unlike the author of Darkness at Noon, neither he nor any of the other scientists were attracted to Zionism; they considered themselves assimilated. In fact, several of them, including Szilárd, converted to Christianity.

Edward Teller

Nevertheless, there is outside evidence relating to Leo Szilárd's philosophical interests, but it is very sketchy. His father was apparently connected with a Masonic Lodge and hence, presumably, with the Free Thinkers Society that helped finance the Galilei Circle. Szilárd himself, at the age of nineteen or twenty, is known to have attended Galilei Circle lectures just before its final dissolution in 1918-19.[39] This means he may well have imbibed some of the ideas on Mach's philosophy, which had dominated the early years of the Circle. In fact, he would become closely involved not just with Michael Polányi in Berlin, but also with Karl Polányi in Austria, who had been the first president of the Galilei Circle, and who, with some reservations about Szilárd's rough personality, would recommend him for a research grant in England.[40] It comes at no surprise to hear that, during one of the lectures held by the fading Galilei Circle in Budapest during that tumultuous and rapidly changing period of Hungarian history (1918 or 1919), Szilárd, a pugnacious fellow, argued with the lecturer, Gyula Pikler (who seems to have been most responsible for founding the organization), another pugnacious fellow. Both Szilárd and Teller continued their studies in Germany during the 1920s and early 1930s, hobnobbing with Einstein and other Hungarian scientists in big cities. Szilárd initially went to Berlin, where his interests turned to physics, and he earned his doctorate in 1922. Szilárd's dissertation, written under the direction of von Laue, showed that the second law of thermodynamics not only covers the mean values of thermodynamic quantities, but also determines the form of the law governing the fluctuations around the mean values. The continuation of this work led to his famous paper of 1929, which established the connection between entropy and information, thereby foreshadowing modern cybernetic theory.[41] As a private lecturer in Berlin, Szilárd carried out experimental work in X-ray crystallography, a field that Michael Polányi had also been exploring. During his stay in the German capital, he also collaborated with Einstein on their notorious refrigerator, or as Bernard Feld puts it:

> *He and Albert Einstein patented an electromagnetic pump for liquid refrigerants, which now serves as the basis for the circulation of liquid coolants in nuclear reactors.*[42]

In future years Szilárd would often try to patent inventions and make money from them, but with generally limited success.

He left Germany in 1933, first for England and then America, staying mostly at Columbia University, where he was granted space for carrying out experiments. His main interest in those years, apart from love of travel itself, appeared to be a wish to prove that it was possible to extract nuclear energy by splitting atoms. In England, his work led to the Szilárd-Chalmers reaction and the discovery of radiation-induced emission of neutrons from beryllium.[43] When, in America, he learned that Hahn and Strassmann had been working in 1938 on the possibility of obtaining nuclear energy by splitting uranium atoms, he began to fear that Nazi Germany might be able to develop a nuclear bomb that would then threaten the survival of the western powers and the Jewish race, and, indeed, western civilization itself.

38. William Lanouette, *Béla Szilárd, Genius in the Shadow* (New York: Scribner, 1992) p. 31.
39. Ibid., p. 44.
40. Ibid., p. 167f.
41. Bernard T. Feld, "Leo Szilárd," *Dictionary of Scientific Biography, vol. 13* (New York, 1976) p. 227.
42. Ibid.
43. Ibid.

Meanwhile, Ede, (later "Eduard," and finally "Edward") Teller was also active. As a child, he had learned numerous languages, played piano, often attended the city opera, and generally acquired a well-rounded Budapest education.[44] He pursued undergraduate studies at the Technical University of Karlsruhe in southwestern Germany. From chemistry, he turned to physics.[45] At the Universities of Munich and Leipzig (1929-31), at Göttingen (1931-33), and at Bohr's Institute in Copenhagen (1934), Teller acquired an intimate familiarity with many of the latest developments in quantum mechanics. In 1934, after the rise of Hitler, he decided that it might be wise to accept a position as a lecturer in London. Wigner has written that Heisenberg and James Franck were Teller's most honored friends in Europe, and Gamow became so in America.[46] Wigner also informs us of Teller's thirty scientific papers, written during the 1930s and before his involvement in applied science with the Manhattan Project. He claims that only one "failed to stand the test of time."[47] But the fact remains that Teller's scientific reputation is closely connected with his work on the atomic and hydrogen bombs.

44. Hans Mark, Lowell Wood, eds., "Foreword," *Energy in Physics. War and Peace* (Dordrecht: Kluwer Academic Publisher, 1988) p. 1.
45. Ibid.
46. Eugene Wigner, "An Appreciation of the 60th Birthday of Edward Teller," ibid., p. 9.
47. Ibid.
48. Wigner, p. 10 (see note 10).

The most famous Hungarian advice to the United States came when Teller and Wigner, prompted by Szilárd, contacted Albert Einstein and urged him to warn President Franklin Roosevelt of the possibility of an atomic bomb, as well as the unconditional need to develop both it and the means to deliver it before Nazi Germany would be able to do the same. Szilárd, with his understanding of how to split atoms and his fears concerning Hitler, was the driving factor, but he fell short when the Manhattan project was formed. Szilárd wanted scientists, especially himself, to direct engineers, but instead, an engineer was chosen to lead the scientists: General Leslie R. Groves, an effective, frequently undervalued organizer, who had made a reputation by building the Pentagon under budget and ahead of schedule. His greatest concern, next to speedy, reliable development of the bomb, appeared to be secrecy. He wanted to complete the project before the Germans learned about it, for they would have accelerated their efforts had they known about it. In fact, the Germans surrendered before the project was completed, and it turned out that the German effort under Heisenberg (a theoretical scientist, not an engineer) was far behind. As far as the Axis powers were concerned, secrecy had been kept. The great Hungarians, led by Leo Szilárd, Edward Teller, Eugene Wigner, and John von Neumann, who were skilled at mathematics, physics, and engineering, contributed immensely to success.

Leo Szilárd's theory that graphite was a better insulating agent than heavy water may well have been the single most important non-administrative factor in helping America beat Germany to the bomb, even if Szilárd — with his envy of General Groves and his wish to run the project himself — often made a nuisance of himself, especially in administration.

But as it turned out, most American physicists, at least those to the political left, would prefer Szilárd to Teller, mostly because of Szilárd's efforts in 1945 to prevent the bomb from being dropped on Japan. Teller's subsequent role in building the hydrogen bomb and his stand against granting continued security clearance for J. Robert Oppenheimer in 1954, who had earlier run the Los Alamos Laboratories and was, by 1953, chairman of the general advisory committee to the Atomic Energy Commission, also made him unpopular.

As far as Ernst Mach's influence on Edward Teller is concerned, it seems to have been negligible in the philosophical realm, given Teller's extremely realistic way of thinking. Yet it is true that the understanding of Mach's work on shock waves and subsequent discoveries in that area would prove crucial in developing the hydrogen bomb, since what was needed was a fission bomb outside that would be sufficient to implode material inside, in order to create a huge fusion explosion. Let us add that Eugene Wigner, who always defended his friend Teller against his many critics, also touched on Teller's scientific activities during the 1940s:

> *The years at Los Alamos were not happy...Nevertheless, he stuck it out and contributed greatly to the success of Los Alamos. Some of the work he carried out there had sufficient scientific importance to be published years later. This applies particularly to the work on shock waves, in collaboration with Bethe, and the properties of matter under very high pressure, on which he, Feynman, Metropolis, and the Rosenbluths collaborated.*[48]

Edward Teller remained quite active after the 1950s, especially in his support of the use of atomic energy for peaceful purposes. During the 1980s, Teller was a strong advocate of President Reagan's Strategic Defense Initiative, which proposed the development of a defensive shield against atomic weapons from other countries. Much money was spent, but the project showed that the technology was too slow to be properly employed.

Was Teller the last great Hungarian? Not in this author's opinion. If Hungarian secondary education, the Hungarian love of mathematics, the extensive tutoring of brilliant students, the Hungarian love of reason, common sense, history, and languages, as well as the Hungarian tendency to combine mathematics with an understanding of chemistry, physics, and engineering continue, then there will always be more outstanding scientists from Hungary. However, they will not all come from Budapest, nor will they all have been influenced by Ernst Mach's contributions to science or philosophy.

Péter Szegedi

The Galilei Circle and the Polányis

Capitalist development came too late to Hungary. Therefore, at the turn of the twentieth century, the most burning economic-political-ideological question was how to get rid of the feudal remnants in Hungary — the archaic structures of the Austro-Hungarian monarchy. The left wing — that is, the bourgeois radical, social democratic, and socialist part of the Hungarian intellectuals — recognized this problem, and concentrated their thoughts, debates, and activities on it. At the turn of the century the majority of the members of the Social Science Society worked in this direction; this attitude was represented in their periodical, *Huszadik Század* [The twentieth century].

The motivation was the same for the Galilei Circle, which was formed on November 22, 1908. The Circle was largely made up of poor university students united in the name of progress, and their program included above all self-education and teaching rather than political activity. However, the events leading to its formation did not occur only in an intellectual sphere. In the Open Teaching Conference held at Pécs in October 1907 — originally devoted to extracurricular education — the left-wing participants (including, among others, Oszkár Jászi and Ervin Szabó) became inquisitive about the role of school education in cultural backwardness, poverty, and exploitation. The leader of this left-wing group was Gyula Pikler, a jurist, sociologist, and psychologist professor from Budapest University, who was also the most influential Hungarian positivist philosopher of law and one of the founding fathers — and at that time the president — of the Social Science Society. After the conference Pikler found himself the center of attacks by the right-wing press in the "cultural war." Encouraged by the provocative articles and reactionary professors, the clerical-nationalist students attempted to prevent Pikler's lectures at the faculty of law. The left-wing students, however — recruited from all the faculties in Budapest — organized the defense of the lectures.

In the corridor fights — with the active participation of Károly Polányi, György Pólya (later a world-famous mathematician), and hundreds of students — students of arts, law, medicine, and engineering — the founders of the Galilei Circle first came in contact. These young people, a considerable number of whom were educated by humanist teachers in secondary schools, were committed to a scientific thinking that resisted prejudices and had a critical attitude to social miseries. They named their group the Galilei Circle after a suggestion by Pikler — who held the inaugural address — because in his opinion, the name of Galileo recalled for everybody his defiant declaration "eppur si muove."

Károly (Carl) Polányi, born 1886 in Budapest. Lawyer, economist, historian of economics, sociologist. He studied law at Budapest, Vienna, and Cluj-Napoca. He was the first president of the Galilei Circle in 1913-1914, then the editor of the periodical *Szabadgondolat (Free Thought)* in 1918-1919. From 1919 he lived in Vienna as an immigrant, he was editor of foreign policy at the newspaper *Der österreichische Volkswirt*. In 1933 he moved to England, where he taught at Oxford University, among others. In 1950 he settled down in Canada, after several years of teaching as a professor in U.S. universities. His main subject was history of economy. He died in 1964 in Canada.

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Leo Popper, Károly Polányi, Mihály Polányi (from left to right)

The explicit aim of the founders was to win students over to the idea of progress, and so to form the attitude of the future intellectuals contrary to the conservatism of the time. For the sake of the cause they organized — mainly for those with a GCSE — summer courses and public lectures with distinguished speakers, study group seminars, and so forth. (The number of meetings during the life of the Circle numbered a few thousand.) Later, they published a periodical — named, characteristically, *Szabadgondolat* [Free thought] and edited in part by Károly Polányi — and the series *Galilei Kör Könyvtára* [The library of the Galilei Circle] and *Galilei Füzetek* [Galilei booklets]. The remarkably wide range of topics were selected to make up for what students had missed in secondary schools and universities, concerning both the fields of science and the

Mihály (Michael) Polányi, born 1890 in Budapest. Physician, chemist, physical chemist, economist, philosopher of science. He studied medicine in Budapest, chemistry in Budapest and in Germany. He was one of the founding fathers of the Galilei Circle. In World War I he was a surgeon, then he made research studies in physical chemistry in Germany. In 1933 he moved to England, taught physical chemistry at the University of Manchester, while an adviser of the *Egyesült Izzó* in Hungary. After World War II his activity in philosophy of science dominated. He died in 1976 in England.

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György Pólya, born 1887 in Budapest. Studied at the Universities of Budapest, Vienna, and – after his doctorate in Budapest in 1912 – in Göttingen and Paris. In 1914-1940 he taught at the ETH Zurich; from 1928 onwards as professor. From 1942 at the University Stanford (U.S.A), from 1953 as professor emeritus. Corresponding member of the Académie des Sciences in Paris, honorary member of the Mathematical Societies of London and Switzerland and of the Société Mathématique de France, honorary doctor of ETH and the University of Alberta (Canada). Died in 1985 in Palo Alto, California.

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ideologies. The Circle did enormous organizing work, despite the fact that it never had a paid employee. Its membership and leadership were renewed annually; nobody held a leading post longer than two years. The idea of work based on conviction enabled the Circle to have continuity and high standards. It is characteristic of these high stands that the scientific committee that organized the epistemological, psychological, physical, biological, or sociological seminars — which often ran parallel — consisted of Béla Bosnyák (who died young), Mihály Polányi, György Pólya, and Mór Korach (a later internationally recognized professor of the Tehnical University of Budapest).

The spirit of the Circle was essentially determined by the activity of the Social Science Society, the articles of the *Huszadik Század*, and the book series published by these forums — *Társadalomtudományi Könyvtár* [The social science library], *Huszadik Század Könyvtára* [The library of the twentieth century], and *Termöszet és Társadalom* [Nature and society] — which published more than fifty (mainly sociological) volumes between 1903 and 1910. In the same way they were deeply influenced by *Filozófiai Írók Tára* [The collection of philosopher authors], containing the most fundamental works from the history of philosophy (about twenty-five volumes up to 1910), actually published by conservative editors. Besides these scientific texts, these young people also read literary works with pleasure. They became acquainted with foreign writers first through the approximately sixty volumes published between 1904 and 1910 in the series *Klasszikus Regénytár* [The collection of classical novels], but of course they also followed with great interest the contemporary Hungarian literature. A peculiar chapter in the history of the Circle is its relation to the great Hungarian poet Endre Ady. They not only read and respected him, but they were in direct contact with him; the poet regularly wrote poems for their March festivals. For example, in their program leaflet of the celebration organized on March 26, 1911, Ady's poem "A túz márciusa" [The march of fire] was first published.

All these readings and influences were treated by the members of the Circle in clarifying debates, during which they developed a relatively uniform ideological stand. If we want to characterize this stand briefly, then we have to call it atheistic, rationalistic, and humanistic. During the twelve years of its life, the Circle exerted a determining influence on the mental maturation of young intellectuals: their number can be estimated in the beginning at a few hundred but later at many thousands. The Circle was dissolved in 1919; both in the period of the Hungarian Soviet Republic (which suppressed free thought) and the subsequent counter-revolutionary regime — for different reasons — the Circle met with many attacks.

To further characterization of the spirit and influence of the Circle, let us briefly consider the career of its two founders, the members of the Polányi family already mentioned above, especially Károly Polányi. At the time the Circle was formed, Károly Polányi was a student of law taking his final examinations. He participated in the work of the Free Organization of Socialist Students (in this society — founded by his brother Adolf Polányi and his cousin Ödön Pór — he became acquainted with Marxism). He appeared in a seminar that existed already before the foundation of the Galilei Circle, and as Zsigmond Kende — a medical student, one of initiators of the Circle — remembered:

> *Some of us felt immediately upon the first conversation that this person — who thought in many respects like us and seemed to be fit for leadership of the masses much better than we — was that person, who had been missing so far. He was a student like we were, even if he was some years older, he had more political experience, he was a splendid public speaker, we simply had to admit him. We needed just this kind of president.*

From that time Károly Polányi took part in the formation of the Circle and became its first president. Károly Polányi (the family took this Magyarized name in 1904) was born on October 25, 1886, and Mihály on March 12, 1891, as Mihály Pollacsek's and Cecile Wohl's third and fifth child, respectively. Their father was a railway engineer who planned and built railways in Austria and Hungary (about 1000 km in the latter). Their mother lived in Vienna from 1879 and worked as a trainee at a jeweler in the Tabor street. They got married in 1881 and at the end of the 1880s moved to Budapest. "Mother Cecile" became one of the centers of the literary and intellectual life there. Károly and Mihály Pollacsek went to the model secondary school at the Trefort street. After secondary school Károly studied at the faculty of law at the University of Budapest, and partly in Vienna, but after the Pikler affair he was compelled to take his examinations and graduate at the University of Cluj-Napoca (Kolozsvár). Mihály received a diploma from the medical faculty at the University of Budapest. As a medical student he was interested in specializing in physical chemistry, and he managed to find his way to Karlsruhe to study. His papers were published from 1910 onward; one of his articles reached Einstein, and they exchanged letters on this occasion. In 1918 Mihály also received his doctorate in Budapest in this branch of science. For the Pollacsek children and for their cousin, Ervin Szabó, the spirit of the Russian revolution was mediated mostly by their mother's friend, Anna Lvova, and especially by her husband, Samuel Klatschko, during the summer holidays in the Semmering (Klamm) and the visits in Vienna. The originally *narodnik* Klatschko had contacts with underground Russian parties in Vienna, where he met Plehanov and many other leading Russian revolutionaries, including Trotsky, regularly. The lessons of the Russian students' and narodniks' movements mediated by Károly Polányi are reflected in the slogan of the Galilei Circle — "to learn and to teach" — or in the work from 1909 with the title "Social and Economic Description of a Hungarian Village."

The young Károly Polányi's ideological views were influenced to a great extent by Marxism and Machism. At the time of the formation of the Circle he considered Mach "the most important and outstanding thinker at the turn of the century," one who conclusively separated science and metaphysics. In 1908 he conducted a seminar in psychology and humanities, studying Mach's *Analyse der Empfindungen* [Analysis of the sensations]. He expressed his very positive opinion on Mach in the journal *Szocializmus* [Socialism] in the following year, and in 1910 he published the (incomplete) Hungarian translation of the book as the second volume of the Library of the Galilei Circle. Very likely it was Polányi who also translated two further shorter writings of Mach for *Szabadgondolat*. Polányi's passionate liking for Mach and his rhetorical talent contributed to the fact that Mach — at that time a world-famous positivist physicist living near Budapest — became the most popular philosopher among the young people of the Galilei Circle.

Mihály Polányi served as a surgeon in the army of the monarchy during World War I. After the war he came back to Germany to do research in physical chemistry. His son, the Nobel prizewinner John C. Polányi, mentions his father's thirty-nine relevant papers in this field, but he is known to have written more than two hundred papers. Károly Polányi arrived in Vienna on June 8, 1919 and he stayed there in exile until 1933. Here he met and later married Ilona Duczynska, who had joined the socialist movement already as a student in Switzerland (she saw Lenin in Zurich, as well). When she came to Hungary she got in touch with the Galilei Circle, but her position was a more radical, politically more active and strongly anti-militarist one. She was arrested in 1918 but set free from prison by the bourgeois democratic revolution. After the Hungarian Soviet Republic — in which she fulfilled different duties — she emigrated to Vienna. Her only child, Karoline, was born there. During the emigration period in Vienna, Károly Polányi at first worked at the *Bécsi Magyar Újság* and *Bécsi Kurír* (Hungarian newspapers in Vienna), then for a decade at the weekly economic and political journal *Der österreichische Volkswirt* [The Austrian economist] as editor for international and foreign-policy problems. As a journalist, he turned his interest to economic subjects because he thought that the roots of the social problems perceived in his youth lay there. He reread Marx, became acquainted with the Austrian economists and with the representatives of other important theories. In the meantime, Mihály Polányi also studied economics. After his visit to the Soviet Union in 1928 he worked until 1935 on a book about the economic status of the Soviet Union. Although he worked in the field of natural sciences, the social sciences were never alien to his nature; as a member of the Galilei Circle he had published sociological and political articles in radical journals.

In 1933 the Polányis moved to England. Mihály Polányi taught physical chemistry at the University of Manchester. Between the two World Wars he visited the land of his birth several times; so he became advisor to the Egyesült Izzó (at present, an affiliate of General Electric).

After World War II, however, he switched to the Institute of Social Science where he specialized in the philosophy of science. His completely original theory on personal and tacit knowledge made him world famous in this field. He died in England on February 23, 1976. During his exile in England, Polányi still sent articles to his old journal. However, using existing economic theories, he formed his highly original (and very critical, as far as market mechanisms are concerned) viewpoint, which made him one of the most important historians and anthropologists of economy in the twentieth century. After many invitations to visit the US, he settled in Canada in 1950, because US authorities refused to allow his wife to enter owing to her Communist past. He died on April 23, 1964, but before that he was able to visit Hungary twice — in 1960 and 1963 — to meet old members of the Galilei Circle.

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7

László Ropolyi

György Lukács and the Sunday Circle

György Lukács, born 1885 in Budapest. In 1906 doctor of law and in 1909 in philology. He studied philosophy in Berlin (with Dilthey and Simmel) and wrote an existentialist essay book *Soul and Forms*, Budapest 1910. Moved in 1912-1917 to Heidelberg. Research in aesthetics, sociology, and history of philosophy. In 1918 he became a member of the Hungarian Communist party. During the Hungarian Soviet Republic he was the people's commissary for public education. 1919-1929 he lived in Vienna, was activist in the illegal movement and theoretician of the proletarian revolution. 1931-1933 he lived in Berlin and then in Moscow, where he became a dedicated Marxist and rejected his earlier works. In 1945 he returned to Budapest and became a member of parliament and professor at the university. In 1949 he lost influence because of the so-called Lukács-arguments. In 1956 for a short time he was member of the Imre Nagy government. In 1957 he returned to his philosophical studies. The group of his students was called the "Budapester School" Died in 1971 in Budapest.

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György Lukács is among the most important philosophers of the twentieth century, as well as a creator and (until recently) the most eminent representative of Hungarian philosophy. His contemporary, Ernst Bloch, said that "Lukács is one of those great philosophers who appear only once in every generation, if at all, and nobody comparable to him was seen by at least three generations of our time."

The young Lukács's view of the world was influenced, above all, by his immediate environment, which was the monarchy in its last days, and life in Germany, with all the cultural impacts that it exerted. The relentlessness of his thinking led him from the ideas of Kierkegaard and Kant to Hegel and Marx; he spent most of his life as a Communist thinker. Apart from the most general questions of philosophy, his scientific activities focused on aesthetic, ethical, and social problems. But above all, throughout his life he tried to think consistently, which for him meant taking his own ideas quite literally, and conducting a life according to them. The fundamental idea of his life, in his own words, was, therefore: lived thoughts. It was in this spirit, that he never hesitated to make sharp aesthetic, moral, or political judgments or to take exposed political roles.

György Lukács was born into a Jewish family in Budapest's Leopoldstadt (a rich neighborhood in the inner city) in 1885. His father, an influential, self-made banker, and his mother — Adele Wertheimer, a bright and educated women of Austrian or German ancestry — possessed a considerable fortune. Typical for the upper-middle-class lifestyle of the family is that highly prominent personalities such as Béla Bartók and Béni Ferenczy served as tutors for the children. Both German and Hungarian culture were present in the family; moreover, the father was an Anglophile as well. Yet a critical view of the strongly expressed, formal aspects of the family's lifestyle made the young Lukács sensitive and open-minded to absorb other worlds as well. During his search for an acceptable world of values in the coming decades, he could safely rely on the generous support of his father.

The young Lukács saw a clear contradiction in the life of the turn-of-the-century Hungary. Feudal backwardness, the lack of inhibitions of the ambitious social classes, the poverty for so many, the hypocrisy of the official politics towards the actual problems, towards even the revolutionary traditions of the country that dated from 1848, the empty and illusory acts of the festivities of the turn of the century: all this together gave support and ammunition for a new feeling of life, where intellectual uncertainty, existential panic, and a desperate search for the way out were characteristic. Lukács discovered Hebbel (just as Kafka did in Prague), and later Ibsen, whose dramas offer a search for new human values and dramatize the moral questions of various real-life situations. There is a thought from Hebbel that accompanied Lukács for the rest of his life: "If God had placed sin between me and the acts prescribed for me, who am I to relieve myself from this?" Another milestone experience that fundamentally transformed his views was the publishing of *Új versek* [New poems] by Endre Ady in 1906. From this point on Lukács saw it as his task to associate himself with the new tone and value system of Ady and to look for opportunities to use the poet's progressive attitude in fields outside poetry. A leitmotif by Ady, formulated in a famous verse — "Eb ura fakó, Ugocsa non coronat" [I am my own Lord] — became so important for Lukács, that it can safely be conceived as a background tune for his entire philosophical œuvre. With Ady's verses he finds the way home: for a long time, Hungary means Ady for him.

Lukács obtained a doctorate in law in 1906 and a doctorate in philology in 1909, but by then philosophy was playing an ever more important part in his life. He began to study philosophy at the University of Budapest, but soon became a student of Dilthey and Simmel in Berlin. At this time, recognizing his own limitations, he gave up his literary ambitions and attempted to do literary criticism, essays, and literary studies. His first writings appeared in *Nyugat* [The West] and *Huszadik Század* [Twentieth century] — there and elsewhere, he published his writings praising Ady. Together with Lajos Filep he published a short-lived philosophical journal with the title *A Szellem* [Mind]. His first major work, *The History of Modern Drama*,[1] won a prize in 1908. In this period Lukács made friends with Leo Popper and Irma Seidler and became acquainted with Béla Balázs. Seriously influenced by the writings of Rudolf Kassner, he began to study the mystics (Böhme, Meister Eckart) and Kierkegaard.

Under Kierkegaard's influence, Lukács starts a systematic search for a new world view, or *weltanschauung*. Does a relationship really exist between everyday life, life as depicted in literature and art, and life subordinated to moral laws and the perennials of philosophy? Authentic life is necessarily tragic: either life or life's work gets lost. The most important thoughts of this essay period of Lukács were published in the collection *Lélek és a formák* [Soul and form], soon published in Germany as *Die Seele und die Formen*.[2] Many historians of philosophy consider this book as one of the earliest works of existentialism, a work that influenced many contemporaries (e.g., Thomas Mann). The publication of this book coincided with other important events of Lukács' personal life — his friend Leo Popper died; his great love Irma Seidler committed suicide; he failed to obtain a position at the philological faculty of Pest. Thus, following an invitation from Ernst Bloch, he moved for a few years to Heidelberg. During his stay he made several contacts, among others with Max and Alfred

1. György Lukács, A modern dráma fejlődésének tötrénete, vols. I–II (Budapest: Franklin, 1911).

2. György Lukács, *Lélek és a formák* (Budapest: Franklin, 1910); German edition, *Die Seele und die Formen. Essays* (Berlin: E. Fleischel, 1911).

Weber, Karl Jaspers, Emil Lask, Ernst Troeltsch, Heinrich Rickert, Martin Buber, and Paul Ernst. He participated regularly in the Sunday afternoon meetings at Max Weber's. In this new intellectual environment Lukács' philosophical interest turned towards Kant, where he was mainly interested in aesthetic questions. His basic manuscripts concerning the philosophy of art, which were written in those years — then hidden for decades — were published after his death as *Heidelberger Aesthetik* [Heidelberg aesthetics]; yet the famous question behind the work became widely known already in its own time: "There exist works of art; how is this possible?"

Preparations for the war created a fundamentally new situation. This is how the elder Lukács commented these years:[3]

The fundamental change was caused by the war. It revealed the deceptive, inhuman nature of the inertia that threatened to ossify within me and become systematized: for inhumanity as a driving force of life that unconsciously featured in the first, initial constructions of my philosophy grew to become an all-dominating form during the war, so that it became impossible to avoid an intellectual confrontation. All the social forces that I had hated from childhood, and which I sought to destroy intellectually, now joined forces to unleash the first, universal and at the same time unimaginative war on ideas. Not, that is, as a formative aspect of life, but rather as universal definitions of life, in all its extensive and intensive totality. Man can no longer exist alongside this new reality of life, as was the case in former wars. It was universal: life dissolved in it, regardless of whether man approved of or opposed this dissolution.

From the very outset I was on the side of the opponents: they wanted to impose a form of life on us that was inhuman in every limb, in order to uphold as a generally approved power of paramount importance those forces of life that had once before appeared contemptible due to their inhumanity. My home, the Habsburg monarchy, was to my mind — morally — nonsense grown into destruction. Now we were supposed to put our lives at stake so that we could take part in this universal battle and thereby continue to preserve this final hurdle of becoming man with the aid of the stringent, mindlessly strict order of the German Reich. We were, for our part, supposed to become murderers, criminals, victims, etc., in order to keep this monarchy alive.

At the time when I rejected all this most vehemently, this radicalism had nothing to do with pacifist moods. I never saw violence as abstract violence, in itself, as inhumanly evil... The aim was not to destroy violence in general, but rather the violence of the reaction of Wilhelm II or his ilk, violence as an obstacle to becoming man, if necessary by force.

So when I did not reject war as a pacifist, or not from the Western, democratic standpoint, but rather fell back on Fichte's "age of perfect innocence" for my assessment of the bellicose present, I remained truer to my views than if I had stayed between the paths through life, between the then widespread antinomies of events. War as the emergent, central, negative peculiarity of existing social order: the content of this hatred is a continuation of my youthful attitude towards feudal Hungary... Left-wing ethics with right-wing epistemology.

His views at that time are best summarized in his *Die Theorie des Romans*.[4] It was first published in 1916 in a German journal and only later as a book. This work of Lukács is often considered to be one of the most important writings in the "history of ideas" tradition of cultural theory. Because of the war, Lukács started spending more time in Budapest, where he increasingly took part in the local intellectual movements. Several groups — separated by their basic concepts, values, views, and more or less by their members — came to integrate the progressive intellectuals of the time, who attempted to find solutions to the pressing problems of society, problems becoming ever more difficult. It was common to these groups that they all strongly disapproved of the traditional intellectual positions held by the dominant arch-conservative representatives of official culture, science, and philosophy. At the same time, each of these individual groups, discussion circles, and movements strove to establish forums and platforms for ideas of their own. The groups blossomed: they held regular meetings, published journals and books, founded associations, and spread their views in various lecture series. Among these groups, the Sunday Circle formed around Lukács played an exceptional role. The history of the group (which was also called by several other names, such as *Vasárnap társaság* [Sunday society] and *Vasárnaposok* [the Sunday people]) started in December 1915, as Lukács was enlisted in the army to serve as a censor of letters. At that time, following a repeated initiative of Béla Balázs, a regular series of meetings was started in the apartment of Balázs and his wife Edith Hajós on Naphegy (i.e., Sun Hill, a noble place in Buda). These meetings lasted from Sunday afternoon to early Monday morning. Normally there was no previously defined topic of discussion, and the meetings were quite informal. Thus, Anna Lesznai remembered:

Lukács always acted as an unofficial chairman. The discussions were completely uncontrolled up to the point when Lukács arrived. But then, if we were talking about something that interested him philosophically, he said

3. György Lukács, *A megélt gondolat* (Budapest: Magvető, 1989), pp. 57-60; translated as *Records of a Life* (London: Verso, 1983). [Quotations here are own translations, as this book was not available to us.]
4. György Lukács, *Die Theorie des Romans* (Berlin; P. Cassirer, 1920); translated as *The Theory of the Novel* (Cambridge, Mass.: MIT Press, 1971).

5. György Lukács, "Önéletrajz hangszalagon," autobiography on tape (Budapest: Malik, Magvető), pp. 123–124.
6. Ibid.

"Stop, now we will talk about this." All sorts of topics were treated this way; painting, folklore, or history. Most words were spent about love, the philosophy of love... Besides this, the members of this circle had another duty: they had to confess. If somebody had done something that was considered bad or unjust, it had to be told to the public and it was morally judged and discussed. Given the permanent moral and literary questions on the order of the day, it is no wonder that Meister Eckart, Kierkegaard, and above all, Dostoyevsky, enjoyed the greatest popularity as discussion topics. It is also worth noting at this point that the meetings were almost completely devoid of politics, and the whole association was more like a religious assembly than a political club.

A permanent or inner circle of participants existed, but every participant was also allowed to bring one guest. Among the permanent participants (besides Lukács, Béla Balázs, and Edith Hajós) were Karl Mannheim, Anna Lesznai, Lajos Fülep (an irregular participant), Béla Fogarasi, Frigyes Antal, Arnold Hauser, Emma Ritoók, Anna Schlamadinger (Béla Balázs's second wife) and, after 1918, György Káldor, Károly (Charles de) Tolnay, László Radványi, Tibor Gergely, and Ervin Sinkó. Time and again, others such as Michael and Charles Polányi, Géza Révész, Edith Rényi (Gyömrői), Imre Kner, Ernő Lorsy, János Wilde, René Spitz, and Sándor Varjas joined in.

In the summer of 1916 Lukács returned to Heidelberg. From this point on, the meetings became somewhat different: the members began to study and discuss each other's works, but yet the novelty and the attraction of the meetings declined. On the initiative of Béla Balázs, the Circle began to organize a free school in the spring of 1917. They managed to hold two semesters in what became known as the Free School of Humanities. The lectures of the first semester were held from March to June 1917. Béla Balázs talked about dramaturgy, Béla Fogarasi about problems of philosophical thinking, Lajos Fülep, Arnold Hauser, Emma Ritoók, and Frigyes Antal about aesthetic topics. Karl Mannheim lectured about epistemological and logical issues, Zoltán Kodály held seminars about Hungarian folk songs, and even Lukács came home in May to deliver lectures on ethics. The size of the audience was between fifty and sixty people. The second semester started late in autumn of 1917. Among the lecturers we find, in addition to those mentioned above, Ervin Szabó, Béla Bartók, and Sándor Varjas. In the meantime Lukács also returned to Budapest and joined the work of the Circle and the Free School again.

Then, there was a political turn. The new round of young people associated with themselves with the Circle late in 1918 may have already been confronted with topics of a more political nature: one had to reckon with the upcoming revolution. Typical for the contemporary position of Lukács is this line of thought:

Members of the Sunday Circle:
Károly Mannheim, Béla Fogarasi, Ernő Lorsy, József Nemes Lampérth, Elza Stephani,
Anna Schlamadinger,
Edith Hajós, Béla Balázs

All right, if Austria-Hungary and Germany defeat Russia, then the Romanovs will be overthrown, and that is okay. It could also happen, that the English-French army wins over Germany and Austria, but then the Hohenzollers and the Habsburgs will be dethroned, and that is also okay — but who will then protect us from the Western democracies?[5]

Or, a little later, this:

... at that time I saw nothing with which we could replace the existing system, and from this point of view the revolution in 1917 was such a big event, because there it suddenly showed: things could be otherwise. And independently from how one today thinks about this "otherwise," that "otherwise" changed us all, indeed it changed the life of an essential part of my generation.[6]

Lukács delivered his political statements in diverse forums outside the Circle. So he lectured, for example on the problem of conservative and progressive idealism in the society for social philosophy. His well-known paper "Bolshevism as a Moral Problem" was published in the journal of the Galilei Circle. Activities of the Sunday Circle were not essentially influenced even by the fact that Lukács joined the Hungarian Communist Party in December 1918 — this was not even known by the Circle at first. But the lives of the members were seriously transformed by the events of the revolution. Many of them (Lukács, Balázs, Antal, Varjas, Fülep, Hauser) took positions in the political organizations of the Hungarian Soviet Republic, mostly in the Commissariat for General Education. With the worsening of the conditions in the country, political and later armed fighting came in the foreground; the members of the Sunday Circle did meet again, but the history of the Circle came practically to an end. After the fall of the Soviet Republic most of its members left Hungary. Almost everybody went to Vienna first, many of them in the hope that they would not even have to unpack their suitcases and could return to Hungary soon. But they stayed in Vienna for years, and the Viennese residents of the Circle started to meet regularly again. Here we find Lukács, Frigyes Antal, Béla Balázs, Arnold Hauser, György Káldor, Anna Lesznai, Ervin Sinkó, Charles de Tolnay, Edith Gyömrői, and Tibor Gergely. Their association was later expanded with new members: Andor Gábor, József Révai, Béni Ferenczy, and others who joined the meetings. At these encounters, political questions pushed themselves inevitably into the foreground, and the Circle became fragmented; from 1922 on they met less and less frequently, and the whole series of meetings finally stopped in 1926.

Lukács made the most decisive step of his life when he joined the Communist movement. In this decision his would-be wife, Gertrud Bortstieber, played an important role, but the step was organically linked to the earlier development of Lukács as a thinker. The entire bourgeois society, entwined in war, was for Lukács in the stage of complete culpability, and this determined, so he maintained, every aesthetic and ethical possibility of man, from the beginning to the very end. A break with the bourgeois value system, considered sinful, meant the possibility for an entirely new one. Lukács' radical decision was also motivated by his tenet that there must be practical implications from even the most abstract philosophical thoughts. Thinking, isolated from practical life, is useless and meaningless, he believed. Resting on foundations provided by this idea, Lukács never hesitated to make available his mental (and also physical) energies to the Communist movement. Depending on the needs of the movement, he played a sometimes more political role, other times less political. During the Soviet Republic he was Commissary of General Education; in the years of the Vienna emigration (1919–1929) he appeared on the board of the illegal Communist Party a few times; on several occasions he secretly returned to Hungary for one or two months to carry out some illegal activities; among other things, he edited journals, wrote theoretical papers, and masterminded new strategical and tactical plans in order to further the revolution of the proletariat. Due to a variety of circumstances his political role started to diminish in 1927, only to become important in Hungarian history again between 1945 and 1956. Despite the ups and downs, his political interest never faded, and he often liked to express himself on political questions. He kept his Communist conviction until the end of his life. Between 1919 and 1927 Lukács lived in Vienna. Besides carrying on his party activities, he devoted himself to analyzing the morals to be drawn from the failed revolution. In studying the revolution's political legacy he recognized the false agrarian politics of the Soviet Republic. In these years he also came to know and accept the political ideas of Lenin, and he suggested to the party leadership a new, democratic strategy of proletarian revolution, which he delivered under the name "Blum-Theses." Other members of the leadership did not share his viewpoint and his ideas were not accepted; after sharp criticism, he was removed from the leadership and from the informal inner circles where the political decisions were made. Lukács examined in a number of writings theoretical and political aspects of the revolution; these essays were collected as *Geschichte und Klassenbewusstsein* [History and class consciousness].[7] In this worldwide acclaimed and highly influential book, Lukács made a serious attempt to point out the importance of Marxist philosophy for the workers' movements. Making use of the concepts of alienation and materialization, he formulates a new revolutionary program without the intellectual compromises of most Communists.

In Vienna, Lukács' private life also took a new direction. He lived with Gertrud Bortstieber and her children, and this togetherness brought him new, important input and experience in terms of his own intellectual life: there finally was, in these years of his life, "a daily concern with a specific human reality." We can get an image of the Lukács of that time from several sources — a Hungarian police profile from April 20, 1920 stated that the special traits of György Lukács, journalist, commissary, were: "c. 168 cm tall, thin, slightly humpbacked, speaks in a low voice, has a puffy lower lip, a bent nose, an oval, high forehead, long, curly hair, combed back, brown eyebrows, short mustache, shaved, typically wears a pince-nez."[8] Theodor W. Adorno's description of Lukács after their meeting in Vienna is also known. Young Adorno thus reported to his friend Kracauer (1925):

> *My first impression was deep and overwhelming: he is a small, fine, blonde Eastern Jew with a Talmudic nose and with wonderful, inscrutable eyes, in a linen sport jacket like a scientist, creating a deadly clear and solid atmosphere around himself, an atmosphere without conventions, from which only a certain reservation of his personality strikes out.*[9]

According to widespread opinion, the character of Naphta in Thomas Mann's *Magic Mountain* is patterned after Lukács. The two men actually met a few times, and one of their encounters is remembered by the great German writer with these words:[10]

7. György Lukács, *Geschichte und Klassenbewußtsein* (Berlin; Malik, 1923); translated as *History and Class Consciousness* (Cambridge, Mass.: MIT Press, 1972).
8. Éva Fekete and Éva Karádi, eds., *Lukács György élete képekben és dokumentumokban* (Budapest: Corvina, 1980), p. 116.
9. Zoltán Tarr, "Weber és Lukács," in Miért Lukács?, ed. Tibor Szabó (Budapest, 1990), p. 9.
10. Thomas Mann, *The Order of the Day* (Ayer, 1969). [Our own translation, as this book was not available to us.]

György Lukács, Béla Balázs

I know Lukács personally, too. He once explained his theory to me for an hour in Vienna. All the while he spoke, he was right. But then, the almost unpleasantly abstract impression nevertheless left a sense of intellectual nobility and purity.

And from the novel:[11]

His name...was Naphta. He was small and thin, clean-shaven, and of such piercing, one might almost say corrosive ugliness...Everything about him was sharp:the hooked nose dominating his face, the narrow pursed mouth, the thick, bevelled lenses of his glasses in their light frame, behind which were a pair of pale-grey eyes – even the silence he preserved, which suggested that when he broke it, his speeh would be incisive and logical. According to custom he was bare-headed and overcoatless – and moreover very well dressed, in a dark-blue flannel suit with white stripes.

But what does Lukács have to say about this?[12]

There is no doubt that he modelled the character of Naphta on me. But he was far too clever a person and knew that Naphta's views are not my views.... Just as I shall never investigate whether a figure portrayed by a writer can be similar to the person involved or not, as this is not the interesting question, but rather whether or not the writer has succeeded in characterizing the type he wished to portray, nor shall I investigate to what extent Naphta is similar to me. In the case of Naphta it was successful, therefore all is well ... of course ... the writer must sometimes depart from the model for the sake of the work. To give an incidental example: I left Pest in August '19 and, of course, I had no money. I was wearing the suit I had left in, even in '19-'20, as it was my only suit; and it was in this suit that I visited Thomas Mann — so he could not see that I was elegant. He invented the elegance for the character. I should add that I never was elegant. Liebermann had a nice saying: "I painted you more similar than you are"; the writer needs a certain character, I supplied Thomas Mann with the necessary inspiration, and everything he needed he simply reshaped. I do not think that he really took notice of whether I was elegant or not.

Under exactly what conditions did the Lukács live in Vienna? Here is how Paul Ernst's wife recalled this time (1924):

One day we were invited by him for lunch. He lived on the outskirts of Vienna, in a rented apartment in a villa ... where a lady in gray silk trousers greeted us as the wife of György Lukács. She led us to the large room of our friend, which lay separate from the rest of the apartment by a staircase. There was a kind of sleighbed in it, a washbasin, a brown painted cupboard, a straight wooden chair with a washed-out cover, a large desk, several bookshelves, and chairs of various origin. All of this in a complete chaos, and the room was so full, that one had to press oneself through furniture in order to meet each other. An iron stove flooded heavy heat into the room. Somewhere from there Lukács himself emerged, forced himself to us, and greeted us with a bewildered smile.[13]

As every other refugee, also Lukács had to accept that he was not allowed to carry out any political activity while in Austria. Naturally, he was arrested by the police a few times, each time threatened by extradition; but German and Austrian intellectuals always stood by him and so he was soon free again.

Nevertheless, as it happens in every exile, the Hungarian Communist Party commissioned me to establish certain contacts, and most importantly, they ordered me that in case any of us was threatened by extradition I should intervene through Otto Bauer, and also that I should discuss several other things with him. As far as these discussions were concerned, the two of us got along well, because he was neither an orthodox social democrat nor was I an orthodox Communist. Given that, there was a possibility for the two of us to understand each other in more general terms and somewhat even at the personal level; and so the discussions between us were broader and went far beyond the issues about which I went to him. One should not conclude from this that I had a friendly contact with Bauer. This would not be true because both parties were in a situation where neither were allowed to cross certain borders.[14]

Many other people visited the Lukács. In the said apartment also Attila József, Robert Musil, Richard Beer-Hoffmann, and Károly Mihály showed up as guests.

11. Thomas Mann, *The Magic Mountain* (London: Minerva, 1996), p. 372.
12. Lukács, *A megélt gondolat*, pp. 57–60.
13. K. A. Kutzbach, *Paul Ernst und György Lukács. Dokumente einer Freundschaft* (Emsdetten, Westf.: Verlag Lechte, 1974), pp. 165–166.
14. Y. Bourdet, *Figures de Lukács* (Paris, 1972), pp. 175–176.

György Lukács

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Éva Karádi

G. Lukács, K. Mannheim, and the Sunday Circle

The names of Georg Lukács and Karl Mannheim are well known all over the world. Their main works, Lukács' *Történelem és osztálytudat* [History and class consciousness] and Mannheim's *Ideológia és utópia* [Ideology and utopia] have played a leading role in the ideological development of several generations of intellectuals all through the twentieth century. However, it is a much less-known fact that these two influential thinkers originally belonged to the same group of intellectuals in the first decade of the century in Budapest, the so-called *Vasárnapi kör* [Sunday circle].

Who were the members of this circle and who else became well-known from among them? What was the ideology these young philosophers and art theoreticians shared? How did they appear to the contemporary public? What kind of theoretical achievements were born in this intellectual sphere? How did they react to the great historical events of the era, the World War and the revolutions? How did these events influence their personal and theoretical development? To what extent is it possible to interpret Lukács's and Mannheim's philosophical achievements by referring to this common starting point?

These are the questions we were trying to answer with our selection of works from this chapter of European cultural history scarcely known until now, due to the fact that they had been written in Hungarian. What can the reader find in this volume?[1] The confessions of a generation of intellectuals about the transformation of their views on the ultimate questions. Memoirs and diaries that give us an insight into this milieu and illustrate the importance of the community for its members. Minor writings, lectures, and book reviews — documents of the members' sense of community, their ideological preconceptions, and their relation to other contemporary trends. Small pieces of writing like these are also helpful when we want to trace the process of transformation of the original values and their step-by-step reinterpretation in the context of contemporary events, down to the main works mentioned above. In order to investigate the intellectual context and the background of works that have already been translated into English, we have also included texts that are more loosely related to the series of lectures entitled *Lectures on Humanities* held by the Circle – texts like Lukács's notes on Dostoyevsky and Mannheim's lectures on cultural philosophy from 1919. In our opinion, these writings contain ideas that are stimulating and interesting, even for a reader at the beginning of a new century.

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Éva Karádi, *Lukács, Fülep és magyar szelemtudományi iskola* (Budapest: Magyar Filozófiai Szemle, 1985/1-2).
Éva Karádi, *Adalékok a világnézeti paradigmaváltások történetéhez* (Budapest: Atlantisz, 1994).

What was this Sunday Circle, after all? This is how Eberhard Gothein, a Heidelberg professor saw it during his visit to Budapest in the spring of 1918:

> *What I found the most interesting was that evening with Lukács' circle. ... A very peculiar, fascinatingly spirited party, with a Bohemian tint. They come together each Sunday evening in the apartment of Balázs, the poet of the circle. At eight o'clock they all set off to have dinner in a simple nearby restaurant, then returned to the same apartment. Debating is the vital element of this company of young Hungarians, they are idealists one by one, perhaps a bit too self-confident. Lukács exposes his views politely and dialectically, with constant references to authorities that he respects. The tone is lively and restrained at the same time, even women, artists, and writers, are devoid of mannerisms and stiff female dogmatism. Sometimes they talk all together, sometimes in small groups, just as they feel. This is a generation in which one has hope.*[2]

The facts can be summed up as follows: the Sunday Circle was the informal gathering of a company of friends around Lukács and his intellectual ally, the poet Béla Balázs. From the autumn of 1915 on — when Lukács had to return from Heidelberg because of the war — they mostly spent their Sundays together debating from 5 p.m. to 5 a.m. Who were the participants of these reunions, the members of this circle? In this respect, the recollections do not give a completely unanimous report. They mention several names, some of them are reckoned among the members, others not. After comparing the various documents, we came to the conclusion that a difference must be made between members and occasional participants in the debates. We consider as members only those who identified with the group, expressed their sense of togetherness, a feeling of solidarity, and shared a common ideological framework. Accordingly, the inner structure of the group can be outlined as follows: the central figures were Georg Lukács as an intellectual and Béla Balázs as a personal reference point. Lajos Fülep and Karl Mannheim also became dominant figures of the Sundays as autonomous intellectual personalities. Beside them, Anna Lesznai, Béla Fogarasi, Frigyes Antal, and Arnold Hauser were also founding members and permanent participants. The younger generation of participants were mostly students of the Free Academy of Humanities organized by members of the Sunday Circle in 1917–1918 — György Káldor, Károly Tolnay, László Radványi, and Tibor Gergely. At the time of the revolution, Ervin Sinkó also became a member.[3]

Sometimes other important personalities participated in the reunions, for instance Károly Polányi, who later became renown as a historian of economics, and his brother Mihály Polányi, the philosopher of science, as

1. This essay is an excerpt from *A vasárnapi kör*, ed. Éva Karádi and Erzsébet Vezér (Gondolat, 1980).
2. Eberhard Gothein's letter to his wife, Marie-Luise Gothein, March 3, 5, and 7, 1918. These letters were published in Hungarian in the historical review *História*, with the title "Bankers, Philosophers, Revolutionaries," in 1982.
3. Emma Ritoók was also a founding member, but later she became estranged from the group due to her conservative political views. Edit Hajós and Anna Schlamadinger, Béla Balázs's first and second wives, were also permanent participants of the reunions but did not play an active role in the debates. Edit Gyömrői and Antal Molnár did not have a determining role in the group, yet we included their recollections because of the significance of the texts.

4. Béla Balázs, "Napló", Tűz, October 1922, p. 5.
5. *A vasárnapi kör*, p. 57.
6. *A vasárnapi kör*, p. 89.

well as the psychologists Géza Révész and René Spitz. Among the guest lecturers of the Free School were Béla Bartók, Zoltán Kodály, and Ervin Szabó. We regard these people and those who are mentioned in the memoirs and the diaries as friends and allies who were close to the circle as members of the same generation and as friends of the members, but were not members themselves.

Another disputable question is how long the Sunday Circle existed. As for Lukács, he considered the history of the circle virtually finished after he joined the Communist Party. He was right in a way, since the circle ceased to play a role in his personal career. Nevertheless, he himself continued to be an important person for the rest of the group. Edit Gyömrői remembers some Sundays from the time of the Commune in 1919 and Balázs's diary gives an account of other Sundays during his emigration in Vienna:

Our Sunday academy is together again. It seems that the spirit does have a strong web after all, for even "the storms of history" could not destroy our company. Dispersed all over Europe, from Berlin to Munich, from Prague to Vienna, the Hungarian school of young philosophers still exists.[4]

Some participants in the "convention days" held in Vienna: József Révai (1), Jelena Grabenko (2), Ervin Sinkó (6) in the camp. The others: ErnőMannheim – the younger brother of Károly (3), Károly Garay (4), Irma Rothbart – the wife of ErnőSinkó (5), the wife of Károly Garay (7), and an Austrian employee of the camp (8), and an Austrian colleague. (9).

Thus, as long as reunions were held — until 1926, when Balázs moved to Berlin — the Sunday Circle can be considered as existent. Later reactions to the conversations and the influence of the participants on each other (for instance, the debate between Lukács and Mannheim on Communism in 1927, Mannheim's reflections on Lukács's book *History and Class Consciousness* in 1929, the reception of Mannheim's book *Ideology and Utopia* by former members of the Sunday Circle, Fülep and Káldor in 1930-1932) all belong to the history of ideas of the Sunday Circle; therefore, they were included in our volume.

We can infer the topics of the debates from the diaries. What the group meant to its individual members becomes clear from the recollections and the confessions. Later, Lukács deemed that the significance of the Circle was exaggerated and inflated.[5] However, Balázs's diary reveals what it meant for the others to live so close to a great personality:

Living close to a great person gives some kind of cosmic historical security to one's life. ... In all our theoretical doubts, Gyuri's presence reassured us as the presence of a teacher reassures little pupils. In the end, we could always ask him how things really were.[6]

Karl Mannheim was described by Balázs as an extremely talented philosopher and an even finer human being, characterized by integrity and an ardent thirst for truth, but also by restraint, skepticism, and lack of vigor. Mannheim emphasized (at the time and later) how important the Sunday afternoons at Balázs's place were for him.[7] "Mannheim said to me here a few years ago," Fülep wrote to Imre Kner in 1942, "that ever since, he had not found anything on a par with those 'Sundays'."[8] In Mannheim's paper on generations and in his *Heidelberg Letters*, which describe the intellectual circles in Heidelberg, the emotional residue of the Sundays can be felt when he speaks about shared attitudes and modes of thinking, affinities of interests, topics, questions, and terminology. In his lecture entitled "Lélek és kultúra" [Soul and culture] — held at the Free Academy of Humanities — he describes the unified orientation of a generation akin in development and sensibility.[9]

Fogarasi was related to the Lukács circle by a similar philosophical erudition and interest rather than by friendly ties. Apparently he was the only one who did not defer to Lukács's authority, and, though respectful of Lukács, had some sharp criticism for him. He dedicated his book, entitled *Konzervativ és progresszív idealizmus* [Conservative and progressive idealism] to the "Sunday afternoons," with the following remark:

The ideas I tried to express are mere consequences of a more systematic philosophical perspective that some of us started to propagate together.

Anna Lesznai stressed the ritualistic, quasi-religious tone of the Sundays; she felt that the group was particularly like a religious congregation.[10] Arnold Hauser emphasized that the Sundays provided the possibility of emerging from the narrow and dull provinciality of contemporary Hungary, and claimed that the group represented a European standard and a high level of ethical thinking:

We not only gathered around Lukács because we were aware of what everybody knows today: that he was the only one in Hungary who represented Europe in the best sense and that he was the one from whom we could learn the most, but also because he created an atmosphere around himself without the intellectual intensity of which we could not have lived and worked any more once we had been exposed to it.[11]

Frigyes Antal in his letter to Oszkár Jászi wrote something similar about "György Lukács's old circle":

"It was a real unity of ideas, a unity not in a void sense, but rather in the sense that our ideas completely coincided with the line of development of the intellectual world of contemporary Europe."[12]

To what extent the Sunday Circle provided a unity of ideas and to what extent it coincided with the line of development of the intellectual world of contemporary Europe was demonstrated when the circle appeared before the public with the Free Academy of Humanities. It was a sort of modern "anti-university" where the lecturers talked about their metaphysics, epistemology, ethics, and art philosophy at the same time that they were conceiving it.[13] In their program written by Fülep they raised their own objective to "positivism and materialism, which are about to vanish" as well as to "relativist impressionism," and advocated an ethical idealism which highlights the problems of transcendence and which professes the unequivocal validity of principles and the pathos of normative ethics.

One possible way of transcending cultural relativism for them was the neo-Kantian philosophy of validity. On that basis, the aesthetic and ethical normativism of Lukács and Fülep could be harmonized with the methodological pluralism — applied in their structural analysis — of some young philosophers (Fogarasi, Mannheim, Hauser) who were admitted into the circle as students of Zalai. What they shared was the attempt to separate theoretical truth, aesthetic and ethical norms from the empirical, mental process of their recognition and to posit them as independent, autonomous, and unconditionally valid values. It was a kind of Platonism, opposing facts and values, turning away from the world in the name of the spirit, rejecting civilization in the name of culture and the natural scientific view in the name of the humanities.[14]

These ideas were represented by the *Lectures on Humanities*, which were:

Frigyes Antal: Cézanne and Painting After Cézanne; The Emergence of the Composition and Content of Modern Painting
Béla Balázs: Dramaturgy; The Development of Lyrical Sensibility
Béla Fogarasi: The Theory of Philosophical Thinking; The Methods of the History of Ideas
Lajos Fülep: The National Element in Hungarian Visual Art
Arnold Hauser: The Problems of Aesthetics After Kant; Dilettantism in Art
Georg Lukács: Ethics; Aesthetics

7. *A vasárnapi kör*, p. 136
8. *A vasárnapi kör*, p. 147
9. *A vasárnapi kör*, p. 187.
10. *A vasárnapi kör*, p. 54.
11. Marianne Gács's interview with Arnold Hauser, Nagyvilág, 1971, p. 272.
12. *A vasárnapi kör*, p. 144.
13. Béla Balázs, "Szabad iskola,"Bécsi Magyar Újság, October 12, 1922.
14. For more detail on this see Éva Karádi, Lukács, *Fülep és a magyar szellemtudományi iskola*, Magyar Filozófiai Szemle I.2 (1985).

Karl Mannheim: Epistemological and Logical Problems; The Structural Analysis of Epistemological Systems
Emma Ritoók: The Problems of Aesthetic Effect
Sándor Varjas: Phenomenological Investigations
Béla Bartók: Folk Music and Modern Music
Zoltán Kodály: On Hungarian Folk Songs
Ervin Szabó: On the Ultimate Questions of Marxism

Politics as a Challenge

When a member of the circle, Emma Ritoók, visited her friends in November 1918 after a long absence, she was stunned. She would never have thought that those people would ever transcend the limits of theory:

> *These philosophers, with whom I used to debate in good faith about anything from Plato's Republic to Bolshevik theories of the state, about questions of revolutionary ethics, about medieval and Dostoyevsky's mysticism, about the value and the raison d'etre of the human sciences, about the philosophy of Bergson and Simmel, Windelband and the German Romantics ... were all of a sudden transformed into a group of active revolutionaries and politicians.*[15]

The recollections often emphasize that it would be a mistake to regard the Sunday Circle as a sort of "pre-Bolshevik assembly," since most of the members were hardly interested in politics. They thought that politics was not the "job of their life," only a peculiar situation could compel them to take up a political standpoint.[16]

In the beginning of March 1918 a debate took place at the Association of Social Sciences, where the representatives of the humanities had to give an account of the relation of their philosophy to progressive politics. Fogarasi held the introductory lecture with the title "Conservative and Progressive Idealism," in which he tried to detach progressive politics from the natural scientific view, with which the former had always been traditionally associated, and to attach it to ethical idealism.[17] In the course of the debate — in which two radicals, Oszkár Jászi and Ervin Szabó, also participated — Lukács argued that transcendence does not necessarily debilitate progressive action. Transcendent reality can also be set as a task, an ideal to be attained, bringing down the kingdom of God to the earth here and now. In his contribution, Lukács argued that politics was a heteronymous sphere, subordinated to ethics, and therefore can only serve as a mere instrument to reach aims that are set on the basis of principles and Weltanschauung.[18]

The radical social scientists and the idealist representatives of humanities encountered each other in the sign of Weltanschauung politics and progressive idealism, and decided about the fusion of their Free Academies. The fact that the members of the Sunday Circle actively supported the 1918 Károlyi revolution is due to their approach to one another.

However, the fact that Lukács joined the Communist Party surprised even his closest friends. Apparently, his conversion happened from one Sunday to another: suddenly, he was Saul turned Paul. The others could not follow him in this direction without reservations. Mannheim was one of the skeptics. He believed that doubting is not only a right but a duty of the intellectual, that he has no share in the cheap bliss of blind faith.[19]

Yet when at the end of March 1919 Lukács became the educational commissary of the Hungarian Soviet Government and decided to dismiss the whole staff of the Ministry of Culture and Education, his friends from the Sunday Circle were willing to occupy various posts by his side in the management of cultural politics. Their interpretation of this reversal was not that they started to serve a new political régime, but that, from then on, nothing stood in the way of the attainment of their intellectual goals.[20] They attributed a peculiar cultural mission to the socialist state – an idea that even Mannheim espoused in his lectures on cultural philosophy at the university. In these lectures we can find comments on his relation to the dictatorship of the proletariat that are unique in Mannheim's œuvre. Yet the most interesting aspect of these lectures is Mannheim's elaboration on the ways of life of the saint, the philosopher of history, and the educator. The first description fits Fülep, the second Lukács, the third was obviously one that Mannheim himself was aspiring to put into practice.[21]

The road on which most of the members of the Circle could not follow Lukács was that of the acceptance and justification of terror, of political violence as a means of redemption. Lukács espoused this conception with all its practical consequences just as he had espoused Dostoyevsky's ethics of accepting criminal action. This problem had already come up theoretically in his notes to the monograph of Dostoyevsky that he had intended to write, and became more and more compelling in the all-night debates of the "ethical Communists" grouped around Lukács at the time of the Commune. These young revolutionaries learned from Dostoyevsky that "I cannot simply resign myself to the fact that I live 'decently', because I am responsible for all the horrors

15. The memoirs of Emma Ritoók, property of her family.
16. Cf. *A vasárnapi kör*, pp. 57, 77.
17. *A vasárnapi kör*, pp. 247–70.
18. In György Lukács, *Ifjúkori művek*, ed. Árpád Tímár (Budapest: Magvető, 1977), p. 841.
19. Anna Lesznai, *Kezdetben volt a kert*, (Budapest, 1965), vol. II, p. 505.
20. Cf., e.g., Béla Fogarasi, "A szellemi tudományok jövője,"Fáklya, May 1, 1919, p. 3.
21. Notes of the lectures are extant and are the property of Mrs. Ervin Siminszky. We have published them in the German version of the volume about the Sunday Circle.

that I see around me if I do not rise up against them."[22] The desire to redeem the individual was replaced by the solidarity with and the responsibility for human suffering. Lukács's reflections in his Tactics and Ethics and his moral philosophy resolved in his philosophy of history deeply affected the young Ervin Sinkó:

At that time I believed that the way of the spirit led through objective reality, that after the history of class struggle, the rule of the spirit would begin with the class struggle of the proletariat, and I believed that it existed and would be attained in history and not in spite of history. I still believed that, conforming to the rules of dialectics, the institutions were invested with some kind of magical force and would eliminate themselves at the right moment, that in the proletariat, class selfishness would be transformed into a love for humanity, hatred into self-sacrificing charity, envy into renouncement, all conforming to the rules of dialectics.[23]

Yet as early as in the first days of the Hungarian Soviet Republic, Sinkó had to realize that it is morally much easier to have solidarity with a political movement when it is persecuted than to participate in it after it has come to power. "Why don't we start a revolution against historical necessity?" he asked desperately.

In the name of historical necessity the masses surged to and fro, seething with hatred in the streets, and we sat together, twenty or thirty of us, and prepared to interfere in people's lives, to send people to the army, to imprison them, to hang them, all in the service of historical necessity. We prepared to make decisions about production, private property, the bourgeoisie, the proletariat, in the name of historical necessity, but the fact that these were individual lives, that reality consisted of these people through whose efforts all we wanted to achieve might eventually become possible and that only by dealing with these individuals we can and must achieve anything – this naïve truth was lost in the haze of revolutionary ecstasy.[24]

What followed after the fall of the Commune was to draw the practical and theoretical conclusions. The whole Sunday Circle was forced to go into internal or external exile. The diaries and the confessions show how they became estranged, how differently the members related to politics in the post-revolutionary situation. Almost all the possible intellectual attitudes were represented. Balázs depicts the consequences of Lukács's behavior in his diary very expressively.[25] Mannheim formulated his conclusions in his Heidelberg Letters in a confessional style. It seems as if, contrary to Lukács's experiment, the representation of proletarian class consciousness, he decided to represent the consciousness of intellectuals: a less radical, but not less justified choice.[26]

Balázs interprets his commitment to Communism as a consequence of the spiritualism of the Sunday Circle in his letter to Emma Ritoók straight after the fall of the Commune:

I consider capitalism as bad, immoral and harmful, the attachment to private property as a sin against the Holy Spirit, and Communism as the only way of man to become truly spiritual.[27]

In his diary, Balázs commented on Mannheim's and Hauser's estrangement from the Sunday Circle when it became committed to world revolution as follows:

Today any intellectual work not rooted in the movement has a character of an anachronistic game, a sort of stamp-collecting activity.[28]

Interestingly enough, the same feeling is expressed on the other side by the young and talented student of Fülep, the art historian Tolnay, who was not discredited by any political activity in one of his letters to his mentor:

Somehow I began to feel that today it is immoral to just sit around and do my own job while everyone to whom I feel close sacrifices so much. One just waits around to be called to help somewhere and it is strange that even today there are completely unwanted people who cannot be used for anything and who are never called.[29]

The lesson Fogarasi drew from the events was that philosophers must change not only their interests, but even their way of life.[30] As an ideologist of the party he became even more orthodox than Lukács, just as he was more orthodox as a philosopher. Radványi's work, *Chiliasm and Bolshevism*, is another example of the theoretical treatment of revolutionary experience, obviously influenced by Mannheim.

22. Béla Balázs, "Dosztojevszkij évfordulóra," Tűz, April-May 1922.
23. Ervin Sinkó, "Az út," bequest of Ervin Sinkó, manuscript, p. 30.
24. Sinkó, "Az út."
25. *A vasárnapi kör*, p. 93.
26. Karl Mannheim, "Heidelbergi level," Tűz, 1921–22.
27. Emma Ritoók's bequest, property of her family.
28. *A vasárnapi kör*, p. 99.
29. Károly Tolnay's letter to Lajos Fülep, December 2, 1920, bequest of Lajos Fülep, the Hungarian Academy Library's Archives of Manuscripts.
30. Béla Fogarasi, "Tömegkultúra és tömegfilozófia," Tűz, July 16, 1921, p. 1.

31. György Káldor, "Könyvekről", in *Az új Könyvek könyve*, ed. Béla Kõhalmi (Budapest, 1937), pp. 173–76.
32. *A vasárnapi kör*, pp. 144–45.

This is how György Káldor summarized what the members of this generation retained from the Sundays after their illusions were lost:

> *We have long ceased to believe in the world-shaping force of the soul as we had believed at the time of the first mystical ecstasies, or in the constructive historical power of the spirit as we had in the years of ardent socialist faith. But the 'little spark' that is still there within us is ready to flame up again when stirred by the true soul and the radiant spirit.*[31]

After all this, to what extent can we say that the understanding of the original spiritual context of the Sunday Circle and the shared world view of the members contributes to a better understanding of Lukács's and Mannheim's œuvre? A certain continuity of theoretical attitudes can definitely be demonstrated: the opposition to the natural scientific world view and to positivism characteristic of the Sunday Circle are preserved in Lukács's Marxism, as is their anti-reductionism in his conception of culture and in his rejection of vulgar sociological, "proletkult" tendencies, and above all his theory of alienation. However, Lukács's theory of alienation has a messianic rather than a pessimistic overtone and is more a philosophy of history than cultural criticism. Mannheim retained an interest in the structural analysis of various styles of thinking within the framework of sociology (as sociology of knowledge), a social science that was formerly despised because of its reductionism, then acclaimed as secular philosophy.

In Mannheim's letter to Béla Balázs, the person who embodied the Sundays for him, he formulated the difference between his former and later attitude in the following terms (at the peak of his career, after the publication of his book *Ideology and Utopia* and his appointment as head of the Department of Sociology at the University of Frankfurt):

> *I was truly glad to read your positive reactions to the changes in my life. I would like to have an evening together with you and talk about the past, our hard struggle and the road we have taken. I have revised several things of the past, as you can see in my book, yet I hope that the core of the 'Sundays' has remained so much alive in me and so intensively, and you will also feel this, that the differences of opinion can be regarded as the honest account of a sphere of experience that has changed and a subject that has also necessarily changed in many respects. What I did in the past and what I cannot continue to do now is a completely rectilinear and one-sided view of life and things. Even if I am inclined to appreciate the significance of people who move in a rectilinear way and are unequivocal, but who are therefore limited or self-limiting, I do not believe that this is the only way for the individual as well as for the society or that whatever recognition one arrives at in life one must spell out and think over without further considerations.*[32]

The problems of the political commitment and the independence of intellectuals are brought up by each generation, as are also the other problems debated by the Sunday Circle, like civilization and culture, l'art pour l'art versus tendentious art, the conflict of individualism and collectivism, the problem of morally motivated terrorism, the meaning of history and individual life, alienation and redemption, ideology and utopia. As for their theoretical achievements, the members of the Sunday Circle made their mark in the theory of alienation, in hermeneutics, in the philosophy of art, in ethics and aesthetics, in neo-Marxism and the sociology of knowledge, in art history and the sociology of art. The talent, originality, and achievement of the individual thinkers are not of equal value — but this is true of all groups of intellectuals where there are mentors and followers, those who produce and those who apply new ideas. In the final analysis, this circle definitely represented something: it is a representative document of an era and of a generation, an intellectual community which captivated even the less great and without which the great ones would have been less than what they had become.

Éva Karádi and Erzsébet Vezér, eds., *A vasárnapi kör* (Gondolat, 1980).

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György Lukács

Leo Popper 1886–1911. An Obituary

Greatness negates all sentimentality. The mute senselessness of his passing is more terrible and stronger than any words of pain or lament could ever be. His latent creative potential may have sufficed for the vitality and life span of a Renaissance man, yet he was granted only a short life, which he led in chronic illness. The limited hours available to him had to suffice for his creative work. Yet the smiling, calm severity of his life prevented any mention of unfulfilled hopes, of paths cut off, of fragments. His sickly body did not enable him to realize his music and painting, but what he wrote in his essays blossoms, is powerful, abundant, and well-rounded. These are not derived from the meaningless disruptions during his life, of life itself. He awakened his work to life, each piece of his work had its own life, and each piece was preserved in a form.

This form is Leo Popper's thought. Every person of importance has only one single thought: the question arises whether the concept of "thought" can even be plural — and if the cheap abundance of diversity exists only to favor superficiality or is also meant for satisfaction. The compelling, spellbinding, resolving, and releasing force in his world is form itself. No one has ever split open the rifts between work and life, between the world and form, among creator, design, shape, and observer as wide as Popper did. The dreadful inadequacy of life, in which everything is driven by sheer strength and controlled by falsifying fictions, was an imperative for this world of form, for the necessary, irreparable misunderstanding of the expression functioning as its cradle and path; as the segregating unity of form and being. Every distortion of matter, every mode of expression brings forth a form; our poverty and limitations will give birth to release. In Popper's art philosophy, the theory of techniques becomes a theory of metaphysics. The basic fact behind all painting is that one employs colors and that the singularity of these colors, as material, should reflect a painting's material diversity. Yet painting does not accomplish this. This boldly undertaken impossibility and its inevitable failure emerge as a cosmic vision of everyday art production, as an all-embracing concept of form. Thus, granite forces the sculptor — who is always in search of nature, yet never able to find it — to join the form enclosed within the block, to form a unity with it. It is this very unity that transforms folk art's desire to employ colorful forms of expression into a form representing the mystical completion of hidden, lost, yet omnipresent senses. Popper's concept of form is stripped of everything that is restricting and abstract: the world of form is generous; it affords and bears happiness; it is filled with more truth, reality, and life than life itself. (It is a classic, in the way that Giotto, Breughel, and Cézanne are also considered classics.) Form awakens to activity; it is groundlessness itself, the grand coincidence. Driven by its own, unable to be experienced as a metaphysical force, it bounds right into one's life, forcing itself between one's will and work. It falsifies its own intention and transforms actions so that all ambitions human beings aspire to realize — be they cunning or subconscious — fail to succeed, and may their desire for truth arise through their failure to succeed.

The form is the last and strongest reality of existence itself. The (quantitatively) small collection of Leo Popper's work remains with us, carried by the power of his vision of the form. It rises above all possibilities of his empirically given life, it soars into the life that should have been and feels at home there. Everything he wrote was born out of abundance and is full of power, beauty, richness, and skill. As a master, he employed the noble deliberateness of this abundance in his writing. All of the painful senselessness and fragmentation of his life never cast a shadow on his ability to shine. This luster silences lamentation: during his lifetime, he heroically accomplished the feat of bringing out the essence in his work, and forming his work into an essence itself. The astonishment and silence of rapt attention — and in the face of that, all mourning remains without a tear.

Pester Loyd, 18 December 1911, reprinted in *Dialógus a muvészetröl. Popper Leó és Lukács György levelezése* (MTA Lukács Archívum, T-Twins Kiadó, 1993) pp. 441-442.

Leo Popper, born 1886 in Budapest. His father, David, was a world-famous musician. His family was in close contact with György Lukács's family. Popper studied at the music academy, but he also studied painting at the academy of fine arts in Budapest and then later in Naghbánya and Paris. Popper's tuberculosis prevented him from becoming an artist, however, so he turned to theory. After publishing a few articles in Hungarian, he began publishing in German in *Kunst und Künstler* and *Die Fackel*. His brief articles were of extreme importance to art theory, even though they were first widely received in the 1960s. Popper especially influenced the aesthetic theories of Lukács. Died in 1911 in a sanatorium in Goerbersdorf, near Dresden.

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7

Friedrich Stadler

The Vienna Circle

Friedrich Stadler, born 1951 in Zeltweg. Founder and Scientific Director of the Vienna Circle Institute. Research and numerous publications on the cultural and intellectual history of the nineteenth and twentieth centuries, specializing in Austrian philosophy and science as well as emigration and exile. Head of the Department of Contemporary History at the University of Vienna, since 2001. Lives in Vienna.

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The Vienna Circle was a group of about three dozen thinkers drawn from the natural and social sciences, logic, and mathematics who met regularly in Vienna to discuss philosophy during the period between the wars. The word of this group constitutes one of the most important and most influential philosophical achievements of the twentieth century, especially in the development of analytical philosophy, and philosophy of science.

The Vienna Circle made its first public appearance in 1929 with the publication of its manifesto, *The Scientific Conception of the World: The Vienna Circle*. At the center of this modernist movement was the so-called "Schlick Circle," a discussion group organized in 1924 by a professor of physics, Moritz Schlick. Friedrich Waismann, Herbert Feigl, Rudolf Carnap, Hans Hahn, Philipp Frank, Otto Neurath, Viktor Kraft, Karl Menger, Kurt Gödel, and Edgar Zilsel belonged to this inner circle. Their meetings in the Boltzmanngasse were also attended by Olga Taussky-Todd, Olga Hahn-Neurath, Felix Kaufmann, Rose Rand, Gustav Bergmann, and Richard von Mises, and on some occasions by visitors from abroad such as Hans Reichenbach, Alfred Jules Ayer, Ernest Nagel, Willard Van Orman Quine, and Alfred Tarski. This discussion circle was pluralistic and committed to the ideals of the Enlightenment. It was unified by the aim of creating a scientific philosophy, with the help of modern logic, on the basis of scientific and everyday experience. At the periphery of the Schlick Circle, and in more or less strong osmotic contact with it, there were loosely organized discussion groups centered around Ludwig Wittgenstein, Heinrich Gomperz, Richard von Mises, and Karl Popper. In addition, mathematician Karl Menger established an international mathematical colloquium in the years 1926 to 1936, which was attended by Kurt Gödel, John von Neumann, and Alfred Tarski, among others.

Thus, the years 1924 to 1936 saw the development of an interdisciplinary movement whose purpose was to transform philosophy. Its public profile was provided by the Ernst Mach Society, through which members of the Vienna Circle sought to popularize their ideas in the context of programs for national education in Vienna. The movement's general plans were reflected in its publications, such as the journal *Erkenntnis* (Knowledge, later called *The Journal for Unified Science*), and the *International Encyclopedia of Unified Science*. Given this story of intellectual success, the fate of the Vienna Circle was tragic. The Ernst Mach society was suspended in 1934 for political reasons; Moritz Schlick was murdered in 1936, and around this time many members of the Vienna Circle left Austria for racial and political reasons. Soon after Schlick's death, the Circle disintegrated, for political as well as theoretical reasons. As a result of the emigration of so many of its members, however, the characteristic ideas of the Vienna Circle became more and more widely known, especially in Scandinavia, Great Britain, and North America, where they contributed to the emergence of the modern philosophy of science. In Germany and Austria, however, the philosophical and mathematical scenes were characterized by a prolongation of the break that was caused by the emigration of the members of the Vienna Circle.

1. Scientific Philosophy and Philosophy of Science

Proponents of "scientific philosophy" think of philosophy not as an autonomous discipline prior to the sciences, but as a critical discipline dependent upon the natural and social sciences, logic, and mathematics. Paraphrasing Kant, they hold that philosophy without science is empty; science without philosophy is blind. Adoption of this scientific notion of philosophy does not, however, determine the details of one's epistemology, methodology, and ontology. As far as epistemology is concerned, the Austrian tradition offers contrasting examples: the phenomenology of Franz Brentano and the positivism of Ernst Mach. Similarly, there are those who stress the unity of the natural and the social sciences, and those who contrast explanation in the natural sciences with the distinctive type of understanding characteristic of human affairs. Finally, both idealist and materialist ontological positions are compatible with this understanding of philosophy. Nonetheless, all proponents of scientific philosophy demand exact methods and an empirical orientation. They oppose irrational and theological systems of philosophy with an attitude that displays their commitment to the ideals of the Enlightenment, as well as to science.

Historically, the positivism of Mach's scientific philosophy was the most important precondition for the development of the position adopted within the Vienna Circle. The term "philosophy of science" was used to describe this position, but by this was meant a general scientific concept of philosophy as well as a commitment to providing a philosophy of the sciences. Hence, within the Vienna Circle, philosophy was regarded both as a generally analytical and language-oriented activity, as well as a discipline concerned with the foundations of both the natural and social sciences. At the same time, within the Vienna Circle we find those — such as Moritz Schlick — who defend a methodological dualism of philosophy and science, as well as those — such as Otto Neurath — who seek to absorb philosophy entirely into a scientific concept of the world. Independent of this variety of positions, however, empiricism, an orientation towards the sciences, and an exact logical-mathematical methodology remain essential features of the Vienna Circle.

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2. Logical Positivism

The name "Vienna Circle" was used in public for the first time in 1929 in an essay, *The Scientific Conception of the World: The Vienna Circle* (Hahn/Neurath/Carnap 1929). Neurath suggested the term, and it was supposed to have a pleasant connotation, similar to the "Vienna Woods" or the "Viennese Waltz." At the same time, the term was meant to indicate the origin of this philosophical movement and its collective orientation (Frank 1949), although strictly speaking, it is anachronistic to use this term for the period before 1929. In this essay, the position of the 'radical' wing around Neurath, Carnap, Hahn, Frank, and others was especially prominent. This wing, institutionalized in the Ernst Mach Society, supported the idea of a unified physical science, as represented in the International Encyclopedia of Unified Science program. By contrast, the more moderate wing of the Vienna Circle, consisting of Schlick, Waismann, Feigl, and others (actually, the majority) emphasized their adherence to a dualism of science and philosophy with changing names like "consequent empiricism" (Schlick), "logical empiricism," or "logical positivism."

The widely used term "logical positivism" comes in fact from Herbert Feigl's and Albert Blumberg's paper, "Logical Positivism. A New Movement in European Philosophy," which was published in the *Journal of Philosophy* in 1931. Feigl and Blumberg give a concise description of the new synthesis of logical and empirical factors:

> *The new logical positivism retains the fundamental principle of empiricism, but, profiting from the brilliant work of Poincaré and Einstein in the foundations of physics and Frege and Russell in the foundations of mathematics, it feels it has attained, in most essentials, a unified theory of knowledge in which neither logical nor empirical factors are neglected. From the point of view of logical positivism, Kant's synthesis concedes too much to rationalism by assuming the existence of synthetic, a priori truths. Opposing Kant, the new movement's fundamental thesis is that there are no synthetic, a priori propositions. Basing its assertions on recent developments in factual and formal sciences, it holds that factual (empirical) propositions, though synthetic, are a posteriori and that logical and mathematical propositions, though a priori, are analytic. It is fundamentally this new understanding and use of the analytic character of logic that has made possible the convergence of the empirical and logical traditions. By means of the theory of knowledge thus constructed, logical positivism goes beyond Comt's pragmatic rejection of metaphysics as useless or superfluous and shows that the propositions of metaphysics, in most senses of the term, are, strictly speaking, meaningless.*
> *(Blumberg/Feigl 1931, 282).*

Blumberg and Feigl go on to describe the philosophical transformation from old to new positivism with the adoption of symbolic logic, epistemology, and research into the foundations of science. Finally, they explain, following Wittgenstein, their notion of philosophy: "The purpose of philosophy is the clarification of the meaning of propositions and the elimination of...meaningless pseudo-propositions" (ibid., 269). Despite its widespread currency, however, the disadvantage of the term "logical positivism" is that it associates the Vienna Circle too closely with positivism, and thus, for example, with the "positivism dispute" that runs from Lenin to the Frankfurt School. Hence, the term "logical empiricism" is now often preferred. It takes into account the synthesis of rationalism and empiricism, and clearly signals the two most important elements in the philosophy of the Vienna Circle.

In Schlick's logical empiricism, the classical philosophical positions of empiricism and rationalism were integrated with the help of modern logic and mathematics, but a distinction between philosophy and science was still admitted. As part of his scheme for a unified physical science, Neurath's more radical scientific concept of the world aimed at overcoming philosophy itself. This divergence in philosophical approaches left room for debates within the Circle on such topics as the merits of phenomenal and physical languages, coherence, correspondence theories of truth, logical syntax, semantics, verification, confirmation, and ideal and natural languages. At the same time there was a consensus concerning the merits of a logical analysis of language, a fallibilist epistemology, a scientific attitude to the world and the unity of scientific explanation, and knowledge in general. After Schlick's death in 1936, however, his logical empiricist project collapsed following personal and theoretical disagreements. The project of a unified science, however, continued in the unity-of-science movement.

An important element of Vienna Circle's brand of logical empiricism was the refusal to accept synthetic judgements a priori. Following in the path of Russell and Whitehead, symbolic logic and mathematics were regarded as purely analytical (because merely "conventional") and a priori (and thus independent of any experience). Analytic truths of these kinds were contrasted with empirically true statements from the natural sciences and ordinary experience; these were synthetic judgements a posteriori. But there was no further class

[5] R. Carnap, *Intellectual Autobiography*, P.A. Schilpp, ed. (1963) pp. 1-84.

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[31] V. Kraft, *Der Wiener Kreis. Der Ursprung des Neopositivismus. Ein Kapitel der jüngsten Philosophiegeschichte* (Vienna/New York, 1950).

[32] V. Kraft, *Einführung in die Philosophie. Philosophie, Weltanschauung, Wissenschaft* (Vienna, 1950).

of synthetic a priori judgements; instead there was thought to be an important class of "meaningless" postulates. The elements of this class, being neither analytic nor synthetic a posteriori (Hanfling 1981, cap. 2,3), are "metaphysical" in a sense, which implies that they are not part of knowledge at all, even though they may express some realm of experience. This anti-metaphysical position in the Vienna Circle is most prominently represented by Rudolf Carnap's *Elimination of Metaphysics through Logical Analysis of Language* (Carnap 1931). It prepares the logical empiricist scheme for the task of achieving a unified reconstruction of science. But the question of whether an empirical basis could be a foundation for all knowledge received strongly divergent answers, from Neurath and his coherence theorists on one side and Schlick and his correspondence theorists on the other (Hempel 1981, 1993). The apparently strict division between the analytic and synthetic sentences was also being questioned (Menger 1979, 1-60, 1994). Indeed, the idealized notion of one language of science, logic, and mathematics had already been strongly relativized by the Vienna Circle itself, long before Quine put forward his classical critique (Quine 1953). Thus, contrary to its popular reputation, a heterogeneous pluralism of views was, in fact, characteristic of the Vienna Circle: for example, in questions of ethics (Schlick 1930; Menger 1934; Kraft 1937), with regard to the alternatives of "realism" versus "positivism" (Schlick 1933; Carnap 1928; Feigl 1929; Kraft 1925) and advocates of verification versus falsification (Neurath 1935), as well as in questions of an ideological and political nature (Haller, ed., 1982).

3. Logical Empiricism and the Scientific Conception of the World

The relationship between Schlick's logical empiricism and Neurath's distinctive scientific conception of the world is a complex matter. They do, of course, have certain points in common, such as the view of philosophy as a language-oriented, analytic activity (Delius 1970, 269ff.). Again, the principle of verification ("The meaning of a sentence is the way to verify it," Schlick 1938, 341; Hempel 1950) and logical atomism (following the path set out by Wittgenstein's *Tractatus*) are constitutive features of the entire movement, but are in themselves not enough to characterize it. Mainly referring to Carnap's positions, Kamitz (1973, 118ff.) describes the Vienna Circle up to about 1930 using the following principles: the formal character of mathematics (logicism, meaning the subordination of mathematics to a type of logic that is itself purely analytic), verifiability, methodological phenomenalism, such as Carnap's epistemological position in *The Logical Construction of the World*, and "scientism," which makes claims for the omnipotence of science as compared to alternative forms of knowledge in philosophy and art. For the period of 1930 to 1935, the following principles are listed: the hypothetical character of empirical claims (the criterion for verifiability is replaced by a criterion for confirmability), the conventionalist interpretation of logic, physicalism as the foundation of the unified science (a physical, quantitative, empirical language as a unifying, intersubjective language of science), and the concept of philosophy as the logical syntax for the language of science. These principles reflect the growing dominance of Neurath's point of view within the Circle. In particular, the last principle restricts questions of truth to comparisons among sentences along the lines of Neurath's coherence theory, in order to avoid the dualism of "language" and the "world" suggested by the correspondence theory of truth. In line with this, Carnap and Neurath deny any absolute "foundation of knowledge" of the kind sought by Schlick (Schlick 1934). They hold that in any empirical justification it is not single postulates that are tested, but whole systems of postulates, and science in general. This is a form of relativism that makes Neurath in particular a forerunner of recent holistic approaches in the philosophy of science (see Hempel, Popper, and others in Skirbekk, ed., 1977).

Although this last point of view is clearly Neurath's, it is important to grasp that the "scientific concept of the world" that he and others promulgated within the Circle had a much broader cultural goal. It was not simply a neo-positivist, anti-metaphysical, science-oriented program. Instead, he looked forward to a type of unified science and a truly scientific concept of the world, hoping that these would make everyday life more humane and democratic. In depictions of the Vienna Circle written after World War II, these practical aspirations are often treated as non-essential political ambitions, as compared to the scientific programs of logic and empiricism — whereas, in fact, internal debates about them were emphasized and regarded as representative of the Vienna Circle. We find the clearest presentation of the claim to social reform that is inherent in the scientific concept of the world in an essay describing the program of the Vienna Circle in 1929:

> *The scientific concept of the world is characterized not so much by theses of its own, but rather by its basic attitude, its point of view, and its direction of research. The goal is unified science. The endeavor is to link and harmonize the achievements of individual scientists in their various fields. From this aim follows the emphasis on collective efforts, as well as the emphasis on what can be grasped intersubjectively. This gives rise to the search for a neutral system of formulae, for a kind of symbolism free of the slag of historical languages, as well as for the search for a total system of concepts. Neatness and clarity are striven for, and dark distances and*

unfathomable depths rejected. In science, there are no 'depths': all is on the surface. Experience forms a complex network, which cannot always be surveyed and often can be only partially understood. Everything is accessible to man, and man is the measure of all things...the scientific concept of the world knows no unsolvable riddle.
(Carnap/Hahn/Neurath 1929, 15; 1973, 305f.)

This concluding paraphrase of one of Wittgenstein's claims in the *Tractatus* is the starting point for this anti-metaphysical scientific program of the late Enlightenment. Traditional philosophy and its mannerisms must, in a first step, be reduced to a critical analysis of language:

Looking back, we now see clearly what is the essence of the new scientific concept of the world, as contrasted to traditional philosophy. No special ,philosophic assertions' are established; assertions are merely clarified, and assertions of empirical science at that, as we have seen when we discussed the various problem areas. Some representatives of the scientific concept of the world no longer want to use the term 'philosophy' for their work at all, so as to emphasize even more strongly the contrast with the philosophy of (metaphysical) systems. Whichever term is used to describe such investigations, this much is certain: there is no such thing as philosophy as a basic or universal science alongside or above the various fields of the one empirical science.
(Carnap/Hahn/Neurath 1929, 28; 1973, 316)

The practical impulse behind this therapeutic destruction of a philosophy of metaphysical systems and the rational subject was the desire for a unified and empirical concept of the world based on simple human experience, directed against the zeitgeist of an increasing number of metaphysical movements, whose rise was connected with social and economic factors. Social criticism thus begins to accompany empirical science, replacing the classical philosophical materialism of the labor movement:

In previous times, materialism was the expression of this view; in the meantime, however, modern empiricism has shed a number of inadequacies and taken a strong shape in the scientific concept of the world.
(Carnap/Hahn/Neurath 1929, 29; 1973, 317)

Its closeness to real-life issues and its solidarity with the forces of progress led, in a period of emerging fascism, to an aggressive determination of its position on social issues:

We witness the spirit of the scientific concept of the world penetrating in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles. The scientific concept of the world serves life, and life receives it.
(Carnap/Hahn/Neurath1929, 30; 1973, 317f.)

In this notion, social criticism, the sociology of knowledge, and philosophic, scientific collective work formed a schematic unity, in hope of comprehensive progress, which was partly put into practice. In the natural sciences, Neurath thought, considerable progress had already been achieved, yet the situation in the social sciences was less clear (1930/31, 121; 1983, 44). Therefore, in his book, *Empirical Sociology* (1931), Neurath attempted to give a "physically oriented" description of the processes of human social interaction, of the forces that make groups of people cooperate or work against each other, and of their influence on the lives of the masses. His general attitude toward the long-term predictions made by the social sciences is manifested in his cautiously optimistic view of possible future developments of society and science (which seems rather utopian to a contemporary observer):

Starting from magic, the path leads through religion and philosophy to materialist empiricism. And then? What can we expect of the development of the scientific concept of the world on a materialist basis? If we already knew this in detail today, the change would already have come about. We can only try to make guesses for short periods ahead. Bound to the cooperation of other thinkers, to the living conditions of the age, each individual is subject to limitations. Intellectual community work, if planned on a great scale, is probably only possible in a planned, fully organized society that energetically and consciously shapes the order of life with a view to early happiness with the help of earthly means. Social changes put their stamp on intellectual changes.
(Neurath 1930/31, 124; 1983, 46f.)

[33] V. Kraft, "Dinglers 'Methodische Philosophie' und der Neopositivismus," Zeitschrift für philosophische Forschung (8:1954) 259-266.

[34] V. Kraft, "Der Positivismus," Studium Generale (2:1954) 73-79.

[35] V. Kraft, "Wissenschaft und Weltanschauung," Anzeiger der österreichischen Akad. der Wissenschaften, philos.-histor. Klasse 92 (1956) 239-251.

[36] P. Kruntorad, et al, eds., *Jour Fixe der Vernunft. Der Wiener Kreis und die Folgen* (Vienna: hpt, 1991).

[37] J.C. Marek et al, eds., *Österreichische Philosophen und ihr Einfluß auf die analytische Philosophie der Gegenwart I* (Innsbruck/Munich/Salzburg/Graz/Gießen, 1977).

[38] M. Mandelbaum, *History, Man, and Reason. A Study in Nineteenth-Century Thought* (Baltimore, 1971).

[39] K. Menger, *Moral, Wille und Weltgestaltung. Grundlegung zur Logik der Sitten* (Vienna, 1934).

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[41] K. Menger, *Reminiscences of the Vienna Circle and the Mathematical Colloquium* (Dordrecht/Boston/London, 1994).

[42] R. von Mises, *Kleines Lehrbuch des Positivismus. Einführung in die empiristische Wissenschaftsauffassung* [Den Haag 1939] (reprint, Library of Unified Science Series, 1, newly edited and introduced by F. Stadler, Frankfurt 1990).

[43] R. von Mises, "The Role of Positivism in the XX Century," P. Frank, et. al, eds. (1962) see note 12.

[44] R. von Mises, *Positivism. A Study in Human Understanding* (New York, 1968).

In this respect, it is worth mentioning that, after the disintegration of the Vienna Circle (which was also a process of political neutralization), reference to the "scientific concept of the world" was occasionally used by former members of the Vienna Circle in connection with general ideological questions. For example, Carnap (1963, 81) refers to "scientific humanism" as a standpoint shared by the majority of the members of the Vienna Circle. By this, he means, first, that everyone determines his or her own life; second, that mankind has the ability to improve living conditions; and third, that every liberating action presupposes knowledge about the world — knowledge that is best achieved by scientific means, so that science becomes the most important instrument for improving our lives. According to Carnap, such aims require rational planning, which, in turn, would be best achieved by some form of socialism and a world government.

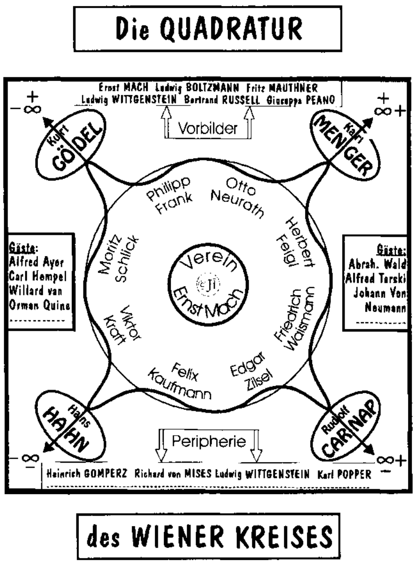
4. Encyclopedia of Unified Science

After the dissolution of the Vienna Circle, the forced emigration of most of its members, and the diffusion of the logical empiricist movement from its centers in Vienna, Prague, and Budapest, the twin aims of a transformation of philosophy and the establishment of a scientific concept of the world could be envisaged only without reference to their previous cultural context and audience. But even in these difficult times, Neurath and his circle still succeeded in organizing well-attended conferences of high standards (International Congresses for the Unity of Science). He also managed to ensure that the unity of science movement continued in the U.S.A. (Morris 1970/1971). After 1935, Neurath devoted himself to the encyclopedic model as a means of furthering this movement. In cooperation with Carnap, Frank, and Morris, he planned an international encyclopedia of the unified science and, corresponding to it, worked on a picture language (ISOTYPE) for visual representation. He presented this program as a further development of the ideas of the French Enlightenment:

> *Thus the encyclopedia is, for us, the very territory in which science lives. In some way, representatives of logical empiricism continue the work that d'Alembert, with his aversion to systems, originated. But they are much more consciously encyclopedists, and, in a sense, much more rigorous than their great forerunners. The encyclopedia can thus become the symbol of a developed scientific cooperation, of the unity of the sciences, and of the fraternity among the new encyclopedists.*
> *(Neurath 1936, 201; 1983, 158)*

This version of an unfinished Enlightenment project remains a striking challenge for the scientific community to this day.

Paul Kruntorad, ed., *Jour Fixe der Vernunft. Der Wiener Kreis und die Folgen* (Vienna, 1991; revised in 1996).



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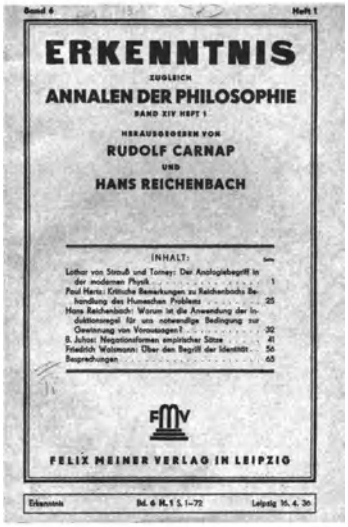
KRISE UND NEUAUFBAU IN DEN EXAKTEN WISSENSCHAFTEN

Fünf Wiener Vorträge

MARK:
Die Erschütterung der klassischen Physik durch das Experiment.
THIRRING:
Die Wandlung des Begriffssystemes der Physik.
HAHN:
Die Krise der Anschauung.
NÖBELING:
Die vierte Dimension und der krumme Raum.
MENGER:
Die neue Logik.

FRANZ DEUTICKE · LEIPZIG UND WIEN · 1933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HERAUSGEGEBEN VON
RUDOLF CARNAP
UND
HANS REICHENBACH

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Paul Hertz: Kritische Bemerkungen zu Reichenbachs Behandlung des Humeschen Problems	25
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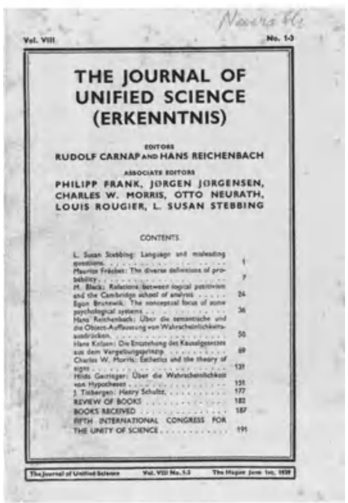
FELIX MEINER VERLAG IN LEIPZIG

Erkenntnis Bd. 6 H. 1 S. 1–72 Leipzig 16. 4. 36


Neurath

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EDITORS
RUDOLF CARNAP AND HANS REICHENBACH
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The Journal of Unified Science Vol. VIII No. 1-3 The Hague June 1st, 1939

Members of the Vienna Circle

Rudolf Carnap (1891-1970)

Herbert Feigl (1902-1988)

Philipp Frank (1884-1966)

Kurt Gödel (1906-1978)

Hans Hahn (1879-1934)

Felix Kaufmann (1895-1949)

Viktor Kraft (1880-1975)

Karl Menger (1902-1985)

Otto Neurath (1882-1945)

Moritz Schlick (1882-1936)

Friedrich Waismann (1896-1959)

Edgar Zilsel (1891-1944)

Eckehart Köhler

The Circulation of the Concept of Philosophy in the Vienna Circle

Philosophy is the last authority for those who are seeking advice in their attempts to solve problems of technology, the environment, and life in general. Often philosophy fails, but when it does, there are no further natural authorities beyond it.

What is this philosophy, which carries such a burden and has so much responsibility? If philosophy is meant to give advice, then certain knowledge must stand behind it, and therefore philosophy must work with scientific standards. One could even directly demand that philosophy itself be considered a science. This is, of course, an ancient demand: indeed, philosophy itself begins with it, since what were those efforts of Thales, Democritus, Zeno, Edoxos, Plato, and Aristotle, if not an attempt to set up a critically based science in place of the old myths and sagas?

Nevertheless, in the course of history, the alienation of philosophy and science appears again and again, maybe most strongly in Schelling and Hegel's era, and then again, clearly, after the turn of the century to the present day.

On one hand, the philosophy of history and the philosophy of life became stronger in a methodologically questionable way, while, on the other hand, growing numbers of specialty areas splintered off from philosophy, among them, chiefly: psychology (Brentano, Schuppe, Wundt), sociology, and political science. For a century, mathematics, physics, chemistry, biology, and economics have no longer been considered philosophical disciplines. In the meantime, most philosophies find consolation in at least maintaining their ancestral core. To list them: logic, metaphysics, theory of knowledge, and ethics. Should we adhere to this narrow list in the future?

Viennese philosophers, supported by the once socially oriented climate of the Socialist Party that led Vienna, used precisely this question to follow a decisively new orientation. The philosophers of the Vienna Circle, centered around mathematician Hans Hahn and trained physicist Moritz Schlick, were more strongly influenced than were the professional philosophers of their time, as the developments in the new logic of Freges and Russell, the new mathematics of Riemann, Cantor, and Hilbert, and the new physics of Boltzmann, Planck, and Einstein circulated. They were deeply convinced that any just future philosophy must take into consideration these developments, which had no precedents since Descartes and Newton — even as far back as their Greek origins. Not only because fundamentally new knowledge was gained, but also because a new, much more critical, yet much more collegial style of research became advisable and necessary.

The group surrounding Hahn and Schlick, joined by Neurath, Carnap, Menger, and Gödel, clearly predicted that also the old inherited cores of philosophy would soon become specialty sciences. As far as logic was concerned, this process was almost complete, and it was just a question of time for the theory of knowledge. Today one can consider both of these as sub-fields of mathematics and cybernetics (statistics). However, there is no room left for metaphysics (in my opinion, this is because logic and metaphysics have been utterly and falsely separated ever since Aristotle). On the other hand, ethics is understood as the study of bliss or as part of economics. What, then, remains for an abandoned philosophy, which had once been entrusted with a burden of great responsibility, when even the holy cores have fled? When philosophical knowledge is embodied in specialized fields, does not philosophy then lose its appearance and, simultaneously, its task? Here, one must inquire further: does society not become ill, if highly talented specialists do not look over their respective fences? Moreover, Schlick says something very wise that perhaps reveals why he was renowned and highly respected as the leader of the Vienna Circle. He asserts:

> *Everywhere in science and in life, where precisely the most basic problems are dealt with and a solution is supplied (and thus, where the most important questions fueling humanity lie) there, you will find, is philosophy!*

This answer is captivating precisely because philosophy can no longer claim a special realm for itself, yet at the same time, it remains essential. Nonetheless, it remains unclear as to where the points of condensation of philosophy lie, and therefore, where the fundamental problems are (we see that philosophy retains its fundamental character). Schlick believed that he could give somewhat more exact information relating to this question in his last lecture, held in Paris in 1936: he claimed that what provides sense is fundamental. He formulated the answer so as to point out that it is the task of science to determine facts, while philosophy occupies itself with finding sense, or more exactly stated: to give sense to words and to regulate their logical grammar. At first, Schlick's solution made it seem as if he had created a separate autonomy for philosophy, and that in doing so, he was obviously influenced by his discussions with Wittgenstein, whose later teachings only allowed philosophy the modest role of explaining linguistic confusion. Still, 'making sense' is a much more important concern for Schlick than for Wittgenstein, since for Schlick, the concept of logos (from whence sense can be traced) includes an entirely practical rationality.

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Beyond that, Schlick's later understanding of philosophy can be compared with Carnap's attempt to replace philosophy with logical syntax, in as far as it was meant to exhaust logic. It was, however, in connection with Carnap, not with Wittgenstein, that Schlick believed that logos comprised all of practical rationality. Under the influence of Wittgenstein and Neurath, Carnap had first thought, or rather hoped, that all questions of sense could be reduced to purely structural, syntactic relationships between symbols. However, by the end of the 1930s, he admitted that, in addition, one needs semantics and pragmatics.


Aus dem Nachlasse von H. HAHN

SCHRIFTEN ZUR WISSENSCHAFTLICHEN WELTAUFFASSUNG

HERAUSGEGEBEN VON

PHILIPP FRANK, O. Ö. PROFESSOR AN DER UNIVERSITÄT PRAG UND MORITZ SCHLICK, O. Ö. PROFESSOR AN DER UNIVERSITÄT WIEN

BAND 2

ABRISS DER LOGISTIK

MIT BESONDERER BERÜCKSICHTIGUNG DER RELATIONSTHEORIE UND IHRER ANWENDUNGEN

VON

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VON

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This development of the concept of philosophy in the Vienna Circle is therefore particularly noteworthy, because — in view of Wittgenstein's early work, when the *Tractatus* served as a starting point, so to say, for the discussions in the Vienna Circle — philosophy was considered to be completely without sense — precisely, indeed, because the questioning of sense never occurs at the "level of fact," which alone comprises the sensory realm. Schlick, however, did not share this extreme asceticism or the skepticism of Wittgenstein's early works with the other members of the Vienna Circle. Now, when "questions of sense" once again attain sense, they are still somehow of a matter-of-fact nature, although possibly at another level. But then again, Schlick's "questions of sense" belong to science, obviously a normative type of science, such as mathematics or ethical decision-making theory. Philosophy is, then, not outside of or separate from science; it is, however something special within science: namely, the most fundamental aspect.

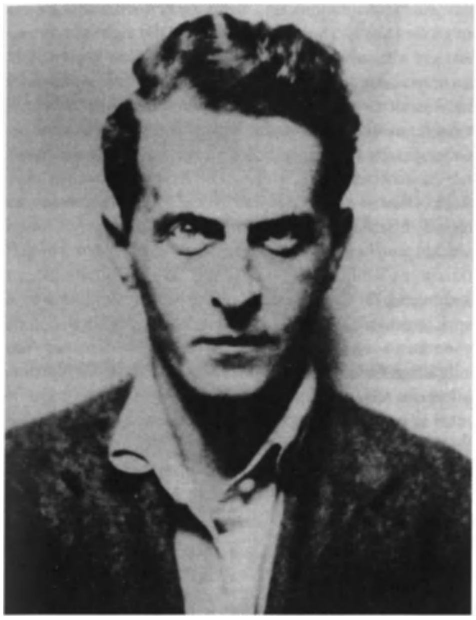
However, Schlick had no more time to derive these suggested conclusions from his Paris lecture, for a few months later he was murdered by a man who thought quite differently.

1984
(unpublished lecture)

Elisabeth Leinfellner

Wittgenstein and Mauthner – Mauthner and Wittgenstein

Bioi paralleloi – Parallel Lives is the name that Plutarch gave to a piece in which he contrasted pairs of biographies of renowned personalities. The lives of Wittgenstein and Mauthner show but a few parallels, but the case is different as far as their works as concerned, primarily when we compare Wittgenstein's later philosophy with Mauthner's.



Ludwig Wittgenstein

Fritz Mauthner

(1/a) All philosophy is "critique of language"...
(1/b) All critical philosophy is critique of language.
(2/a) Language has become like a major city. Room to room, window to window, flat to flat, house to house, street to street, neighborhood to neighborhood, and all of that is packed into each other, connected with each other...
(2/b) Our language can be seen as an ancient city: a maze of little streets, squares, old and new houses, and houses with additions from various periods; this surrounded by a multitude of new boroughs with straight, regular streets and uniform houses.
(3/a) But if we want to learn something from the destruction of an old building [i.e., of language], then it is always advisable to tear it down brick by brick.
(3/b) Our investigation is therefore a grammatical one. Such an investigation sheds light on our problem by clearing away misunderstandings. Misunderstandings concerning the use of words...the process sometimes resembles that of taking things apart.
(4/a) Thinking is speaking.
(4/b) If, however, I wanted to say in words everything that I intend to express by...then I would have to write down the same thing...that I wrote before.
(4/c) "The purpose of language is to express thoughts"...Then what thought is expressed, for example, by the sentence "It's raining"?
(5/a) We know that it is essential for language to be undetermined and foggy. Even the most concrete term is fuzzier than reality.
(5/b) ...every familiar word...actually carries an atmosphere with it in our minds, a corona of lightly indicated uses. —Just as if each figure in a painting were surrounded by...delicate shadowy drawings of scenes...
(6/a) ...because the critical spirit represents the strongest form of human understanding, the limits of humanity ultimately will lie in the dependency on the words of each era. There is no revelation and no prophetic inspiration. There is only the mystical.
(6/b) The limits of my language mean the limits of my world...However, the inexpressible exists. This shows itself: it is the mystical.

Ludwig Wittgenstein, born 1889 in Vienna. He studied engineering sciences in Berlin and Manchester. In 1911 he went to Cambridge, where he studied logics and philosophy with Bertrand Russell. Wittgenstein was a volunteer in World War I. In 1919 he returned to Vienna from an Italian prisoner-of-war camp. He finished teacher training and for some time worked as an elementary school teacher in Lower Austria. In 1921 the *Tractatus* was first published in a magazine, in 1922 as a book in German and English in Great Britain. Apart from this book only a small *Wörterbuch für Volkschulen (Dictionary for Elementary Schools)*, 1926, and two short essays were published during his lifetime. In 1929 he moved to Cambridge, where he got his PH.D. and taught until 1936. In 1936 he went to Norway and worked there in solitude. From 1939-1947 he was professor in Cambridge. Until 1949 he worked mainly in Ireland under similar conditions as in Norway. He died in 1951 in Cambridge.

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TLP = Tractatus Logico Philosophicus (1922 und 1923). PU1-2 = Philosophische Untersuchungen Teil 1-2 (1953). (TLP und PU in Bd. 1).

Ludwig Wittgenstein, *Tractatus Logico Philosophicus* (Routledge, 2001).
Ludwig Wittgenstein, *Philosophical Investigations: The German Text, with a Revised English Translation* (Blackwell Publ., 2002).

Fritz Mauthner, born 1849 in Horzitz, Bohemia. In 1876 he moved to Berlin. He worked as journalist, publisher, and writer of novels, narratives, and the very successful parodies *Nach berühmten Mustern*. From 1901, the *Beiträge* appeared. In 1905 Mauthner left Berlin. After a short stay in Freiburg, in 1909 he moved to Meersburg am Bodensee where the *Wörterbuch* and the monumental *Geschichte des Atheismus* were written. Publisher of the *Bibliothek der Philosophen*. He died in 1923 in Meersburg/ Bodensee.

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Fritz Mauthner, *Beiträge zu einer Kritik der Sprache* 1923, vol. 1-3 (Frankfurt/Main-Berlin-Vienna: Ullstein, 1982) (= B1-B3).
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Fritz Mauthner, *Der Atheismus und seine Geschichte im Abendlande* (1920/23), vol. 1-4, Stuttgart-Berlin: Deutsche Verlagsanstalt) (= A1-A4).
Fritz Mauthner, *Selbstdarstellung* (1922), in: Raymund Schmidt (ed.), *Die deutsche Philosophie der Gegenwart in Selbstdarstellungen*, vol. 3, (Leipzig: Meiner) (= SD).

(7/a) Language is language use.
(7/b) The meaning of a word is its use in the language.
(8/a) If a lion could talk, we would not be able to understand him.
(8/b) And if nature could talk, it would not speak our language.

Those who encounter these quotations for the first time and only have a vague idea of Wittgenstein and Mauthner would have a difficult time assigning the correct authors (solutions in footnote one). And (4/b) is an outright stray bullet, a statement by Tolstoy — who is, by the way, one of Wittgenstein's favorite authors — about his Anna Karenina.

(1/a) reads in full: all philosophy is "Critique of Language" (but not at all in Mauthner's sense).

And it would certainly be inadequate if one were to write "parallel works" in place of "parallel lives." But, as the other quotes from (1/b) to (8/b) demonstrate, it is not so simple, and the parallels are often baffling. Very little agreement exists between the Wittgenstein of the *Tractatus* and Mauthner. What is primarily the same for them is the basic empirical position. Furthermore: both Wittgenstein and Mauthner use the metaphor of the ladder. The ladders are the language critique/philosophical sentences that one can throw away, according to Wittgenstein, if one has climbed up, or whose rungs, according to Mauthner, can be smashed while ascending them.

Their judgment of both the aesthetic and the ethical is also the same: in the *Tractatus*, first of all, ethic and aesthetic are "one"; and secondly, they can't be summarized in clear, meaning natural science theorems. Therefore, in principle, they cannot be expressed at all. For Mauthner, ethics and aesthetics are related, since they both consist of value judgments. Neither are sciences.

(6/a) and (6/b) deal with the limits of language and what lies beyond it, the mystical. But since, according to Mauthner, everything in natural language — including the theorems of the natural sciences — is figurative (i.e., metaphorical, which means that nothing can be said clearly), then the mystical, the "godless mystical," has a completely different status than it does in Wittgenstein's view, for whom there is something that can be clearly articulated, namely the theorems of the natural sciences.

The fundamental difference: in the Tractatus, Wittgenstein introduces the logical form of the sentence as a realistic structure. For Mauthner, on the contrary, a type of logic such as a grammatical system is nothing more than a formal abstraction of the respective natural language: like language itself, it can therefore only depict figuratively, metaphorically.

As one sees in the quotes, the picture changes in Wittgenstein's later writings. Philosophy now truly becomes a critique of language in "Mauthner's sense." For both, language is the same as thinking. The classical view — in which words obtain meaning by indicating existing objects, the referents — is rejected by Wittgenstein and Mauthner. Both must then necessarily arrive at some form of use theory: meaning is the way language is used. According to Mauthner, language is nothing more than an individual usage of language in dialogue and in society, i.e., the pragmatic/practical use of language (see 7/a). According to Wittgenstein, meaning is usage in the language (see 7/b). When interpreting Wittgenstein, this "in" is often left out, and he is attributed an opinion that is closer to Mauthner's than his own. Wittgenstein had to define meaning as inner-lingual, since he does not admit that meaning is a relation to a (referential) object or (unlike Mauthner) a type of (linguistic) idea. This makes a pragmatic interpretation impossible, in spite of his references to life forms, language as action, and the word that only has meaning in the flow of life. The disadvantage of Wittgenstein's approach is then that he must explain the meaning of a word through other words and is thus thrown into a circular reasoning.

Mauthner regarded language as a real social game; Wittgenstein introduced a specific concept of language as a game. The types of Wittgenstein language games have a model-like schematic character, so that they find themselves in a transition from real language to a language system. Mauthner, as well as Wittgenstein at a later point, represented the view that language games or language itself should not be reformed. Language critique is therefore not language reform, but rather "clear representation" for Wittgenstein and clear semantic/historical representation for Mauthner.

Language games follow rules. Mauthner and Wittgenstein both agree that these rules do not exist a priori, but rather develop along with the game. Since Wittgenstein, however, understood meaning as the language-immanent usage of language — the language game as chess game! — he was incapable of systematically explaining the pragmatic, practical origins of the rules. Mauthner, on the contrary, considered the rules from the beginning as a simple pattern of pragmatic language use. Hence, philosophy is also, for Wittgenstein, critique of language as it is. The problem of self-reference that arises here, where one tries to explain language through language, is recognized by both: for Wittgenstein, language becomes a trap from which the way

1. (1/a): TLP 4.0031; (1/b): SD, 15; (2/a): B1, 27; (2/b): PU1, § 18; (3/a): B3, 358; (3/b): PU1, § 90; (4/a): B3, x; (4/b): Tolstoy on Anna Karenina; (4/c): PU1, § 501; (5/a): B3, 15; (5/b): PU2, vi; (6/a): A2, 566; (6/b): TLP 5.6, 6.522; (7/a): B1, 24; (7/b): PU1, § 43; (8/a): PU2, xi; (8/b): W1, 340.

out must be shown; for Mauthner, the language critic gets entangled like a fisherman with his head in his own net.

A private language, that is, a language that is only understood by an individual, is rejected by Mauthner as well as Wittgenstein. But Mauthner represented a more realistic opinion here: since absolutely mutual understanding is empirically impossible, every communication contains the "residue" of a private language.

In addition to the parallels, there is also a difference here: Mauthner's language critique is epistemologically motivated. It aims to connect language and the world. Wittgenstein's later philosophy, on the contrary, remains, to a certain extent, stuck in the chess-game metaphor, which means that he analyzes language mainly "from the inside," which leads to the well-known epistemological difficulties of classical analytical philosophy, which uses Wittgenstein's later philosophy as reference. The classical linguistic structuralism proceeding from de Saussure, by the way, struggled with the same fundamental problems (de Saussure also compared language with a chess game).

So where do the parallels come from? Certainly the parallels in the writings of Mauthner and Wittgenstein cannot be traced back to an — often reactionary — critique of language à la Karl Kraus. Yet the "fin de siècle" (a descriptive term that inspired Mauthner's ironic "fin de siècle to no end") brought forth a philosophy, based on Mach's work, which was empiricist, nominalist, and sometimes also skeptical. Mauthner and Wittgenstein are products of this environment.[2]

Currently, it is fashionable to dismiss empiricist/nominalist philosophy and with it, the Vienna Circle and Wittgenstein's *Tractatus*, as something belonging to the past. With that, it is believed, Wittgenstein is saved for a community enthused by Habermas and, once again, Heidegger. One side or the other also lays claim to Mauthner: he believed in science, they say, for example; but in reality, Mauthner saw the truths of science as merely more certain than those of daily life and, as Popper did later, as "more truth-like."

In conclusion, two further quotes are placed side by side in which Mauthner and Wittgenstein characterize the goal of their philosophizing in a parallel fashion.

First Mauthner:

I would like to teach and learn questioning.

And Wittgenstein:

I do not want to spare others from thinking with my writings, but rather, if it were possible, to stimulate the thoughts of others.[3]

2. Leinfellner, Schleichert, 1995, p. 145.
3. B1, 620; PU, Preface.

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Gershon Weiler, *Mauthner's Critique of Language* (Oxford: Oxford UP, 1971).

Elisabeth Leinfellner, studied in Vienna and Munich. Moved to the USA in 1967. Taught at Doane College, Nebraska, and at the University of Nebraska. Returned to Austria in 1986. Instructor as of 1986 at the University of Vienna, later lecturer there as of 1990. President of the Austrian Ludwig Wittgenstein Society since 1994. Guest professor at the Universities of Nebraska, Michigan, and Rome. Publications on subjects such as euphemism in political language, Adam Müller (with D. Bormann), ontology, semantics (with W. Leinfellner), and semantic networks. Lives in Vienna.

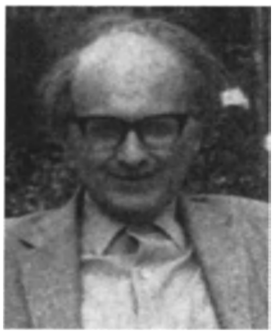
7

György Kampis

Popper's Hungarian Disciple: Imre Lakatos

Imre Lakatos, born 1922. Studied mathematics, physics, and philosophy in Debrecen, Budapest, and Moscow. In contact with Georg Lukács and others who espoused Marxist philosophies. Quickly turned away from the political aspects of philosophy in order to focus on metatheoretical problems of mathematics. As a devoted communist for a while, served in the Hungarian ministry of education. Persecuted during the Stalinist era for being a "revisionist." Imprisoned from 1950 to 1953. In 1954, obtained a position at the Hungarian Academy of Sciences, translating mathematical literature. Immigrated to England in 1956. With the help of Victor Kraft, he was able to become a Rockefeller Fellow in Cambridge and earned a PhD there. Became a professor in 1960 at the London School of Economics, where he was a colleague of Karl Popper's. Became a professor at Boston University in 1971. Is generally known for his work in the philosophy of science, the history of science, and logic. Died in 1974 in London.

References:
Imre Lakatos, *Proofs and Refutations. The Logic of Mathematical Discovery* (Cambridge: Cambridge UP, 1976).
Imre Lakatos, *The Methodology of Scientific Research programs* J. Worrall, G. Currie, eds. (Cambridge: Cambridge University Press, 1978.



Imre Lakatos

The great Austrian-British philosopher Karl R. Popper had few real followers or disciples in the strict sense — despite the fact that numerous sub-fields of philosophy make use of his work to this day. Our title may therefore seem to be a contradiction, and all the more so if we add that Lakatos speaks with considerable distance about Popper — as so often is the case when one has unpleasant dues to pay — and stresses different positions on essential matters. At the same time, Lakatos is often considered to be the one who brought Popper's program to completion. This program consisted of the deconstruction of both the special kind of rationalism found in the Vienna Circle, as well as its striving for certainty. Lakatos accomplished his share by extending Popper's method of altering conjectures and refutations into the heart of mathematics, which was considered the pinnacle of rationalism and certainty.

Lakatos (born Lipschitz) was a mathematician from Debrecen. Attracted after the war by philosophy and communist activism, he became a close follower of Georg Lukács. Lakatos played a key role in the forceful communist transformation of the legendary Eötvös College. In the early 1950s, he held various political functions, but was later arrested, convicted, and imprisoned. He left for England in 1956, where, after receiving his doctorate in philosophy in Cambridge, he became a teacher at the London School of Economics and a colleague of Popper's, which he remained until his sudden death in a car accident in 1974.

Lakatos, who, remarkably, avoided any reference to the Vienna Circle's concept of "verification" and Popper's concept of "falsification," referred to his own work as a battle between dogmatism and skepticism. By this distinction, he understands two opposing views conceived somewhat in the sense of Kant. According to the former, we are supposed to reach truth by pure reason (Kant's *reine Vernunft*) alone; according to the latter, quite the opposite is the case. Truth is never attainable, or — what is, in the end, the same — it is never recognizable (for if we cannot know that we have attained the truth, then we have attained it in vain: it is not in our possession). We do not need much imagination to glimpse the verificationist fanaticism of the Vienna Circle behind the label of dogmatism, which led to extreme methodological imperatives, and similarly, behind skepticism, we see Popper's more proper notion of critical rationalism.

If we proceed one step closer, we will see that there is an even more intimate connection to Popper's philosophy here. It is considered commonplace to notice that the title of Lakatos's most important work (*Proofs and Refutations: The Logic of Mathematical Discovery*, 1976) paraphrases Popper's well-known *Conjectures and Refutations: The Growth of Scientific Knowledge*, 1963. *Conjectures and Refutations* is a work that summarizes Popper's previous ideas regarding the epistemological status of science. It describes science as a selective mechanism that learns from its own mistakes and errors, and depicts the growth of knowledge as a trial-and-error process where absolute certainty can never be achieved, although false beliefs can be safely rejected or systematically corrected. Lakatos's view of mathematics is very close to this overall scheme.

This essential relationship becomes clearly visible if we attempt to find the ultimate subject of Lakatos's criticism. As we have seen, an essential feature of dogmatism (whatever the latter means otherwise) is an ability to distinguish between truth and falsity, which presents the supposed task of science as an instance of a problem in general decisions. We can safely say that this was the most striking element in the advanced methods used by the Vienna Circle to handle experiences. At the same time, it places a formalist method in the foreground, using a development in mathematics that Lakatos targeted as an expression of modern dogmatism in mathematics. Just as Popper refuted our ability to ultimately verify knowledge in logical positivism, Lakatos has attempted to show the impossibility of the perfect mathematical proof within the framework of the formalist program.

That mathematics (as every human enterprise) is not free from the usual twilight zones and ambiguities of knowledge is not Lakatos's discovery. At least three different criticisms of mathematical proof existed before him: the constructivist, the sociological, and the undecidability argument according to Gödel, Post, and Turing. Following Kronecker and Brouwer, the constructivist critique considered the transition from the finite to the infinite as an unfounded step, and it therefore rejected any kind of implicit knowledge of mathematical objects. The sociological critique, which found its full-fledged form in publications such as Davis and Hersh's *Mathematical Experience* (1981), alludes to the idea that mathematical proof itself is subject to historical development and changes along with mathematicians' traits, such as their professional common taste. This makes it difficult to see how it could be made the subject of any systematic study, or how it could be influenced. The third critique shows the incompleteness of the formalist program using its own tools, proving, in any reasonable system, the existence of mathematical statements that are neither true nor false.

Taking these well-known facts into account, we can better understand the uniqueness of Lakatos's contribution. He does not align himself with Popper's critique of inductivism in order to use it in mathematics. Despite his strict Marxist legacy, Lakatos also does not make use of the societal context of mathematics. (Marxism assumes an immediate relationship between culture and the material aspects of society; if you wish, this can be extended to a comparison of mathematical method and the economic system). He is also not interested in what formal systems can and cannot achieve. All this would only detract him from his main problem. Is there a straightforward line of development within mathematics? Is mathematics an unequivocal, unerring, irrefutable science? Lakatos's answer is a generalization of Popper's answer to the same question about the sciences.

[My] modest aim is to elaborate the point that informal, quasi-empirical mathematics does not grow through a monotonous increase of the number of indubitably established theorems, but the incessant improvement of guesses by speculation and criticism, by the logic of proofs and refutations. Since, however, metamathematics is a paradigm of informal, quasi-empirical mathematics that is just now enjoying rapid growth, the essay, by implication, will also challenge modern mathematical dogmatism.[1]

This bold criticism rejects the formalist program, in that it claims that mathematics uses a logic different from the one anticipated by any formalist criterion. Lakatos shows the development of mathematical thought through an example: the history of Euler's polyhedron theorem, suggesting that proofs acceptable at a given moment may, upon further contemplation, provoke a revision of the basic or primitive concepts used in them, making it possible to refute the theorems, which in turn permits the shaping of new proofs with the aid of new concepts and tools. In other words, theorems, like Popper's scientific theories, have a range of applicability; they are neither absolute truths, nor false in themselves. Refutation (or rather, an important kind of refutation) serves to draw the boundaries of the range of applicability, rather than aiding to reject a theorem.

The Euler theorem, for one, states that the edges, surfaces, and vertices ("corners") of a polyhedron are in a certain proportion to each other (i.e., the number of vertices plus the number of surfaces minus two equals the number of edges; for the cube, we have $8 + 6 = 12 + 2$). To prove this is child's play, just cut up a polyhedron along some of its edges, unfold it on a plane, and the rest is just counting. Yes, but what is a polyhedron? It is relatively easy to find counter examples that satisfy our intuition for "ordinary" polyhedra, yet still differ considerably from the cube or the tetrahedron. For instance, these new objects can have one or more permeating holes covered with extra surfaces. Or there is the paraphernalia of more "freakish" polyhedra (or "monsters," as Lakatos called them), which may possess vertices that go toward the "inside" of the object and depart it from another surface on the other side; or there are other horrors, which cannot be built with a sheet of paper. Some of these have a different number of edges and vertices than we would expect.

Beyond the search for general methods of validation, an important part of Lakatos's theory is concerned with the structure of the latter. Here are new concepts of step-by-step, refined analysis: distinctions between "global" and "local" counter-examples, methods for coping with monsters by excluding or neutralizing them, and so on. If we now follow the history of the development of the Euler theorem, then, with the aid of these concepts, we can reflect on the rich interplay between new admissible methods of proof (which can be geometrical, algebraic, or topological) and the even newer versions of the theorem. In the final analysis, we come to the conclusion that the Euler theorem is valid for a well-defined subclass of polyhedra: the Euler polyhedra, which differ from the rest in that — well, in that the Euler theorem is valid for them.

This game of cat-and-mouse, along with the relativization of knowledge and its apparent final trivialization, has its exact counterpart in Popper's concept of science. This completes the parallel between Lakatos and Popper. In Popper's theory, drawing the range of validity of Newtonian mechanics (or, in Popper's logic, the partial falsification of the theory) forces what was earlier believed to be the ultimate picture of reality to become less interesting and yet better known. And, be it as it may, it is obviously this kind of critical knowledge that is most desirable for the scientist.

Lakatos's "critical rationalism" of the philosophy of mathematics is suitable food for thought, even if we grant that some of his malicious critics, such as Professor J.H. Conway of Princeton, sharply debate some of his key points. The most vivid counter-argument against Lakatos is, as one may guess, that he may have chosen an untypical example from mathematics as subject of his study (some people even say that he has chosen the only example that worked). One can go on to argue that the development of the vast majority of "usual" mathematical theorems does not show such romantic and surprising calamities, or hurried tinkering. Is Lakatos's metamathematics only applicable to those theorems of mathematics where it functions? We do not know.

1. Imre Lakatos, *Proofs and Refutations* (1976) p. 5.

Karl Popper, born 1902 in Vienna. Studied mathematics, physics, and philosophy at the University of Vienna. He studied also church music at the conservatory in Vienna, and finished a carpenter training, He worked with Alfred Adler. In 1928 doctorate with K. Bühler (*Zur Methodenfrage der Denkpsychologie*). He studied at the College of Education in Vienna; worked for some time as a teacher. He belonged to the periphery of the Vienna Circle. In 1934 he published *Logik der Forschung*. In 1937 emigration to New Zealand. From 1945 and 1949-1969 professor for logics and scientific methodology at the University of London. 1945-1966 director of the department of philosophy, logics and scientific theory at the London School of Economics. In 1963 he wrote *Conjectures and Refutations*; in 1972 *Objective Knowledge*. His attempt to return to Vienna failed. Lived until his death in 1994 in England.

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7

György Kampis

Arthur Koestler as Philosopher of Science

Arthur Koestler, born 1905 in Budapest. Studied psychology and electronics in Vienna. Foreign correspondent for various European papers. Participated in the Spanish Civil War; internment camp. Later joined the French Foreign Legion, and after fleeing in 1940, he served in the British Army and became a British citizen. Author of more than twenty books.: *Arrival and Departure*, 1943; *Age of Longing*, 1951; *The Sleepwalkers*, 1959; *The Ghost in the Machine*, 1968; *Arrow in the Blue*, 1970; *Der Krötenküsser*, 1972; *Darkness at Noon* (1982, translation into 33 languages). He died in 1983 in London.

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Arthur Koestler, *The Ghost in the Machine* (Arkana, 1990).

Hungarian-born Arthur Koestler (whose original name was Köstler Artúr; Hungarian names are written in reverse) is best known for his political and literary activities. As a delegate of the London newspaper News Chronicle, he participated in the Spanish Civil War, where he was unveiled as a Comintern agent, imprisoned, and sentenced to death. Fortunately, thanks to intervention from the British government, Koestler was released.

Important documents depicting his ambiguous relationship to Communism and his Spanish experiences are the popular books *Darkness at Noon*, a key novel concerning Soviet conception trials, and *Spanish Testament*, which was published in a Penguin edition under the telling title, *Dialogue with Death*.

A dialogue with death: the life of Koestler was, indeed, adventurous. He tested his skills in a number of things. After graduating from the University of Vienna, he worked in Berlin as a science journalist, was employed by several English newspapers after fleeing Hitler, and spent several years in the Middle East as a political correspondent. But he also visited Moscow and Soviet central Asia at a time when this was a special risk and, as member of a 1931 airship expedition, he made it to the vicinity of the North Pole. In World War II, he actively served in the French Foreign Legion and the British Army.

His work as a free-thinker is characterized by independence, transcendence of common categories and, above all, a fondness for risk. Besides his numerous novels, he wrote more than a dozen non-fiction books on the most diverse variety of topics. They range from the allegedly lost thirteenth tribe of the Jews to the history of the Lamarckian feud and the subsequent suicide of swindler Rudolf Kammerer in the Vienna Woods, to the issues surrounding the mechanization of humans and the philosophy of mind. Beyond that, he published his studies on the (dubious) prospects of life after death. In other words, he wrote about nearly everything he came across.

It would be impossible to classify his scientific works as merely professional or merely popular or lay writings. In the first place, they are reviews and analyses written with a philosophical ambition. At the same time, thanks to his selection of topics and unique tone of presentation, they convey a radical, often surprisingly fresh and personal view. Even more than that, these works are engagingly subjective essays, and owing to Koestler's vigorous use of the language, as well as his dry, often ruthless, sometimes unjust humor and impulsive prose, they make good entertainment as well.

Although from the point of view of proper science, there is some reason to accuse Koestler of being superficial (and, in fact, some of his topics, such as telepathy or life-after-death, are likely to drive away the scientifically literate). Yet it is also true that Koestler was ahead of his time on many issues, especially those dealing with the crossroads of science and philosophy.

His *Sleepwalkers* (1959), an unorthodox history of astronomy and cosmology, best exemplifies this. The book is indeed valuable, although not necessarily because of its scandalous elements, such as when Koestler reckons with Copernicus, calling him "the timid canon" and an "obscurer." He also turns one of Copernicus's visitors, the young Rheticus, into the real hero of the new scientific worldview. Rheticus — prior to the "never again read," "murky," and "cautious" *De Revolutionibus* of Copernicus — writes and immediately publishes his own *Narratio Prima*, a rather straightforward, clear book, despite its Aristotelian overtones. This book is followed just two years later by an original work by Copernicus, and even then only because Rheticus has urged him to write it. Copernicus's book is topped by a scandalous foreword, which partly contradicts the meaning of the entire work. This foreword was written by Osiander, but without any hint at his authorship, so the reader must have attributed it to Copernicus. All this is true. However, Koestler indicates that Copernicus was not two years late, but twenty years, and implies that he messed up the whole thing even then. If it had not been for Rheticus, we would still be waiting today for the new cosmology: an idiosyncratic view, one could say.

Yet the book is special from the point of view of the philosophy of science. It presents and documents the idea of how and why political circumstances, unconscious prejudice, and other external factors can influence not only the fate but also the content of scientific theories. And note that the book was written not long after the era of the Vienna Circle, during the years when critical rationalism — another anti-metaphysical system of thought — became widely known. It was written before Kuhn and well before the "strong program" promoted by the sociology of knowledge, which made headlines twenty-five years later when it proposed searching for a sociological reason (or any relevant reason at all) behind every true or false belief. All of that was well in the future. But Koestler was not interested in the prevailing views of his age. He considered the dividing line between science and the humanities to be a fiction from the outset — and the line between science and the scientist even more so. He conceived of religion, philosophy, psychology, social, and scientific ideas as a single unity. In addition, he broke with the myth of science as an abstract cognitive process and with that of the individual scientist as the perfect representative of his science, meaning he disavowed the twin starting points of impersonal research and epistemological individualism. Instead, Koestler presents science as a situated, contextual, historical, and essentially human endeavor. In doing so, he follows in the footsteps of Karl Marx and Karl Mannheim — not really astonishing, given his earlier left-wing intellectual commitment. However, as the book does not theorize, but instead tells stories, the connection is left unarticulated, although continually present. As a result, despite its many printings and world fame, few people realized that this detective story of some six hundred pages sells, quietly and artfully, a very theoretical, far-from-trivial idea.

Another Koestler book that has received increasing professional attention (besides the airport bookstore popularity it has had for several decades) is *The Act of Creation*. Obviously, the title refers to the creation of the world, but the book is about thinking. However, this is no error. In this book, Koestler searches for the roots of psychological creativity by studying the logic of jokes, among other things — but the book also has a cosmological point to serve. It is not philosophy of science in the traditional sense, since it does not immediately deal with either the heuristics of scientific discovery or the causal structure of the world, yet — as is the case so often with Koestler — it is on to something that might alter our view of both.

There is a parallel between this work and the ideas in another famous Koestler book, *The Ghost in the Machine* (1967). The book is primarily a reaction to a Ryleian metaphor (see Gilbert Ryle, *The Concept of Mind*, 1943). In both works, Koestler comes close to a notion that was intensively promoted in the 1980s by Searle's Chinese Room argument and the intentionality debates of popular psychology. In all these cases, the key question is the validity of a mechanistic model of the world and, with that, of a LaMettrie type of artificial intelligence. Ultimately, they deal with the position of the mind in the physical world. ("What kind of object is the mind, if it exists?")

Here, despite Koestler's rejection of mechanistic explanations, he does not simply allude to a dualistic standpoint. *The Act of Creation* suggests the notion of a multiple mind instead, which could be an attractive idea for modern, non-reductive materialism, a naturalistic philosophy of science, and interactive monism flirting with body phenomenology. Instead of one central mental process, Koestler assumes a dialogue (or "multilogue") of sub-processes. For Koestler, the act of creation occurs when two or more of these separate sources of information, that is, sub-processes, connect. This is where jokes help explain the idea. That jokes function by joining statements that do not fit into a single propositional system, and that a typically non-propositional relaxation of this tension or contradiction, caused by these misfits, can be laughter, is not an idea Koestler discovered. Freud already spoke of jokes in this vein. But Koestler's application of this idea to problem solving, psychological creativity, and the emergence of new causal structures is a novel and fruitful idea. It is reflected in the fact that a book by M. Boden (*Computers and Creativity*, 1995) adopts — unexpectedly, for many readers — an essentially Koestlerian position in the philosophy of artificial intelligence.

The cosmological dimension of the creativity problem is also clear. If we follow Koestler's suggestion, we obtain a picture of nature (of which our own mind is a part) that assumes the existence of delicate, self-sufficient, creative forces capable of producing genuine novelty without divine intervention. This possibility points towards a radically emergentist natural philosophy and a type of creative evolution, as Bergson and perhaps C. Lloyd Morgan would view it. Recently, Koestler became a standard reference for related discussions. By the same token, Koestler was also soon discovered by those researching the "distributed universes" of parallel computational models, as well as students of the various notions of "societies of mind."

Koestler's work relating to 'real' philosophy of science is worth serious attention. And there is still much more to discuss: his well-known battle against reductionism (as exemplified by his *Beyond Reductionism*, co-edited with Smithies in 1969), or his notion of the "holon" and its career in systems theory, to mention just two of the many other ideas Koestler enriched us with.

György Kampis, born 1958 in Budapest. Associate professor and Chairman of the Department of History and Philosophy of Science at Eötvös University in Budapest. His main research fields are methodology of modelling, complexity theory, theoretical biology with an emphasis on evolution systems research, cognitive science, philosophy of biology, and philosophy of mind. Numerous lectures on conferences and seminars. Lives in Budapest.

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7

Peter Weibel

Paul K. Feyerabend – The Scientist as an Artist

Paul K. Feyerabend, born 1924 in Vienna. Soldier in the German army in 1943, became an officer in 1944. As a wounded war veteran, he began studying theater and music in 1946 in Weimar, and then went to Vienna, where he studied mathematics, physics, astronomy, and history, as well as philosophy later in London and Copenhagen. Wanting to become an opera singer, he took voice lessons. He earned his PhD in philosophy in 1951 under Viktor Kraft, the only member of the Vienna Circle who returned to the university in Vienna after the war. Between 1951 and 1956, he worked with Hans Thirring as a lecturer at the Vienna Institute for Science and Art. Feyerabend worked with Popper from 1952 to 1953, then began lecturing in Bristol in 1954. From 1959 on, until he became a Professor Emeritus, he was at UC Berkeley and the ETH Zurich, with occasional guest professorships at Yale, Berlin, and London. He died in 1993 of a brain tumor.

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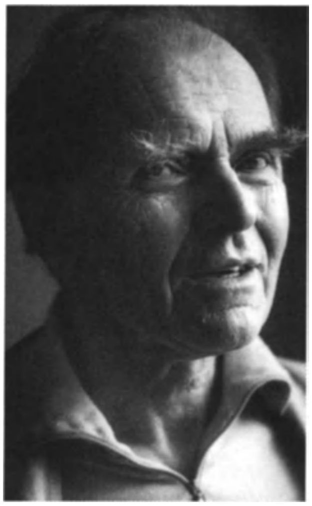

Paul K. Feyerabend

But art is, for us, whatever we understand by this name. Something that is; that does not need to exist according to laws, a complicated social product. (Robert Musil)

Paul Karl Feyerabend is one of a philosophical foursome that not only had a decisive formative influence on the philosophy of the twentieth century, but also subjected its object — science — to harsh criticism, much to the surprise of experts and the trusting public. Karl R. Popper accused science of not proving its theories, but simply falsifying them, and that so-called scientific progress is founded upon falsification as the *Logic of Scientific Discovery* (1935). Imre Lakatos not only questioned the principle of verification, but also even accused science of not acknowledging falsified results. Thomas S. Kuhn not only relativized truth and falsity, but also demonstrated with the aid of the concept of paradigm change that they are malleable servants of political interests. Science is more the product of social consensus than rational process. But Feyerabend, who was, incidentally, a close friend of Imre Lakatos, was the worst enemy of those adhering to science, for he considered truth not just an absolute criterion, but also an enemy of mankind, a tyrant. He treated science as an irrational voodoo cult. He not only robbed science of its claim to logic and objectivity, but also even condemned this claim in view of the fact that science, in its craze for objectivity and truth, has all too often become an inquisitorial instrument in the hands of tyrants throughout the history of mankind.

Before Feyerabend made his appearance as a critic of science, he had gained public attention with his extremely precise philosophical contributions to quantum theory and numerous astute analyses of problems of scientific theory following Popper's critical rationalism. But his scientific critique of knowledge soon turned into a critique of science in the service of knowledge.[1] His writings gained him renown and notoriety beyond expert circles, and he sought to demythologize science in a radical way.

To Feyerabend, scientists were not the glorious liberators of mankind, but all too often its tyrants — criminals, even. This radical skepticism with regard to science, presented at the highest level of scientific expertise, developed into an anarchistic epistemology in books with such characteristic titles as *Against Method* (1975), *Science in a Free Society* (1978), and *Farewell to Reason* (1987). Having emerged from Popper's school of critical rationalism, he finally even turned against him, too. He envisioned science as an anarchistic undertaking in a free society, attempting the both abolition of science's monopoly on truth, objectivity, and effectiveness, and the admission of alternative practices of knowledge, such as the rituals of so-called primitive peoples. He condensed his plea for diverse theories and methods into the famous post-modernist leitmotif of "anything goes." With his critique of science, its practices and methods, he was able to square the power of the critique of science, as it were. If the paradigms issue from the agreements of the scientific community; if truth and falsity are alternating criteria depending on social agreements; if, indeed, falsification is not heeded, then science, too, must relinquish the function it took over from religion — that is, the role of the sole custodian of truth. But in so doing, Feyerabend actually did science a favor. He liberated it from the structure of an orthodox fellowship, democratizing it — meaning he described it as an opportunity for free individuals to cooperate under democratic conditions to shape reality. Hence, he modernized people's understanding of science. In terms of our subject — the relationship between science and art — he is, therefore, the most relevant of all scientists, as the collected essays in his book, provocatively entitled *Science as Art* (1984), clearly demonstrate. Following the progressive understanding of art set forth by art historian Alois Riegl, according to which the arts have evolved a wealth of different series of art coexisting as equals, Feyerabend describes science as a myriad of styles, including styles of investigation, etc. The choice of a style, a reality, a form of truth, criteria of reality, and rationality, is a social act. Science, like art, is the product of social consensus. The scientific community determines what science is and what important science is. If the scientific community itself is a free society, then — and only then — can there be a free science that allows more methods and ideas than do the so-called objective, true methods. Then, objectivity is just a feature of a style. Thus, in the sense of this progressive understanding of art, Feyerabend sees the sciences as arts.

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Nadja Rottner

Some Portraits of Austrian Art Historians

1. Ernst H. Gombrich: The Knight of Austrian Art Historiography

Ernst Hans Josef Gombrich was born in Vienna in 1909. He was a student of Julius von Schlosser (in art history) and Emanuel Löwy (in archaeology) and was thus part of the tradition of thought of the Vienna School of art history. After having finished his studies in 1934, he applied to the Albertina, with a recommendation by Otto Benesch. In spite of his Protestant education, his application was refused because of his Jewish origins. Through mediation by his friend Ernst Kris, who worked for the Museum of Fine Arts, he was hired for the publication of the Warburg estate by Fritz Saxl, who at the time was the Warburg librarian. In 1933, the Warburg Institute had to emigrate from Hamburg to London; during the exile, Gombrich together with E. Kris, O. Kurz, O. Pächt, and Saxl, brought significant impulses and ideas of the Vienna School of art history to the institute.

The affinity between these two schools is revealed in the method of iconology (the Warburgian Method) that was established by Aby Warburg in 1912. It is close to Gombrich's own views: the limitations of a purely formal way of looking at art should be overcome. Iconology as an analysis of symbols consists mainly of a historical understanding of the changing and the stable features of a symbol; the history of art becomes part of a universal cultural history. The contested notions of "content" and "symbol" characterize the iconographic and the iconological discipline within art history. What lies behind the symbol is something hidden and can thus be a question of psychoanalysis, whether the interest is in the history of the work or that of the artist. Gombrich's titles are telling: *Art and Illusion* and *The Image & the Eye* show his involvement with the psychology of perception as a way to analyze the possibilities of apperception (object and reproduction) and the related questions about the shift in ways of seeing. This determines an essential aspect of the tradition that Gombrich created for his profession, which pleads for an extension of the field of analysis not only within one's own discipline but also across disciplines. Gombrich takes up the psychology of perception and gestalt (E. C. Tolman and E. Brunswick, *The Organism and the Causal Texture of Environment* [1935]; J. J. Gibson, *The Perception of the Visual World* [1950]), psychoanalysis, and sociology (Arnold Hauser's *Social History of Art*, inspired by materialism, which Gombrich criticized). He combines them with questions of art history in order to gain insights into the problem of value in art (abstraction and expression), visual fantasy, and the perception of physiognomy (caricature), as well as social conditions for the constitution of art.

In 1934 he met Egon Brunswick, who participated as a subject in one of his experiments (conducted with Ernst Kris) on the understanding of expression in images. Shortly after that, he established a lasting friendship with Karl R. Popper (*Logik der Forschung* [Vienna, 1935]; *Logic of Scientific Discovery* [London, 1959]). In 1936, Gombrich moved to London. During the war, he worked for the BBC's monitoring service, mainly translating German war propaganda. With a scholarship, he returned in 1945 to the Warburg Institute, which had become part of the University of London. From 1959 until his retirement in 1976 he was director of this institute. Above all, his views on the applicability of psychological methods for the history of art were affirmed by the already-mentioned art historian/psychoanalyst Ernst Kris, who was his close friend for twenty years. A result of their collaboration was the *History of Caricature* in 1941 and an article in Ernst Kris's book *Psychoanalytic Explorations in Art* (1952).

> *The observation that aesthetic satisfaction is of a compensatory nature was also suggested to me by the study of the history of caricature which I was able to conduct together with Ernst Kris.... the reason why the caricaturing of portraits emerged so late in the history of art is the aggression which is inseparable from the distortion of the features of the human physiognomy. Its eventual recognition as a form of art is apparently due to the aesthetic enjoyment of virtuosity, the joy in the sophisticated play with features that are intentionally created to look unlike, and yet, at the same time, like the original. This play, however, assumes the corresponding reactions of the connoisseur of art that make it possible to follow the imagination of the artist in a reproductive act. The process is basically the same as the one Freud has laid bare for the joke.... Thus the caricature did not need a biological evolution of humanity for its emergence, but the evolution of a method of visual suggestion in Italian art.*[1]

Characteristic of Gombrich's view is his approach to history that starts from the present, including new media — film, television, and visual communication. His thought has greatly expanded the field of art history. His search for a widely understandable language, one that tries to express "real" thoughts in a "simple" way, has created a possibility for a broader reception. One of his first tasks — writing, at the age of 26, *A Short History of the World for Young Readers* in 1935 — forced him to remain as objective as possible. "Because it is only those who abuse scientific language to impress the reader, who do not take him seriously."[2]

Ernst H. **Gombrich**

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1. Ernst H. Gombrich, in *Meditationen über ein Steckenpferd. Von den Wurzeln und Grenzen der Kunst* (1978) (Frankfurt/Main: Suhrkamp, 1988), p. 76.
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Ernst Kris, born 1900 in Vienna. Graduation to PhD of art history in 1922 (Vienna School). In 1927 he married Marianne Rie, the physician of Freud's children. Training analysis with Helene Deutsch; member of the Viennese Psychoanalytical Institute. Kris spent the year 1929 at the Metropolitan Museum of Art, New York. Research on Renaissance gems about which he published a reference work in 1929. 1930-1938 he lived in Vienna; curator at the Museum of History of Arts (sculpture and applied arts); at the same time training analyst at the Viennese Psychoanalytical Institute. From 1932, co-editor of *Imago*. After two years in England, emigration to New York in 1940. Recognized authority in psychoanalytical theory. He evaluated German radio propaganda with the methods of psychology of the subconscious; edition of Sigmund Freud's letters to Wilhelm Fließ together with Anna Freud and Marie Bonaparte. He died in New York in 1957.

Otto Kurz, born in 1907. Study of art history (Viennese School). While he was still at school he already specialized in Latin texts of German humanists of the Renaissance. From 1932 onward, he worked for the Warburg Institute, first in Hamburg, then in London; from 1949 as its librarian. He was said to be the "scholarly oracle of this institution of erudition." (E.H. Gombrich). He died in London in 1975.

2. Ernst Kris and Otto Kurz: The Legend of the Artist

Ernst Kris and Otto Kurz met each other as students of the Viennese art historian Julius von Schlosser. In 1934 they co-wrote *Die Legende vom Künstler. Ein historischer Versuch [Legend, Myth and Magic in the Image of the Artist: A Historical Experiment]* that "searched for a new style of representation in the humanities, with an exhaustive documentation, but without the distractions of a scientific apparatus and its annotations" (quoting E. H. Gombrich from the preface to the English edition). During his research on the Austrian sculptor Franz Xaver Messerschmidt, Ernst Kris's attention was drawn to Messerschmidt's mental illness by the psychotic features in his representations of grimaces. This brought Kris to the central question of his book: to analyze the stereotypical anecdotes and legends that have emerged around the artists of the past and to set up a theory of biography. *Die Legende vom Künstler* is a sketch for a new psychology of the creative act:

> *You can look at the "mystery of the artist" — the magic emanating from him and the secret surrounding him — from two different standpoints: you can ask questions about the nature of those who have the capacity to create the work of art that we admire — which is a question of psychology — or you can ask how the one whose work is usually connected with a certain value is judged by his environment — which is a question of sociology. Both questions presume that there is a mystery of the artist, that you need extraordinary qualities and talents that are still not very well known in order to create the work of art, and that at certain times and in certain places, the community is willing to concede a specific, not precisely determined status to the creator of the work of art ... both questions refer to historical studies. The different conditions for an impulse to create art and the sum of those qualities that impress us as talent on the one hand and the role of the artist in the community on the other hand ... can obviously only be understood in the context of the specific historical situation. This text asks for the attitude of the environment towards the artist, and its problem can therefore be seen as a sociological one; where it analyzes the grappling of the environment with the mystery of the artistic personality, it becomes a problem touching the border of psychology. This border should not be transgressed. The material we are setting out from is presented according to the principles of historical critique ... Our source is not the curriculum vitae of the artist but the judgment of her or his contemporaries and posterity, the biography of the artist in the broadest sense; the legend of the artist is at its core. ... we think we can show that certain basic concepts about the artist are to be found in all biographical writing. These concepts whose essence can be understood from their common root can be traced back to the beginnings of historiography.*[3]

The emergence of artists' biographies is part of a modern understanding of art that consciously emphasizes the artist as someone who can raise an object from mere handicraft to the level of artes liberales/artes ingenium. The Renaissance as *rinascità* was a revival of the antique and the myths that were attributed to the image of the artist, if we think only of Zeuxis, Apelles, Lysipp, Pygmalion, and others. However much those narrative patterns may vary (the anecdote is especially popular), they still produce stereotypes that make heroes out of artists and fix the image of the deus artifex who possesses a God-like capacity for creation. Kris and Kurz explain this process through their meticulous study of resources and their comparisons. This Positivist approach is characteristic for the Viennese School of Art History, which was influenced by the Institute for Historical Research, founded in 1854. It carried out its first serious study of sources in 1924, with Julius von Schlosser's *Die Kunstliteratur* [Art literature], a comprehensive history of previous theory and historiography of art in whose production also Kris and Kurz were involved. Through their objective presentation, they dispose of the myth of the artist as a genius and show that the notion of art is a normative one. It was precisely at the end of the nineteenth century that the efforts to permanently revive the genius cult were intensifying because the relativity of the historical process had been acknowledged and history could no longer be seen as something final. In its place, a continual possible change became the object of (art) historiography (A. Riegl).

In a reaction to the phenomenon of the genius, Edgar Zilsel — whom Kris and Kurz mention in their book as a "recent, clever" author, although with a different "basic conception" — assumes a consciously value-driven attitude. In his book *Die Geniereligion* he speaks of the danger of rampant genius-worshipping as a changing force in society. Both representations of the notion of genius that had been established as a basic aesthetic category (those of Kant and Schelling) share the demythologizing of the romantic image of the artist. In Postmodernism this demythologizing is also applied to the art of the avant-garde (Donald B. Kuspit, *The Cult of the Avant-Garde Artist* [Cambridge, 1993]): the avant-garde artist is seen as equivalent to the notion of genius.

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3. Excerpt from the first chapter of "Das Rätsel des Künstlers als soziologische Frage," in *Die Legende vom Künstler. Ein geschichtlicher Versuch* (1934) (Frankfurt/Main: Suhrkamp, 1980), pp. 21–23.

3. Edgar Zilsel: Mathematician, Philosopher, Science Historian

Edgar Zilsel was born in 1891 in Vienna, the son of a lawyer. From 1910 to 1915 he studied mathematics, physics, and philosophy at the University of Vienna. Like Otto Neurath, who called himself the "technician of society," he belonged to the leftist wing of the Vienna Circle and shared their anti-metaphysical efforts to establish a unity of scientific knowledge of the world *(Welterkenntnis)* through the cooperation of philosophers, mathematicians, and specialists. In 1916, he published his dissertation *Das Anwendungsproblem: Ein philosophischer Versuch über das Gesetz der großen Zahlen und seine Verwandten* [The application problem: A philosophical experiment on the law of large numbers and their relatives). In 1918, he became qualified to teach mathematics, physics, and biology for secondary school education. He taught high school in Vienna as well as at the Viennese adult education program in philosophy and physics. Already this early, the socialist Zilsel showed a strong commitment to popular education.

His legendary book *Die Geniereligion: Ein kritischer Versuch über das moderne Persönlichkeitsideal, mit einer historischen Begründung* [The genius religion: A critical experiment on the modern personality-ideals, on a historical base] also appeared in 1918. Relatively early, it defended a consistent Enlightenment position based on modern science against the zeitgeist in Vienna, which was suffused with a German national ideology. The book asks — in a partly smug, partly pathetic voice that cannot deceive the fundamental concern of the author — about the conditions and requirements of modern science in society. Notions like genius worship, genius ideals, and the doctrine of genius (eg, most people lack any kind of creative talent; moreover, they are unintelligent and cannot really judge things beyond that necessary for practical use; apart from that, there are geniuses who, like somnambulists, let their gigantic productive power take complete control over themselves and think only of their fellow geniuses; geniuses only work for posterity, they go without recognition, and therefore are futurists, and so on) are introduced in order to empirically seize the phenomenon in its religious, psychological, and social scope.

> *A Chinese, who has heard and thought about our European ideas, will take up a book whose title contains the word "genius" with some suspicion. From a book with such a title he would expect a conception of human things and celestial wisdom that appears very strange to him. He will assume that the book which found its way into his hands will not convey wise thoughts and interesting facts but will attach a strange importance to some people who will mostly be poets, painters, musicians, and philosophers, and its meaning will be accompanied by odd reproaches against the rest of humanity and presented with great reverence and enthusiasm.*[4]

> *... a considerable part of our literati, i.e., our writing and reading audience, satisfies its religious needs exclusively through the cult of the genius. This quasi-religious nature of genius worship has thus not remained unacknowledged and has already become the object of scientific elaboration. Strangely enough, it has not been noticed that not only the emotion of genius worshippers is tinged with religion but that, like any other religion, the genius religion has developed its own doctrine. Apparently, this is due to the fact that these doctrines have not yet been established by official genius priests at councils and synods. ... Unfortunately, the genius worshippers have chosen such a very important field for their enthusiasm that it does not seem possible to accept or support their quasi-religion without examining it: the issue at stake is too sensitive and the damage that has been done to it by our current vague and mushy enthusiasm is too obvious. ... Enthusiastic dabblers, literati, and semi-erudites with little understanding of the issue have damaged the knowledge, have sacrificed truth for profundity, cause for great personalities: philosophy and science seem to be endangered by zealots.*[5]

In 1923 Zilsel applied for the *venia legendi* (the right to teach at universities) for philosophy at the Faculty of Philosophy in Vienna. His two-part manuscript *Beiträge zur Geschichte des Geniebegriffs: I. Die antiken Wurzeln des Geniebegriffs, II. Die Renaissance* [Contribution to the history of the notion of genius: I. The antique roots of the notion of genius, II. The Renaissance] was supposed to be the work to get him a professorship (Habilitation). After much discussion, it was rejected by the commission (Reininger, Bühler, Schlick, Meister, Gomperz, Schlosser, Wegscheider, Ehrenhaft) for its lack of philosophical accomplishment, in spite of the additional opinions provided by Ernst Cassirer, Adolf Dyroff, and Heinrich Scholz.

In some of Zilsel's formulations there are frightening parallels and presentiments of the events in the Third Reich. In the appendix to *Die Geniereligion*, Zilsel quotes Houston Stewart Chamberlain as a "deterring example" of a science driven by a "metaphysics of personality" and who has "exactly the right mixture of apparent erudition and charlatanism" in order to "be able to influence a wider, yet educated audience." Chamberlain,[6] Richard Wagner's son-in-law and author of the bestseller of 1899, *Die Grundlagen des 19. Jahrhunderts* [The foundations of the nineteenth century], wrote in the introduction that "[t]he capacity to

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4. Edgar Zilsel, in the introduction to his book *Die Geniereligion. Ein kritischer Versuch über das moderne Persönlichkeitsideal, mit einer historischen Begründung* (Leipzig/ Vienna: Braumüller, 1918; Frankfurt/Main: Suhrkamp, 1990), p. 51.
5. Zilsel, *Die Geniereligion*, p. 54.
6. Edgar Zilsel, "Über ein Spinoza-Zitat in H.S. Chamberlains Kantbuch," in *Die Geniereligion*, p. 230; cf. Houston Stewart Chamberlain, *The Foundations of the 19th Century* (London; John Lane Publishers, 1911.

7. Johann Dvorak, ed. and intro., Zilsel, *Die Geniereligion*, pp. 7–40.
8. About his membership in the Vienna Circle, see F. Stadler, *The Vienna Circle*.
9. Edgar Zilsel, *Die sozialen Ursprünge der neuzeitlichen Wissenschaft*, ed. Wolfgang Krohn (Frankfurt/ Main: Suhrkamp, 1976), p. 49; cf. *The Social Origins of Modern Science* (Netherlands: Kluwer Academic Publishers, 2000).
10. Karl-Markus Gauss, ed., *Ernst Fischer. Kultur, Literatur, Politik. Frühe Schriften* (Frankfurt/Main: Sendler Verlag, 1984) p. 230.

create characterizes the genius and simultaneously the true essence of the Nordic race." The ideological link between the sympathetic superhuman personality that dreamed of dominating the German nation (whose only identity trait is language and thus the "Aryan," Germanic race) and the way it evolved out of the security concerns of a politically as well as economically weak bourgeoisie of the nineteenth century is explained by Johann Dvorak in his brilliant introduction to the new edition of *Die Geniereligion*.[7] As a Jew, the Holocaust affects Zilsel in two ways. His efforts for a unity of scientific knowledge — the dissolution of the separation between philosophy and natural processes, the combination of Marxist theory and the natural sciences, as well as the establishment of a connection between science, education, and a conscious way of life are doomed to fail at this time, just as he is doomed.[8] In 1934, Zilsel, who consciously detached himself from a university career by refusing to submit a changed version of his Habilitation manuscript, lost his job at the adult education program. In 1938, he was removed from his school and forced to retire. In the same year he emigrated with his wife, also a teacher — first to England, then to the US. In exile in America he started — as a continuation of *Die Geniereligion and Die Entstehung des Geniebegriffs*, 1926 — a study about the evolution of natural sciences and worked on a sociology of a history of science. Due to his death, the results exist only as fragments, a compilation of articles published in *The Social Origins of Modern Science*.

> *Science was born, when progress in technology allowed the experimental method to overcome all social prejudices against manual work and was taken up by rationally educated scholars.*[9]

Other subjects of the articles collected in this compilation are: the development of the terms of the physical laws, the origins of the scientific method, the development of the terms of scientific progress, Copernicus and mechanics, problems of empiricism, and history and the biological evolution. Edgar Zilsel committed suicide with sleeping pills in 1944 at Mills College, a renowned private women's college in Oakland, California.

4. Ernst Fischer: On the Necessity of Art

Ernst Fischer

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Ernst Fischer was a literary critic, an essayist and a supporter of democratic socialism. His significance as a representative of an aesthetics free of dogma and as a significant political journalist reaches beyond the German-speaking countries.

Fischer was born in 1899 in the Bohemian town, Komotau. He grew up in Graz, as the oldest of four children of an KK (Austrian army) officer and a general's daughter. He experienced his origins, the discipline and strictness of his father and the narrowness of the province as a "burden and impediment":

> *In Austria there were no horizons. The Russian Revolution was a thunderstorm in the distance; I knew very little of it, I didn't read any newspapers, I dreamed of an overthrow, a kind of apocalyptic Bohème.*[10]

After experiencing the collapse of the Austrian army in Italy at the end of World War I, he studied philosophy in Graz, worked as an unskilled worker in a briquette factory, and after this as a journalist for the Graz-based newspaper *Arbeiterwille* [Worker's will]. He wrote essays influenced by modernism, reviews, theater and art critiques. He joined the Social Democratic Party when he was still very young, at age twenty-one. Working as a journalist for Otto Bauer, he continued his lively political commitment in Vienna, where in 1927 he started as the feature editor of the *Arbeiter-Zeitung* [Worker's newspaper]. At the time he was said to be one of the most original socialist journalists in Austria. While his earlier critique (see quote above) originated in a "radical longing for overthrow," a "romantic image of revolution," he now worked out a political concept, which remained visionary but set out from a concrete analysis of the historical situation. The theater as a dramatic mise-en-scène, which "no longer rummaged in an individual destiny but put the revolution, the anonymous, revolutionary masses themselves on stage," fascinated Ernst Fischer as a possibility for expression. In 1924, the Burgtheater showed his play *Das Schwert des Attila* [The sword of Attila]. Shortly after that, he was nominated as director of the Arbeiterbühne [Worker's theater] in Graz. From 1925 on, he presented the ideas of a new "collective" theater that overcame distance and alienation by giving the most important role to a speaking chorus in order to let the workers experience themselves (*Der ewige Rebell* [The eternal rebel], performed for the first time in 1925 in Graz). In his theoretical essay *Theater und Technik* [Theater and technique], written in 1929, he develops a materialistic aesthetics close to Walter Benjamin's, in which he uses technological progress for an interpretation of the progress of drama. After the publication of his social-psychological study *Krise der Jugend* [Crisis of youth] in 1931, he became the speaker of the so-called "Left Opposition" that turned into a party within the party and demanded a more radical implementation of ideas.

The political situation of the 1934 "civil war" — he avoided arrest by hiding in Elias Canetti's flat — forced him and his wife Ruth von Mayenburg to emigrate to Prague. After his arrival he became an active member of the Communist Party. As the representative of the central committee, he spoke at the 7th World Congress of the Comintern. From 1939 to 1945 he remained exiled in the Soviet Union. While working for the Comintern and the German broadcast of Radio Moscow (as the head commentator), he met György Lukács, who became his friend. Although he wrote important studies on Austrian literature and history during this period, they were published only after his return to Austria: *Die Entstehung des österreichischen Volkscharakters* [The development of the Austrian national character] (1945); *Das Fanal: Der Kampf Dimitroffs gegen die Kriegsbrandstifter* [The signal: Dimitroff's fight against the arsonists of war] (1946); *Franz Grillparzer* (written 1941); *Das Jahr der Befreiung* [The year of liberation] (1946; a collection of speeches and essays since 1945); *Österreich 1848* [Austria 1848] (1947); *Kunst und Menschheit* [Art and humanity] (1949); *Goethe, der große Humanist* [Goethe, the great humanist] (1949). After returning to Austria in spring of 1945 he became Minister for Education in the Renner government. From 1945 to 1959 he was a representative of the Communist Party in the Austrian parliament and was considered its best speaker. In addition to his official political functions, he continued to write literature. He wrote free renderings of the poems of Baudelaire, Rimbaud, Aragon, Eluard, and Nazim Hikmet, and published his own poetry, such as *Herz und Fahne* [Heart and flag] (1948); *Denn wir sind Liebende* [Because we are lovers] (1952); *Elegien aus dem Nachlass des Ovid* [Elegies from Ovid's inheritance] (1963); as well as *Dialogroman Prinz Eugen* [Dialogue-novel Prinz Eugen] (1955), which he wrote together with his second wife. In 1962 he produced a significant collection of studies on Austrian writers with the title *Von Grillparzer to Kafka* [From Grillparzer to Kafka]. Fischer found continuing "alienation" in the countries under "real socialism" and criticized the "real socialist" cultural politics as well as "socialist realism" itself. Frequent visits to Czechoslovakia in the wake of Prague Spring and a public discussion with Sartre in Prague gained him some influence with Czech intellectuals. His essay "Marxismus und Ideologie" [Marxism and ideology], published in *Rinascità*, the weekly magazine of the Italian Communist party, triggered an international debate, it attacks the rigid dogma of Marxism-Leninism and questions "tank communism." After lengthy internal struggles over party orientation, his critique of the system resulted in expulsion from the Communist Party after thirty-five years of membership. Bans against the "revisionist" Fischer appeared, especially in the GDR. At the twenty-fourth party conference of the Communist Party of the Soviet Union, Leonid Brezhnev appealed to the Communist parties in all countries to fight against "renegades" like Fischer.

His books *Probleme der jungen Generation* [Problems of the younger generation] (1963); *Zeitgeist und Literatur* [Zeitgeist and literature] (1964); *Kunst und Koexistenz* [Art and coexistence] (1966); and the most important, *Von der Notwendigkeit der Kunst* [The necessity of art] (1967) were translated into dozens of languages.

> *It [The Necessity of Art] is an effort to apply the Marxist method, free from dogmatic prejudices, to the nature and development of art. I consider art to be indispensable for knowing the world, and Marxism indispensable for knowing art. Yet because I am a Marxist I do not believe in dogmas and immutable aesthetic categories. Art is made by humans for humans, and is thus a social phenomenon....*
> *To understand the work of art as a substitute for life, and art as a means to balance man with his environment means also to have a partial knowledge of the nature of art and its necessity. But a perfect and permanent balance of man with his environment is not to be expected from even the most highly developed society. In this, we see the guarantee that art has not only been necessary in the past, but will remain necessary for man in the future.*[11]

During the last years of his life, Ernst Fischer devoted himself to collecting his own work. His literary criticism appeared in 1968 as the collection *Auf den Spuren von Wirklichkeit* [On the traces of reality]; in 1969 the first volume of his autobiography *Erinnerungen und Reflexionen* [Memories and reflections] was published, followed by the second volume *Überlegungen zur Situation der Kunst* [Considerations on the situation of art] in 1971. He died of a heart attack in 1972 in Deutschfeistritz in Styria. Until the very end, he was convinced of the necessity of a revolution; he only doubted its methods (*Die Revolution ist anders* [The revolution is different] (1971).

This article draws on the concluding remarks in: Karl-Markus Gauss (ed.), *Ernst Fischer. Kultur, Literatur, Politik. Frühe Schriften* (Frankfurt/Main: Sendler, 1984) pp. 229–53.

11. Ernst Fischer, in the foreword to *Von der Notwendigkeit der Kunst* (Hamburg: Claassen Verlag, 1967) pp. 8–9.

Nadja Rottner, born in 1972 in Bruck/Mur. Nadja Rottner is a doctoral candidate in art history at Columbia University, New York. She graduated in 1998 from Karl-Franzens University, Graz, with a thesis on appropriation art. Most recently she was curatorial assistant and coordinating editor on Documenta11, curated by Okwui Enwezor, Kassel, 2000-2002, and an associate teacher at Karl-Franzens University, Graz, 1994-1996. Her essays have been published in *Camera Austria*, *EIKON*, *Art Journal*, *NKA: Journal of Contemporary African Art*, and *Flash Art*.

7

Katharina Scherke

Arnold Hauser and the Social History of Art

Arnold Hauser, born 1892 in Temesvár (now part of Romania, then belonging to Hungary). He studied philosophy and history of art and literature in both Paris and Budapest, earning his Ph.D. in Budapest in 1918. After studying in Berlin from 1921-1923 Hauser moved to Vienna, where he worked as a freelance author and as advertisement manager of a movie company. In 1938 he emigrated to Great Britain, where he lectured at various universities. 1951-1965 he was assistant professor of art history at the University of Leeds. Arnold Hauser died in 1978 in Budapest.
Among Hauser's main works are: *Sozialgeschichte der Kunst und Literatur*, 1951; *Philosophie der Kunstgeschichte*, 1958), *Der Manierismus. Die Krise der Renaissance und der Ursprung der modernen Kunst*, 1964, and *Soziologie der Kunst*, 1974.

Arnold Hauser was born on May 8, 1892 in Temesvár, which was then part of Hungary (today part of Romania). In Budapest, he studied both philosophy and history of art and literature, earning his Ph.D. in Budapest in 1918. With his main works — *Sozialgeschichte der Kunst und Literatur* [The social history of art] (1951), *Philosophie der Kunstgeschichte* [The philosophy of art history] (1958, re-published in 1970 with the title *Methoden moderner Kunstbetrachtung* [Methods of modern art reflection]), and *Soziologie der Kunst* [Sociology of art] (1974), his contributions to integrating sociological reflections in theoretical discussions of art were enormous. It is remarkable that Hauser not only focused his attention on literature and the plastic arts but also took music, theater, movies, and the modern mass media into account. His theory of art was oriented toward a historical materialism shaped by dialectics. Hauser's theory was then taken up and developed by the representatives of the Frankfurt School, especially by Theodor W. Adorno. Representatives of an icon-oriented art theory, however, such as Ernst H. Gombrich, were critical of Hauser's dialectical theory.

Hauser got his first stimulus concerning his art-theoretical reflections in the so-called Sunday Circle in Budapest — centered around György Lukács — where he was introduced by his friend Karl Mannheim. The intellectuals of that forum were oriented toward the political left, mainly discussing religious and aesthetic problems as well as the consequences of modern rationalization, which was chiefly considered as evil. Later, Hauser — thereby following Lukács — contrasted the modern rational estrangement of the individual with the arts, which he considered the last area that produces meaning in a holistic and harmonious way.

During his studies in Berlin from 1921 to 1923 Hauser took a critical look at the classics of German philosophy and sociology, such as Max Weber, Werner Sombart, Georg Simmel, and Ernst Troeltsch. It is assumed that this influenced his later work about the social conditions of art in an essential way. After moving to Vienna in 1924, Hauser gained experiences of a totally different kind: besides being a freelance author, he worked for a movie company as an advertisement manager, and thus had the opportunity to deal with the film industry.

In 1938 Hauser emigrated to Great Britain, where he worked as a freelance author until he started lecturing at various universities. From 1951 to 1965 he was a lecturer of art history at Leeds University. At the age of 86, Arnold Hauser died in Budapest, where he had returned only a short time before, on January 28, 1978.[1]

As Hauser himself puts it, art is part of life's totality. Art belongs to the daily practice of life, and the elements of art are based on experiences, thus reflecting reality. The artist — being a social being — both produces and is produced by society. In that respect he summons up social experiences that are then woven into his works. Hauser, however, points out that artistic creation includes spontaneous elements that remain untouched by external conditions:

> *Though a work of art depends decisively on non-artistic stimuli it can be explained only as a product of opposing, i.e., anti-artistic facts, which are part of the objective material and social reality. In addition, art is a product of inherent, shape-taking, spontaneous, and quite creative acts of consciousness.*[2]

The artistic creation must be regarded as a dialectic process of artistic spontaneity, experience (which becomes the content of depiction), and the convention of depiction. Thus emphasizing the social dimension of art, Hauser stands out from those art historians — like Heinrich Wölfflin — who concentrate merely on the formal qualities of a work of art.

According to historical materialism, the social-economic life conditions (base) constitute the basis for cultural construction (superstructure). Though not totally denying it, Hauser tones down this deterministic view of base and superstructure by emphasizing the dialectic process. By referring to Marx and Engels, Hauser states that meaning cannot exist without consciousness, thus holding the view that "social existence cannot be rooted in an idea that precedes the historical process."[3] However, both components — existence and consciousness — are inextricably linked with each other; one does not surpass the other. Foundation and superstructure are developed by simultaneous interaction. Concerning the fundamental questions of whether material life conditions can be regarded as foundations for mental constructions such as art, Hauser states:

> *You can delay discussions and disguise real viewpoints, you can tend towards assuming jumps and mediation, causality, and interaction between material and ideal components; sooner or later, however, you will have to reveal yourself explicitly or silently as realist or idealist, representative or opponent of the materialistic view of history, whether you like it or not.*[4]

With his work *Sozialgeschichte der Kunst und Literatur* [Social history of art and literature] Hauser tries to show how socioeconomic conditions are related to the prevailing products of art in each epoch, thus regarding all phases of art development up to the new media of modern art. He thereby contributed to a stronger

1. See Jürgen Scharfschwerdt, "Arnold Hauser (1892–1978)," in *Klassiker der Kunstsoziologie*, ed. Alphons Silbermann (Munich, 1979), pp. 200–222.
2. Arnold Hauser, *Soziologie der Kunst* (Munich, 1974), p. 21.
3. Ibid., p. 201.
4. Ibid., p. 219.

consideration of sociological and respectively social-historical knowledge concerning the history of art. Hauser's discussion of art is not founded on empirical investigation; concrete examples of pictures are only used from case to case in order to underpin his theory; they are not subject of detailed analysis themselves. As an example, we take Hauser's discussion of the development of art in the Stone Age. He established the thesis that, at the beginning of art development, those societies that are strictly organized and characterized by the power of the nobility and the clergy tend to prefer strictly formal, geometric-ornamental styles; urban and individualistically organized societies, however, tend to prefer naturalistic styles.

Arnold Hauser

According to Hauser's considerations, art as part of life's totality is always oriented towards certain purposes. The art of the early Stone Age was the art of hunter, whose ambitions were centered around providing their lives. Even art became an aid in that struggle for survival. As a way of magic practice, the cave paintings of the Stone Age are intended to gain power over the pictured animals. Though Hauser admits that even the painters of the early days might have experienced aesthetic pleasure during their action, he states that aesthetics were not the main purpose of depiction. As painting was bound to a purpose because of magical practice, depiction was necessarily naturalistic. In the later Stone Age there was a shift of style, leading to the use of geometrical and stylized forms instead of naturalistic ones. Objects were only indicated, represented by their idea; real depiction, however, was no longer found. According to Hauser, a general cultural change can be made responsible for the abovementioned change of styles. The hunters had started to settle down and farm the land. As a consequence, a totally different way of working and management developed. Society became increasingly differentiated and thus the sharing of jobs emerged. The increasingly settled form of existence produced private societies that were more or less centrally organized. Rational and methodical management became important in order to secure people's provisions. At the same time, religious cults and practices emerged. As the farmers became aware of their dependence on the weather and other forces, they began to believe in demons and ghosts more strongly. Fortune or misfortune concerning their provision were seen as depending on the influence of superior powers. This animism divided the world into the sacred and the profane. The sacred cults led to the need for amulets, burial gifts, and so forth, thereby providing a wide area for artistic activities. In contrast to the magical world view that prevailed in the earlier Stone Age, animism led to abstraction in the artistic area, as Hauser puts it:

> *The magical world view is monistic, thus regarding reality as a form of simple interlocking, representing a whole and complete continuum; animism is individualistic, fitting its knowledge and beliefs into a two-world system. Magic is sensualistic, holding onto the concrete; animism is dualistic, preferring abstraction.*[5]

Thus, works of art become a depiction of thought instead of simply picturing objects, thereby pictographically summarizing people's ideas about demons and ghosts, for example.

Besides contributing to the development of animism, the specific way of organization that prevailed in the later Stone Age led to another aspect of changing styles: while huntsmen needed sharp powers of observation, thus leading to a tendency towards naturalistic art forms, farmers needed the capacity to think rationally, thus creating a tendency towards abstraction.

Hauser points out that the connection between social existence and artistic forms can be more readily identified in earlier periods of human development — as later periods are characterized by increasingly differentiated social conditions. In addition, artistic traditions often require the persistence of certain forms even in later periods of history, although not mainly a cause of sociological conditions. According to this thesis, Hauser has to find increasingly complex explanations in order to explain the development and continuance of certain styles in later periods of development.

What remains to be discussed is Hauser's discussion of modern bourgeois art. Hauser distinguishes between the so-called authentic art of the bourgeois educational elite, the folksy art of the uneducated masses, and the actual folk art of the rural people. Only the bourgeois authentic art can, according to Hauser, deal in an appropriate way with the problems of human existence; the folk (and folksy) art of the uneducated masses, however, can only contribute to pleasure and amusement, without being able to provide either production of meaning or coming to terms with existence. Only the bourgeois authentic art can supply people with an evident picture of reality — a picture that refers mainly to the estrangement of human beings that has been caused by rationalization and industrialization. Here, Hauser's theory has some logical difficulties: if all art is characterized by a social foundation and thus a mirror of reality, it seems strange to assume that, in modern times, only authentic bourgeois art can produce an evident picture of reality. Hauser escapes from providing the reader with any empirical evidence for his thesis; in the end, this theory can only be explained by regarding his Marxist-influenced preassumptions about the condition of the bourgeois world and its problems.

5. Arnold Hauser, *Sozialgeschichte der Kunst und Literatur* (1951) (Munich, 1973), p. 12.

Hauser's detailed analysis of the artists' social background in various epochs (their social position, their political environment, etc.) can be regarded as an important interdisciplinary addition to works in art history. To point out different art preferences in different educational classes — thus regarding sociological categories when discussing art forms — can also be viewed as a new concept. Up to then, dominating currents in art history had totally neglected the social dimension of art works while only dealing with their formal aspects.

Hauser's sociology and theory of art can generally be considered as an attempt to look at the development of art under a common historical and philosophical denominator. Thus, the function of his theory resembles that of art in bourgeois times: "fighting the confusing ambiguity and strangeness of things."[6] Because of his simplifying abstractions in connection with the dialectic foundation of his theory that thereby immunizes itself against empirical falsification, Hauser was criticized by art theorists who prefer empirical testing and are committed to the critical rationalism of Karl R. Popper.[7]

6. Arnold Hauser, *Methoden moderner Kunstbetrachtung* (Munich, 1970), p. 24.
7. See Ernst H. Gombrich, "Die Sozialgeschichte der Kunst," in Ernst Gombrich, *Meditationen über ein Steckenpferd. Von den Wurzeln und Grenzen der Kunst* (Frankfurt/Main, 1988), pp. 154–67.

Katharina Scherke, born 1969 in Offenbach/Main (Germany). Since 1982, she has been living in Austria. She started studying sociology and art history at the Karl-Franzens-University Graz in 1987. In 1993 she wrote her master's thesis on *The Life and Working Conditions of Female Artists in Styria and Graz.* (Masters degree in Social and Economic Sciences). In 1993 and 1994 she took part in a project of the Archives of the History of Sociology in Austria (AGSö), making a collective biographical study on emigrated Austrian social scientists. In 1994 she organized a project called *Study on the Leisure Time and the Cultural Interests of students in Graz.* From 1994, Scherke has been working as lecturer at the Institute of Sociology in Graz. She received her Ph.D. in 1997 with her doctoral thesis on *Possibilities and Limits of an Iconologically Orientated Sociology.* From 2001 member of the European Sociological Association.

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Konrad Bayer
the vienna group

i am, or rather was, a member of the wiener gruppe. this working collective no longer exists, having resolved itself into friendly contacts and occasional collaborations. the group came into being in 1952. its members at that time were hans carl artmann (born 1921), gerhard rühm (born 1930), and myself (born 1932). we were subsequently joined by oswald wiener (born 1935) and friedrich achleitner (born 1930). our most intensive period of collaboration was from 1954 to 1959. a large number of collaborative works date from then, and arose from the most varied combinations of two, three, or four of us. our individual works, however, also began to manifest a common style; this was indeed the aim. together we tackled the same themes from different aspects or according to different principles, tested our formal possibilities, discovered new methods and applied them.

the fact that genuine collective works could be produced, and produced as part of our program and not just as odd byproducts of it: this urge towards anonymity, this self-effacement of the author in favor of collaboration – an attitude influenced no doubt by our youth – was a major characteristic of our group, and still strikes me as one of the few conceivable justifications for literary cooperation. the vienna group was not so much an economic organization as a laboratory and a test-bench.

o. wiener was particularly keen on anonymity in those days, and as a result our contributions to a possible theater of the future – presented under the guise of cabaret sketches – appeared under our combined names without any indication of specific authorship (1958, 1959: demonstration of "facts," public acts of destruction, exercises in awareness, attempts at total theater). our varied intellectual backgrounds made for fertile mutual influence. for their part, oswald wiener, gerhard rühm, and friedrich achleitner aimed at constructive, materially-orientated writing (harking back to expressionism and the bauhaus, drawing inspiration from wittgenstein's writings; musical theses, rows, structures, optical presentation; rühm was a musician and composer, achleitner an architect, o. wiener a jazz musician; that was in 1954-1955), whereas artmann and i were more indebted to surrealism, mannerism, black romanticism, or rather to french culture as a whole. in those days we had to master these movements of the past in order to ward off the pre-past that was threatening to engulf us.

rühm and achleitner made contact with gomringer (his publications *spirale*, bern and *concrete poesie*, 3, 4, and 10, frauenfeld, switzerland). o. wiener supported them at the time on the theoretical side, but subsequently gave up all attempts in that direction. gerhard rühm and friedrich achleitner can still be counted as concrete poets.

we still sometimes appear together, for instance in the "mobile salon" of galerie situation 60 in Berlin, or when producing old collective works like our *kinderoper (children's opera)* (written 1958; performed 1964: achleitner, rühm, wiener, and myself).

the final development was the founding of a magazine (*edition 62*, klagenfurt) devoted strictly to the publication of our works; i was made editor. this meant i could save one or two of my friends' earlier works from oblivion (including artmann's *die fahrt zur insel nantucket / the trip to the island nantucket*, 1954). the magazine subsequently fell victim to technical difficulties.

an anthology devoted to our group will shortly be published by walter verlag, olten, under the title *die mustersternwarte (the model observatory)*. there is also to be a novel, poems, and short plays by artmann, as well as my own *der kopf des vitus bering (the head of vitus bering)*. for some time now artmann has been living in malmö and rühm in berlin.

times literary supplement, September 9, 1964,
in: Peter Weibel (ed.), *the vienna group: a moment of modernity 1954-1960 / the visual works and the actions*, Venice Biennial, Springer, Vienna-New York, 1997.


Friedrich Achleitner


H.C. Artmann


Konrad Bayer


Gerhard Rühm


Oswald Wiener

Friedrich Achleitner, born 1930 in Schalchen, Upper Austria. Studied at the Academy of Fine Arts, Vienna. In the mid 1950s contact to the Vienna Group. From 1958 free-lance author *(Konkrete Poesie)*. From 1962 also occupation as an architect. In 1972 he returned to literature, in 1973 *quadratroman* is published. 1983-1998 professor for architectural theory and history at the University for Applied Arts in Vienna. In 1993 participation at *Die Sprache der Kunst*, Kunsthalle, Vienna. Lives in Vienna.

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F. Achleitner (ed.), *Österreichische Architektur im 20. Jahrhundert*, 3 vol., Vienna 1980, 1983, 1990.

H.C. Artmann, born 1921 in Vienna. After his return from an American prisoner-of-war camp literary activities for the magazine *Neue Wege*. Since 1953 close contacts to Konrad Bayer and Gerhard Rühm, which resulted in the constituition of the Vienna Group. Since 1954 many travels through Europe. In 1958 first publication of a book in Viennese dialect: *med ana schwoazzn dintn*. In 1962 he moved to West-Berlin; in 1963 to Sweden; in 1966 to Graz; 1968-1972 back to Berlin. Died in 2000 in Vienna.

Konrad Bayer, born 1932 in Vienna. Was actor and director of a gallery, co-founder and editor of *edition '62*. In 1958-1959 *literary cabaret* with Oswald Wiener, Gerhard Rühm and Friedrich Achleitner. In 1961 first perfomance of the one-act play cylce *kosmologie* at the students' theatre *Die Arche*, Vienna. In 1963 first performance of *bräutigall und anonymphe* at the Theater am Lichtenwerd, Vienna. From 1955 cooperation on experimental films. Scattered publications during his lifetime; post-humous publication of his complete works in 1966 and 1987, edited by Gerhard Rühm. Died in 1964 in Vienna.

7

Oswald Wiener

(short liquidation, effected in ordinary language, of enigmatic art)

Oswald Wiener, born 1935 in Vienna. He was a jazz musician on the Vienna scene and became acquainted with Artmann, Rühm, and Bayer in the early 1950s. In 1954, he began publishing poetry and literary concepts. Wiener had his first public reading in 1957 and produced the erste literarische cabaret in 1958 with G. Rühm, F. Achleitner, and K. Bayer. In 1960, Wiener distanced himself from his literary works. In 1969, his novel, *die verbesserung von mitteleuropa. roman*, appeared, and in 1969, he moved to Berlin. Co-initiator of the "Poets Workshops" and the "Concerts of rarely heard music." In the 1980s, he moved to Dawson City, Canada, and intensified his work as a cognitive scientist. In the 1990s, he was a professor at the Dusseldorf art academy. Lives in Canada and Krefeld, Germany.

References:
Oswald Wiener, *Schriften zur Erkenntnisstheorie* (Vienna, 1996).
Oswald Wiener, *Literarische Aufsätze* (Vienna: Löcker, 1998).

References:
Gerhard Rühm, ed., *Die Wiener Gruppe* (Hamburg, 1967).

Peter Weibel, Valie Export, eds., *Wien – Bildkompendium des Wiener Aktionismus* (Frankfurt/Main, 1970).

Andreas Okopenko, "Die schwierigen Anfänge österreichischer Progressivliteratur nach 1945," Protokolle (75:2) Vienna, 1975.

Hilde Spiel, *Die zeitgenössische Literatur Österreichs* (Munich, 1976).

Oswald Wiener, Humbert Fink, Gerhard Rühm, Herbert Eisenreich, et al., "Die Wiener Gruppe – eine Kontroverse," Neues Forum, Vienna, pp. 171-172.

Peter Weibel, ed., *the vienna group: a moment of modernity. 1954-1960. the visual works and the actions*, Venice Biennial 1997 (Vienna/New York: Springer, 1997).

not evident is what remains to be discovered: discovered are connections, and everyone is free to discover any number of them.
when art reveals something — that is, publishes or provokes discoveries — it is either science or exhibition, model or document: a reward promised in advance to the polite interest in a position or emotion. this explains why understanding hits upon art. artworks are "works" of the artist.
when an artwork is the result of a game, it invites one to play. pretensions vanish, the background remains: history and its revelation to the zeitgeist.
divested of myth, it ultimately becomes reduced to a simple event; allegory without interpretation is still a lecture. if one takes away the trivial meaning, the structural model remains and experts quibble. baroque — to interpret an event as a representation!
critique is the kind of interpretation of species, the specimen depiction of a fact; the miracle that the levels of language tend, unnoticed, to become levels of reality! before so many realities of the work we stand and select, discover what is familiar to us, and overlook what is concealed to us: most notably the fact that positions, relating to each other complementarily, sophisticatedly hide their uncertain relations from us.
i ask the person participating in the subject laid out here to take the following measures:

1. observe one of the exhibited objects.
2. observe the object in connection with the other exhibits.
3. move about in the space.
4. occupy various positions.
5. perceive the possibility of avoiding opinions.
6. withhold comment until conversing about art in private with friends.

Poster text for Marc Adrian's exhibition, *11 Positions*, junge generation gallery, Vienna, Börseplatz 1, January 1960.

the bio-adapter

philosophical rudiments, in anticipation of the system description: in its basic outlines, the bio-adapter offers, in my opinion, the first reasonable sketch of a complete solution for all world problems. it is an opportunity for our century: freedom from philosophy through technology. its aim is, namely, to replace the world...

in its effects, the bio-adapter can be compared to a selectively bred uterus ("joy suit") which, as a result of continuous adaption, is able to meet the most varied requirements of highly organized living creatures. it can be interpreted as both the hypertrophy of organs' modules, which at first extends into the 'physically external,' as well as the nervous structural complex of its owner, and from this point of view, it converts the pleasure impulses that human beings project onto their environment (servo-narcissus)...

viewed from the 'outside,' the adapter is placed between the unsatisfying cosmos and the dissatisfied human being. it hermetically seals off the latter from the traditional environment and only falls back on the information that has been stored for this purpose, as well as any content thereof, in the first stage of adaption. this allows the human being to enjoy a newly prepared, therapeutically enriched perception of selected aspects of the remembered cosmos. in the first stage of adaptation, the adapter formally represents the 'external.' it simulates alternating relationships by conceiving of itself as its own partner. the singularized human being, who feels singled out from his environment in a most attractive way, knows that he is in the middle of a conversation, in a game-like dialogue with a benevolent authority. however, the actual activity of the bio-adapter in this phase is to simulate a communications shield, a membrane separating the contents of the various structures of consciousness. constantly subjected to comprehensive learning processes, it simulates intercourse with the 'outside,' while analyzing, in the course of its exploration of the incorporated human being, all the messages (including the products of the metabolism) the latter sends to the now hypothetical universe, and returning selected portions of it, whereby the emphasis is always on the criterion of happiness. to put it in a nutshell, the bio-adapter functions as an information mirror that simulates the macro instructions of a no-longer existent source of information: the impulses of the bio-unit are analyzed, regrouped, transcodified, and reflected according to the terms of the first presumed emphasis on pleasure.

the human being to be adapted is uninterruptedly probed for his needs, until the adapter is able to reproduce it for the purpose of increased pleasure.

brochure, 1965/66
Oswald Wiener, die verbesserung mitteleuropas. roman (Rowohlt, 1969).

Friedrich Achleitner, Konrad Bayer, Gerhard Rühm, Oswald Wiener

literary cabaret (1958/59)

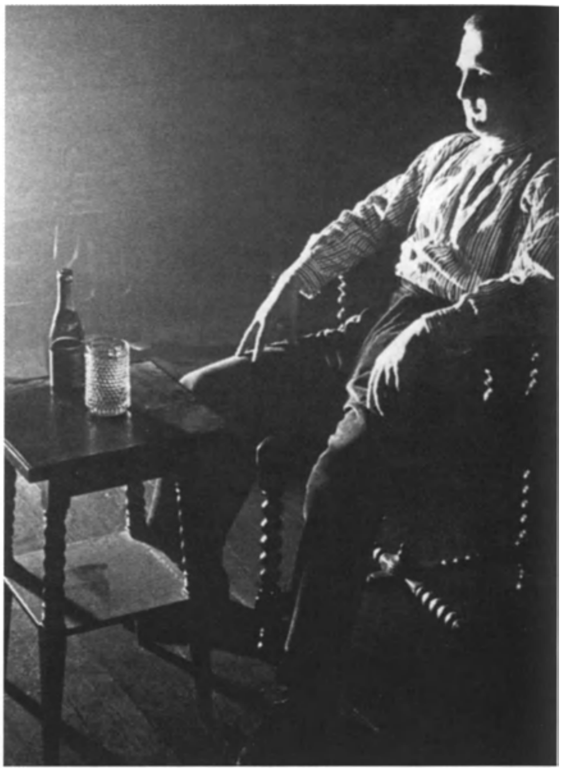
our cabaret will not be — as it might be misinterpreted — a literary disguise for certain measures (meaning, among other things, moral demands) but simply a happening. we will not have to put forward any criticism or protest, unless it be a widely diverse criticism of our specific audience, a protest against their passive notion that they are mere onlookers and against their easily controlled reactions, which we — and this is confidential — will yet provoke somehow.
our cabaret will consist of an entire range of impressions appealing to our guests in this place. if we want to educate our audience, we do so with the aim of enlarging their horizon of perception, enabling them to integrate impressions and to cope with complexly associated ideas. for each individual spectator, our cabaret is going to be exactly what he can take home from it. everything will come into play: floor, seat, neighbor, cloakroom attendant. we will see to it that essential features are veiled and that circumstances, which would otherwise might have easily been overlooked, will be stored in our spectators' memories.
our players will not present the illusions of other people (like stanislavki's actors), nor will they pretend to be other persons (like brecht's players). they will remain themselves, and yet the audience will fall prey to the illusion of a representation that is false and fully intentional. (we are going to knit the stitches into a supernetwork.) our actors have been selected on the basis of their personalities. they are unable to hide their talents, which also explains the fact that our program also features 1 trained actor.
ideas, text, and music by achleitner, bayer, rühm, and wiener.

waschzettel, 1958
reprinted in Gerhard Rühm, ed., *Die Wiener Gruppe* (Hamburg: Rowohlt [1967] 1985) p. 419.
Peter Weibel, ed., *the vienna group. a moment of modernity 1954-1960. the visual works and the actions*, catalogue, Venice Biennial (Vienna/New York: Springer, 1997).

2nd literary cabaret, 15 April 1959
first number, porrhaus, vienna

The first number, and the actual start of the evening. The curtain was drawn, and the actors sat in three rows of chairs facing the audience. "the audience as actors and we ourselves as audience." (O. Wiener). The stage was darkened and the auditorium illuminated. The actors watched the play going on in front of their eyes with great interest, and when individuals in the audience started to laugh, the people onstage applauded.
top, from left to right:
Eva Harand-Schreiber, Kiki Kogelnik, Aino Prethaler, Ortwin Kirchmayr, Ingrid Schuppan
below: audience, as seen from the stage

1st literary cabaret, December 6, 1958
O. Wiener in *mens sana in corpore sano*



1st literary cabaret, December 6, 1958
F. Achleitner as beer drinker

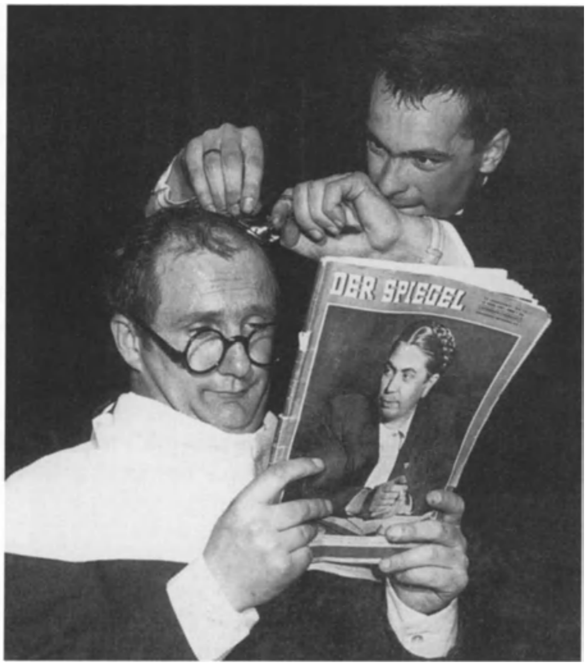
2nd. literary cabaret, April 15, 1959
O. Wiener in *invention of electricity*

2nd literary cabaret, April 15, 1959
F. Achleitner, K. Bayer, G. Rühm, O. Wiener in *two worlds*

2nd literary cabaret, April 15, 1959
G. Rühm in *the awakening*

2nd. literary cabaret, April 15, 1959
F. Achleitner in *stopgap* (arranging rows of chairs)

2nd literary cabaret, April 15, 1959
F. Achleitner, G. Rühm (in the passenger seat) in *two worlds*



2nd literary cabaret, April 15, 1959
F. Achleitner in *an expert contribution*

Gerhard Rühm

Gerhard Rühm
born 1930 in Vienna. Studied at the University of Music and Performative Arts in Vienna. Co-founder of the Vienna Group (F. Achleitner, H.C. Artmann, K. Bayer, O. Wiener). Professor at the University of Fine Arts in Hamburg. Lives in Cologne and Vienna.

Exhibitions
1958 Galerie Würthle, Vienna
1963 Galerie nächst St. Stephan, Vienna
1968 Galerie René Block, Berlin
1976 Kunstverein, Hannover
1977 Galerie nächst St. Stephan, Vienna
1980 Kulturhaus, Graz
1982 Württembergischer Kunstverein, Stuttgart
1984 Museum moderner Kunst, Vienna
1987 Rupertinum, Salzburg
1989 Frankfurter Kunstverein
1995 Kunsthalle, Hamburg
1996 Galerie Fotohof, Salzburg
1998 Galerie 422, Gmunden
1999 Christine König Galerie, Vienna
Generali Foundation, Vienna
2000 Aller Anfang ist MERZ – Von Kurt Schwitters bis heute, Sprengel Museum, Hannover
2001 Kulturzentrum bei den Minoriten, steirischer herbst, Graz
2002 *Fluxus in Deutschland*, Kunsthalle Fridericianum, Kassel
2003 *Phantom of Desire*, Neue Galerie, Graz
2004 *Phonorama*, ZKM, Karlsruhe
SUPPORT – Die Neue Galerie als Sammlung, Neue Galerie, Graz

References:
Gerhard Rühm, *Visuelle Poesie. Arbeiten aus vier Jahrzehnten*, (Innsbruck: Haymon, 1996).
Gerhard Rühm, *Schwellenchronik der Jahrtausendwende*, (Graz: Droschl, 1999).

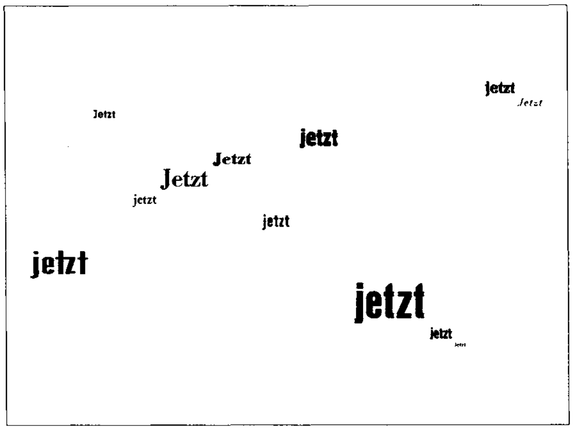
photomontages

every photo is a detail.
this detail focuses
on an object or
a situation.
the various objects and situations are not intermeshed, but are instead positioned next to each other. (they enter into a relationship with each other, as documentary images of reality.)
hence, the paper depicts a constellation (of objects, situations).
as that of all objective representations, the relation of the montages to language at first consists of the fact that they also comprise conceptual (material) relations. what is more, the paper displays formal (purely pictorial) relations.
the arrangement of the rectangular framed photos on the paper creates constructive planar relations, as well as structural and textural relations.
the photos enter into a relationship with the empty areas of the paper in two ways:
structured form to pure white or black,
images of reality to and between these distancing, 'empty' fields of tension.
the photos are generally taken from current newspapers.

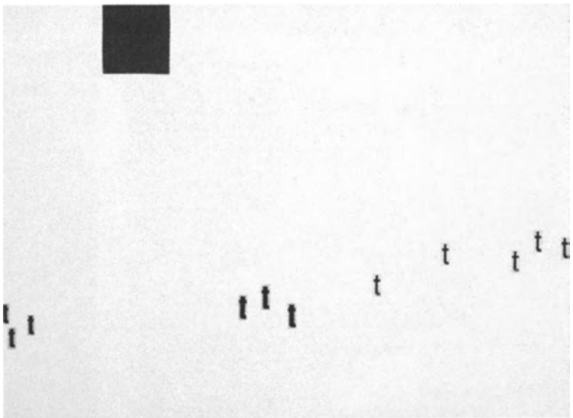
1959

when, starting in 1955, i began to relate individual words and general concepts in constellations in my typocollages, I also related images of certain situations in my photomontages, which is why for a time I considered calling my photomontages photoconstellations, which would have underlined more clearly the fundamental difference to the previous photocollages, which contained parts of photos collaged as inconspicuously as possible into other photos. as early as 1955, i contrasted prints of photos, that is, abstract descriptions of concrete reproductions. this initially led to series of photos and text, comprising what was a more or less free association of prints, which were actually conceived for a book publication. in 1957 i also began creating pure photomontages, completely omitting the use of any language-based elements; some were single prints and others were in series, in the form of folders — "photostories," as it were, whose narratives could be derived from the way the visual material was presented. in this respect, the pure photomontages, like all objective art, also have a literary aspect: the subject 'deals' with something; objects imply their names, concepts interpret situations.
purely pictorial qualities are, however, intentionally woven into the photomontages: in the connections to adjacent photos, in the proportions of the picture details to each other and the chassis, as well as in the color values, if the photos have any.
the images are details of reality and, in order to intensify their reality, I preferred to use documentary pictures taken from current magazines. they are positioned directly next to each other on paper or spaced apart in order to create tension. sometimes, in contrast to the white of the basic surface, a black or often monochromatic square (or rectangle) is placed as a non-image next to the photos — i see this as an 'absolute' site of reference, a kind of force field that cancels out the object by compressing all gray and black tones of the images. if the objects are on a black background, the world of objects is like a stage set confronted with the depth of space, thus constituting, as it were, temporary islands of worlds. where i once used material from the world of advertising and fashion, what we see today is an anticipation of elements of style employed in pop art, something ed sommer once referred to, i think, in kunstform magazine.
starting around the mid-1960s, i stopped doing photomontages, although there was still a wealth of material and ideas; perhaps i'll go back and do some more sometime.

retrospective remarks on my photomontages, 1979
Gerhard Rühm, *fotomontagen 1958-1966, series no. 13/b* (Vienna: Museum moderner Kunst, 1979).



Gerhard Rühm
jetzt (now), 1954

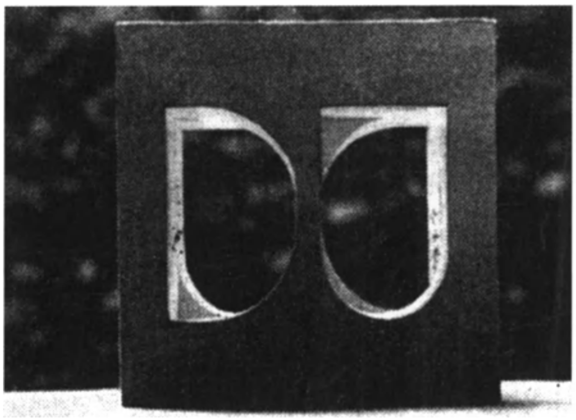


Gerhard Rühm, *Untitled*, 1955
Collage, newspaper clippings

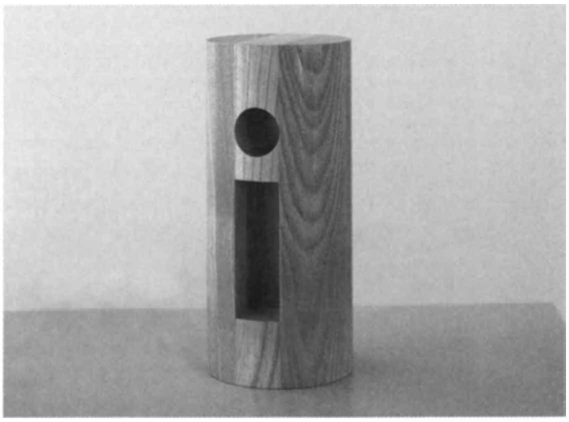
Gerhard Rühm
color poem, 1956/57

Gerhard Rühm, *Untitled*, 1959
Collage, newspaper clippings, 26 × 24.6 cm

Gerhard Rühm, *Untitled*, 1959
Collage, newspaper clippings

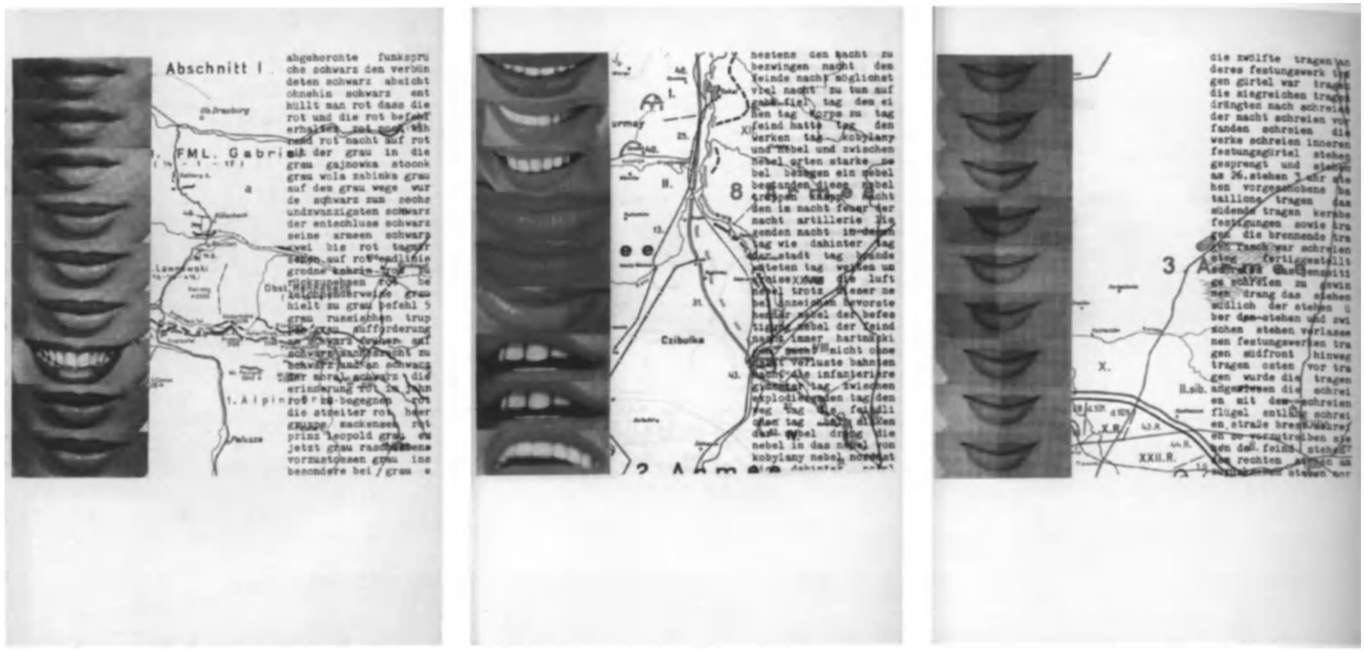


Gerhard Rühm, *DU (YOU, model for a word sculpture)*, 1964
Wooden object

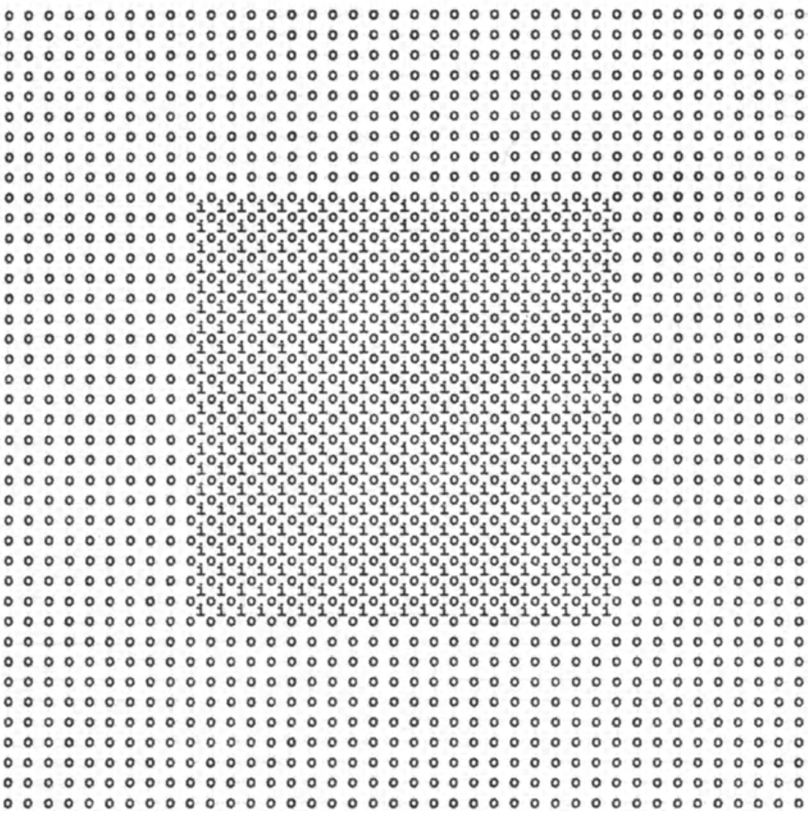


Gerhard Rühm, *I am (not) here*, 1984
Wooden object

Friedrich Achleitner



Friedrich Achleitner, *kobylany sketch,* October 1958

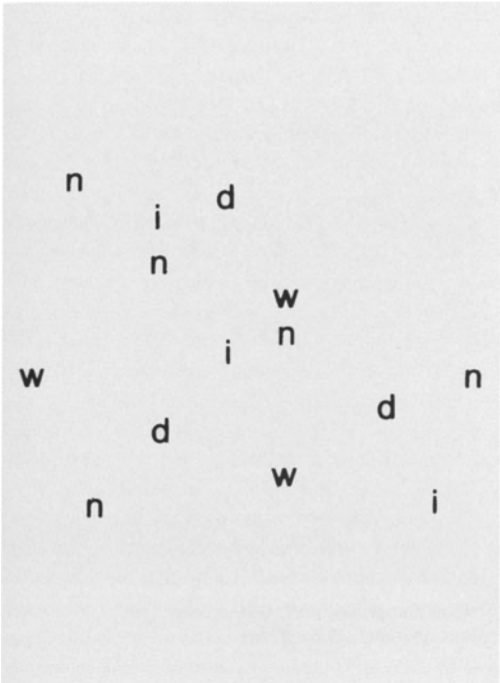


Friedrich Achleitner, *o-i sketch,* 1960

Friedrich Achleitner, *quadratroman,* 1973

Heinz Gappmayr

What Is Concrete Poetry?



Heinz Gappmayr, *WVZ. 15, wind,* 1961
Text on paper, 29.7 × 21 cm

Heinz Gappmayr, *WVZ. 34, weiss (white),* 1962
Text on paper, 29.7 × 21 cm

Concrete is what immediately exists in actual reality in contradistinction to the abstract, that is, something that is conceived. We are accustomed to a sentence saying something about objects or situations outside language; e.g., "the tree is blossoming." We verify an opinion by comparing the statement with the object, to see if they agree. It is also enough if the statement corresponds to a possible circumstance, however fantastic and contradictory it may be. In view of the fact that, in a certain sense, everything can be exchanged with everything else, everything is possible, even if everything is not real.

However much linguistic forms may change, or new forms emerge over the course of time, concepts or compound concepts cannot be conveyed without language. Although they are not identical to the concepts, together, visual and phonetic/acoustic forms of language constitute an indivisible whole. Changing the alphabet or the sounds also entails a change of concepts.

Evidently, then, there is a connection between the number of the visible forms of the alphabet and the conceptual substance of the concept. The same applies to the phonetic/acoustic aspect of language and its relation to the conceptual. We will recall that, as a means of communication, language conveys thoughts and compound concepts that refer to objective things. In the sentence "the tree is blossoming," we use words that convey the concept of the tree along with the concept of blossoming, but the concepts themselves, which are immediately understandable to members of a different linguistic community who use a dictionary, refer to a concrete physical object, of which they themselves are but abstractions. Upon closer examination, however, we notice the following: in the absence of empirical reference, i.e., without pointing or standing in front of the sun and thus investing our speech with comprehensibility and direction, it is not possible to denote the objects with the mere concepts of tree and blossoming, which these concepts are supposed to refer to by themselves. The idea of transitive concepts is evidently too simple. In the concepts we recognize a kind of ideality, something ideational. We distinguish concepts referring to objects that can be perceived by the senses from concepts not derived from other concepts, meaning categorical concepts referring to everything that is, for example, similarity, equality, quantity, quality, dependency, necessity, coincidence, causality, relation, absence, presence, etc.

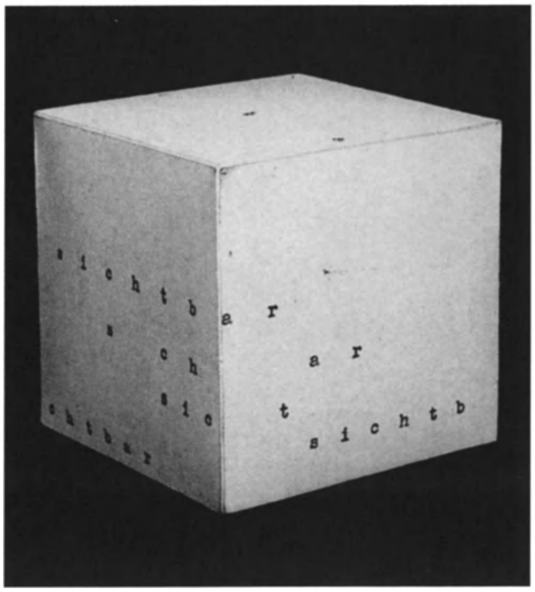
The physiognomy of concepts and their ideational nature play an important role in concrete poetry. Throughout the change of appearances that is manifested as history or natural science, concrete poetry considers the all-embracing aspect of language the unified whole of the sign and the concept. In the antithetics of nominalism and realism, the synthesis of the symbolic aspect of the alphabet and the sounds with the ideality of the conceptual, we find the stringency and the concrete element of new poetry. The importance attached, on the one hand, to

Heinz Gappmayr
born 1925 in Innsbruck. Lives in Innsbruck.

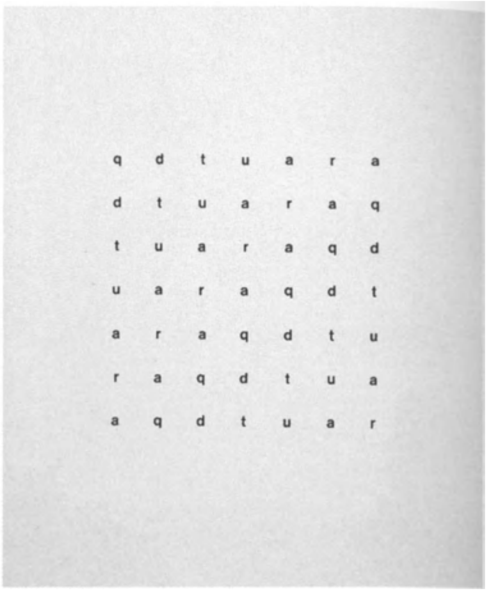
1970 Galerie nächst St. Stephan, Vienna
1973 Neue Galerie, Graz
1982 Frankfurter Kunstverein
1991 Galerie Museum Bozen
Staatsgalerie moderner Kunst, Munich
1993 Rupertinum, Salzburg
1994 Galerie Tilman, Brussels
1995 Kunsthalle Ritter, Klagenfurt
Kunstraum, Vienna (with R. Barry)
1996 Bielefelder Kunstverein
1997 Kunsthalle, Vienna
1998 Mathieu Gallery, Lyon, France
1999 Tiroler Landesmuseum Ferdinandeum, Innsbruck
2000 Galerie Lindner, Vienna
2001 Galerie Taxispalais, Innsbruck
2004 Galerie Grita Insam, Vienna

Group shows
1965 *Between Poetry and Painting*, ICA, London
1969 Venice Biennial
1970 *Concrete Poetry*, Stedelijk Museum, Amsterdam
1975 *Kunst aus Sprache*, Museum d. 20. Jhdts., Vienna; Galerie im Taxispalais, Innsbruck
1980 *Vom Austauschen der Wörter*, Sprengelmuseum, Hannover
1981 *World Art Post Exhibition*, Artpool, Budapest
1986 *Fröhliche Wissenschaft*, Staatsgalerie, Stuttgart
1987 *buchstäblich wörtlich, wörtlich buchstäblich*, Kölner Kunstverein
1989 Xpo-Galerie, Hamburg
1991 *Redukta*, Zentrum für Moderne Kunst, Warschau
1992 *vertikal horizontal diagonal VII*, Tiroler Kunstpavillon, Innsbruck
2001 *Die Cabinette des Dr. Czerny*, Neue Galerie, Graz

References:
Heinz Gappmayr, *Zeichen (1962) + Zeichen II* (1964, reprint, 2000).
Silvia Eiblmayr, *Heinz Gappmayr: Text Farbe Raum* (Vienna-Bozen: 2000).



Heinz Gappmayr, *WVZ. 75, cube*, 1962
Paper object, 7 × 7 × 7 cm



Heinz Gappmayr, *WVZ. 664, square*, 1986
Text on paper, 29.7 × 21 cm

the symbolic aspect and, on the other, to the categorical aspect of the concept in a concrete poem determines its form, which allows us to distinguish among various possibilities within concrete poetry. In concrete poetry, however, we always find reference to concepts as concepts. Hence, it is not about similar or different things, but rather about similarity and difference, the categorical harmony of the world. The pure forms of predicaments must not be marred by the significance and mood of the concepts by means of which they are manifested. It certainly does matter what concepts are used.

Concrete space, concrete visual and phonetic signs, lines and sounds are self-referencing, and thus, in a sense, concrete or immediately given concepts are dependent upon each other. This identity allows the idea to appear, allows generality and factuality to permeate each other. All grammatical functions of language, all logical definitions and problems, the process of reading, all relations between the world of experience and rationality are incorporated, albeit always in such a way that the all-embracing, generally binding, ideational nature of the concepts is made visible. The descriptive, transitive function of language and its dependency on possible and real objects or situations are annulled. It would thus be amiss to look for contexts in concrete poetry referring to an empirical circumstance in the form of a judgment of objects that can be perceived by the senses. This reference to empirically factual or possible circumstances, wherever it is perceived, is a secondary manifestation.

In concrete poetry, concrete implies the immediacy of conception, the logical, perceptible, and ideational manifested in the alphabet.

Heinz Gappmayr, *Opus. Gesamtverzeichnis der visuellen und theoretischen Texte 1961-1990* (Mainz: Dorothea van der Koelen Verlag, 1993) pp. 50-51.

Oswald Oberhuber

How to Kill Art??!! or Artists Without Art!

Artist without art, or man without work: therefore, man without money; or critic without criticism: therefore, art without criticism. Where there is no eye, there it is dark, and there are no differences, just darkness.

Art historian plus art history equals the preservation of monuments, equals strange traffic, equals man without future, or past with man, or man with past; he can only wear stand-up collars.

I'm lost, I'll start again. Everything becomes very rhythmic, as if one were writing a litany; although it is beautiful, it is also tiring. Perhaps things should be taken in hand more firmly. So watch out: I'm taking it in hand! An artist without art, that's a damn difficult thing. There's not much more to say, because that basically says it all. I'll explain it anyway: an artist without art is perhaps like an artist who denies everything, denies what art was before him, the person who does not see anything— besides himself. An egoist down to his bones: whatever is his, is best. The artist over corpses of the past. There are no castles, there are no churches, there was no Michelangelo, there is nothing of consequence. He is the one truthful person, the only one without a beard, the one to whom everything outside himself, his ego, is repugnant. Where are these masters, playing with their whips? No bowing to Otto Wagner! Tear it down, tear it down. What comes next? Something will come. For art that is forced has always had little space to develop and little time to survive. Beard off, take the whip in hand, the only beautiful thing is to exist in time.

I declare further: an artist without art inspires himself, he stimulates himself... well, with what? for whom?

Where are you, dear fat little Muse? The hard facts have pushed away the Muse; maybe there have always been facts, and we have pushed ourselves away.

I declare further: an artist without art; or favor; art without favor. It's like a hot dog stand without hot dogs, or a wallet without money. You have to be a favorite, a favorite of nature, a favorite richly blessed with luck, who leaves the castle with wealth, born a millionaire, an artist with a hat factory like Cézanne. Art without favor means art in the closet, art in planning: plans that are never realized. You can also make a virtue of it and say: I am only planning. There is only planning. Where there is no money, there is only a plan. The art of planning. The blueprint, full of ideas. Ideas in the stars on paper.

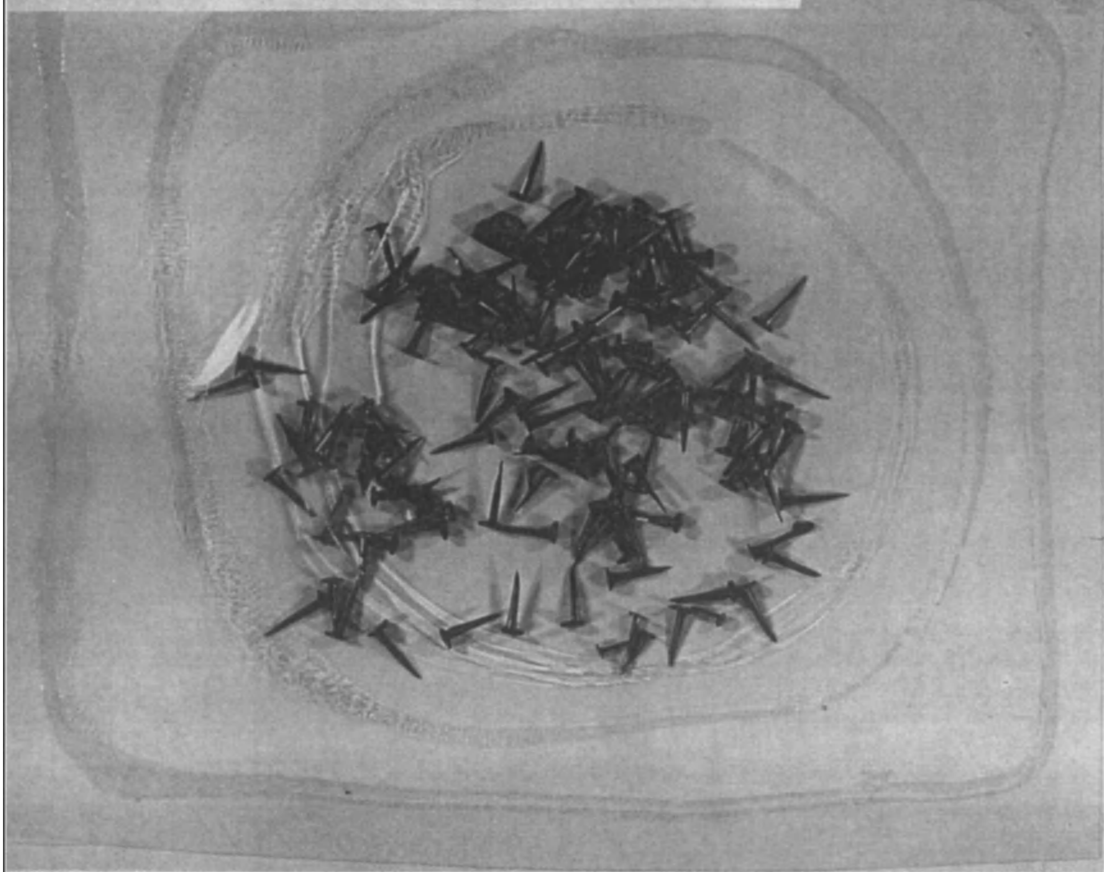
I repeat: an artist without art. Art is dull, and so I should say: an artist without art. It is tiresome and useless to say art, to breathe it. How can I explain it? It is exhausting to make sure that everything is done properly, art not according to perfection, to Vermeer. It is better to exclude art; that means: nothing is created aforethought, with art on the tip of the tongue. Each artistic statement should or must be a demonstration against art, against oneself— the artist. Then we have only the naked human, without the artist. Where is his artist? If the artist puts his artist into the closet, then he is nothing more than a naked man with material or a man in the closet...

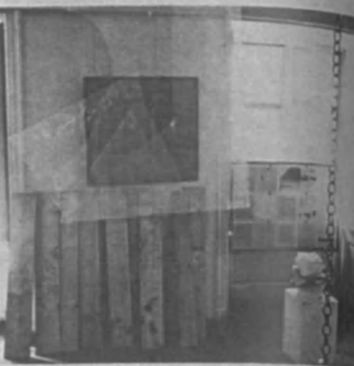
There is no rule for squeezing out a fruit or a word. The one squeezes with all his might, the other so gently that not even a drop comes out. The next one decides to use a juicer. That is why artists are without art, as there is no language that can explain their art to themselves. If there were no art theory, art could breathe without rules, because the language of art theory intentionally avoids art by wanting to see everything organized in contexts and references. Art is a whore, nibbling everywhere. Art, like religion, is abstract, inexplicable: either one believes or does not believe. The artist should do something for something about which he knows nothing. No authority can tell him why he makes art. Where there is no authority giving commands, there is no art. In the days when the artist was known as a genius, a little god with twenty-four legs, then being called a genius was the reward for art. Which explains art without question marks. To preach art is impossible because that would mean preaching theory, and theory is boring. Why does everything have to be explained, the way pasta is rolled out in order to be cooked, overcooked afterward. With experiences instead of explanations.

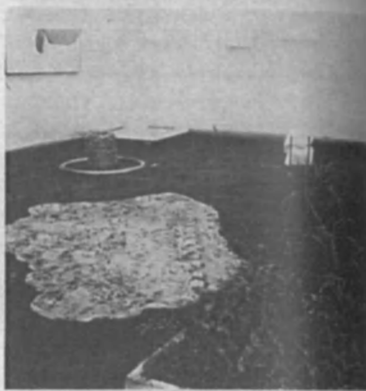
And that is the way I began illuminating the vocabulary of art. I think, and I am now talking about content. Maybe a basket has content if I go shopping with it. I would get content by cutting up a canvas and making a bag out of it. That would give the canvas space for content, content can be added. A good example is the passepartout. The passepartout frames the art, so that the art becomes content and the passepartout becomes art. This gives the wrapping, the dust cover, and the string around the package more meaning than the content they protect. If content is there, it is destroyed, used, consumed, observed. Content means utility, using, soiling. Content is goods, is money. Useful art has content. Anything useless has art. Everything put down, put aside, can be art. The old bed of the dead man, the shards under the bed, the shards on the head, content is merely anything useful...

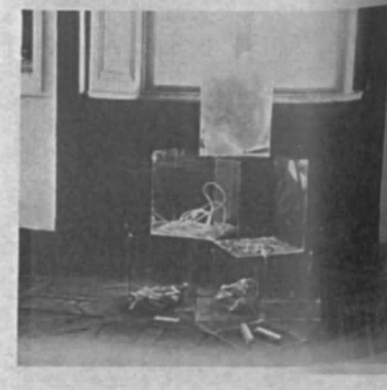
Excerpts from a lecture given at the XV International Art Discourse, 3-5 July 1969, Galerie nächst St. Stephan, Vienna.

Galerie nächst St. Stephan
Wien 1, Grünangergasse 1
9. Juni bis 30. Juni 1969









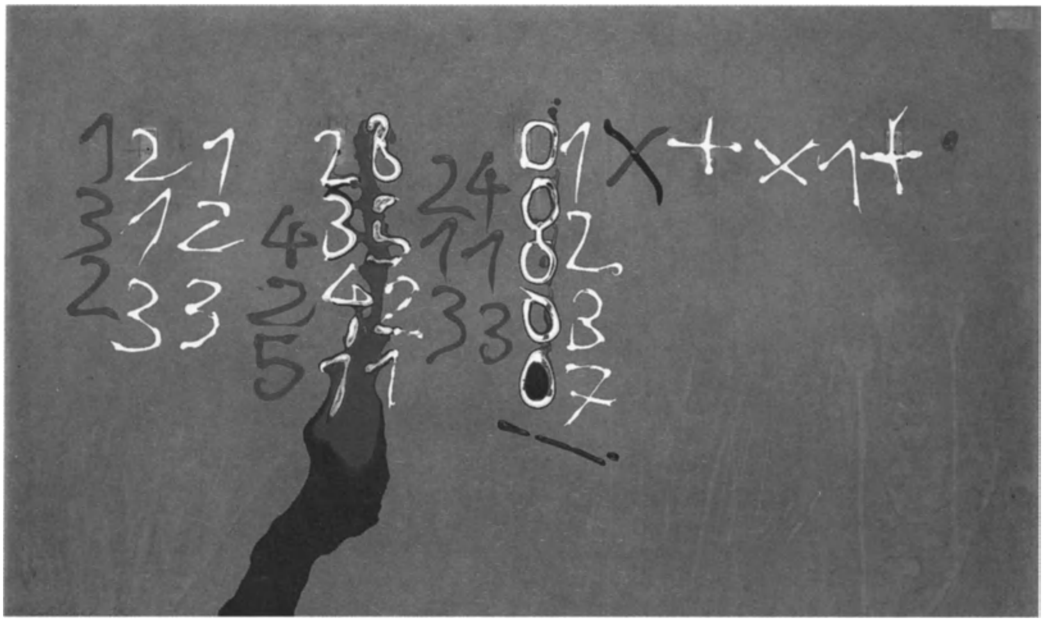
Galerie im Taxis-Palais
Innsbruck
Maria-Theresien-Straße 45
8. Juli bis 10. August 1969

Künstler ohne Kunst

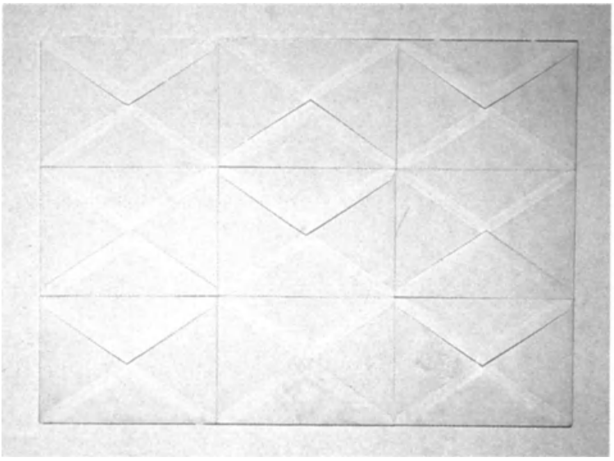
ich erkläre diese Ausstellung :

Erstens : Die Künstler haben keine Kunst mehr , ich weiß nicht , wie sie dazu kommen sollen . Sie versuchen zu finden und suchen herum am falschen Ort - bei der Kunst . Nun kann ich aber nicht sagen , was Kunst sein soll . ich stelle ein Radel Holz hin und betrachte und denke sehr tief : Radel Holz ist Radel Holz , ~~xxxxx~~ ist das Ergebnis . Dann könnte ich es einheizen . Wo bleibt die Kunst ? Kunst ist vielleicht , wenn das Radel Holz nicht eingeheizt wird . Alles , was man abstellt , auf die Seite schiebt , aufbewahrt , kann Kunst sein . Jeder erzeugt diese Kunst , denn es ist schwer zu verzichten : das alte Bett vom toten Mann - das alte Weib fürs Bett - der Scherbn unterm Bett - den Scherbn auf den Kopf , und , so , weiter . OBERHUBER

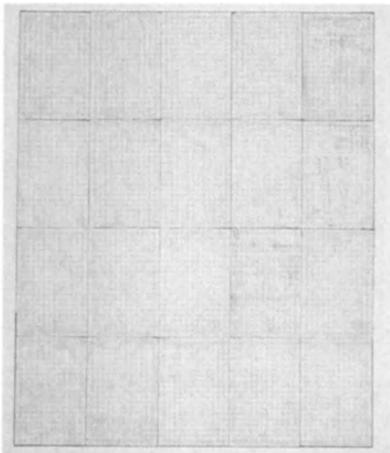
Oswald Oberhuber



Oswald Oberhuber, *Numbers*, 1952
Dispersion on wood fiber board, 70 × 114 cm



Oswald Oberhuber
9 Envelopes, 1964
Paper, 42 × 55 cm



Oswald Oberhuber, *Rumpled Tissue Paper Smoothed Out Again*, 1964
Paper, 63 × 43.5 cm

Writing as Painting

The way handwriting looks characterizes people, how they manifest and show themselves. All of a person's burdens and merits become an image available for anyone to see. The language of handwriting is the direct inner report of any person who dares to write. Poets relieve themselves through anonymous printing. The language of poetry is not just the elucidation and expression of inner processes, but also the need to relieve oneself. This relief can be intensified through handwriting: after all, internal language is dependent on the kind of writing that includes the mechanics and automatisms of the feelings that are reflected in the written expression…

1982/1983

Originally published in Oswald Oberhuber, *Lust auf Worte. Texte aus drei Jahrzehnten* (Vienna/Munich: Löcker, 1985) pp. 243-244.

Oswald Oberhuber
born 1931 in Meran. Studied under F. Wotruba at the Academy of Fine Arts, Vienna, and under W. Baumeister at the Staatliche Akademie, Stuttgart. Professor from 1981 to 1988 at the University for Applied Arts, Vienna, where he later served as Rector from 1993 to 1996. Lives in Vienna.

1970 Neue Galerie, Graz
1978 Museum des 20. Jahrhunderts, Vienna
1981 Galerie nächst St. Stephan, Vienna
1987 Frankfurter Kunstverein
Museum van Hedendaagse Kunst, Gent
1988 Kunsthalle Dusseldorf
1991 Galerie Krinzinger, Vienna
1995 Neue Galerie, Graz
1999 Museum for Applied Arts, Vienna
2003 Kunst Meran, Meran
2004 Galerie Ernst Hilger, Vienna

Group shows
1967 Trigon 67, Neue Galerie, Graz
1968-1970 Biennial, Tokyo
1971 *Die Anfänge des Informel in Österreich*, Museum des 20. Jahrhunderts, Vienna
1972 Venice Biennial
1977 documenta VI, Kassel
1982 documenta VII, Kassel
1983 steirischer herbst, Graz
Sao Paulo Biennial
1990 Venice Biennial
1998 Galerie Claude Samuel, Paris
2000 Museum for Foreign Art, Riga
2001 Galerie Georg Nothelfer, Berlin
2002 Fritz Wotruba bis Bruno Gironcoli – Österreichische Plastik. Galerie bei der Albertina, Vienna
2004 Porträts: Picasso, Bacon, Warhol..., MUMOK, Vienna

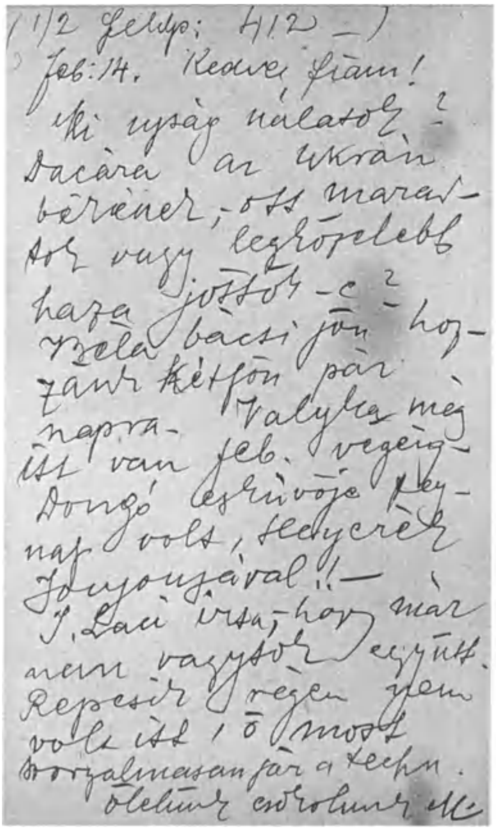
References:
Oswald Oberhuber, Möbelskulpturen (Graz: Neue Galerie, 1995).
Peter Noever, *Oswald Oberhuber: Written Pictures. Up Until Now* (Vienna: Springer, 1999).
Oswald Oberhuber, Mutazione Permanente Veränderung, Ursula Riederer (ed.) (Wien-Bozen: Folio Verlag, 2004)

László Lakner

László Lakner
born 1936 in Budapest. Studied painting at the Academy of Arts in Budapest. First first conceptual works in 1970, book objects and book images. DAAD grant, Berlin, 1974. Returned to Hungary. PS1 grant, New York, 1980-81. 1982-2001 professor at the University of Essen, Department of Experimental Design. Lives in Essen, Berlin, and Budapest.

1969 KKI-galéria, Budapest
1974 Ludwig Museum Aachen
1975 Neuer Berliner Kunstverein
1977 Galerie Denise René-Hans Meyer, Dusseldorf
Galerie Isy Brachot, Brussels
1979 Kunstverein Münster
1983 Bertha Urdang Gallery, New York
Galerie Inge Baecker, Cologne
1985 Galerie Georg Nothelfer, Berlin
1990 Galerie Raymond Bollag, Zurich
1992 Kunstverein Augsburg
1994 Goethe-Institut, Budapest
1995 Galerie Georg Nothelfer, Berlin
1996 Galerie Günter Winkelmann, Düsseldorf
1997 Institute G.A.M.E.S. of Art, Mönchengaldbach

Group shows
1972/1976/1990 Venice Biennial
1977 documenta VI, Kassel
1979 Sydney Biennial
1993 *Die Sprache der Kunst*, Kunsthalle, Vienna
1997 *Olaj, vászon*, Mücsarnok, Budapest
1998 Galerie Claude Samuel, Paris
2000 Goethe Institute, Rotterdam
Museum for Foreign Arts, Riga
2000 *aspekte/ positionen – 50 Jahre Kunst aus Mitteleuropa*, Fondació Miró, Barcelona; John Hansard Gallery, Southampton; Ludwig Múzeum, Budapest; Museum moderner Kunst, Vienna; Southampton City Art Gallery, Southampton
2001 Galerie Georg Nothelfer, Berlin



László Lakner
Letters from Grandmother
material found 1966, painted 1970
Oil on canvas
© VBK, Vienna, 2005

László Lakner
***Signatures*, 1974**
Oil on canvas
© VBK, Vienna, 2005

"Memories arrested in space/human needs and motives." László Lakner wrote down this Jackson Pollock phrase — in his own way.

I suppose because this phrase might be something like a motto for his personal work, which has changed dramatically during the last few years, even though Lakner has not rejected found material. It shines through and at the same time, explains his paintings from the 1980s. One recalls the book objects, which occasionally seemed decidedly polemic; the handwritten words of Dostoyevski, Schopenhauer, Pascal, Cézanne, Freud, and many more, carefully fixed to the canvas, with which a highly sensitive artist mused on the optical materiality of texts. He at first regarded these things as graphic, formal structures, but later, if you want to look at it like this, they were also devotions to the people whose writing he appropriated — devotions that were not without tension sometimes. Lakner, who is an avid reader and sometimes writes poetry himself, is at home in many different kinds of literature. In his paintings he tried to transform this closeness back into strangeness. The imparted messages — often quotations from letters, basically banalities or concepts of the particular authors, that is, things that had not yet been finally fixed in print: workshop samples — became the motifs for his painting.

Roland H. Wiegenstein, "Erinnerungen – gefangen im Raum, freigelassen in die Fläche," *László Lakner* (Berlin: Galerie Georg Nothelfer, 1985).

Rudolf Petrik

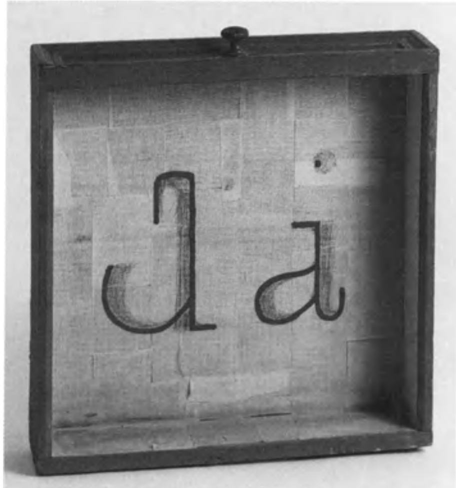
Rudolf Petrik, born 1922 in Vienna. Studied under R. C. Anderson and J. Dobrowsky at the Akademie der bildenden Künste in Vienna from 1945 to 1950. Member of the Vienna Secession. First solo show in 1959 at the Österreichische Staatsdruckerei in Vienna. Also exhibited in group shows featuring members of the Vienna Secession and the Graz Secession. Withdrew from the art scene in 1973. Died in poverty in 1991 in Vienna.

Anti-Commerce Paintings

Don't sell paintings, don't buy paintings: you don't buy a painter. Relieve the painting of its materialistic value. That way it is kept from abuse. Here's to the idea of emphasizing the spiritual! Attitudes often emerge from answers: answers often emerge from attitudes. We don't need the perfect material to communicate our internal forces. Old material, waste, deposits, that's the kind of useless stuff we need for these demonstrations. (Result for result.) Every transition hurts the dealers. Let the paintings die, so that we can live. Art is the idea…

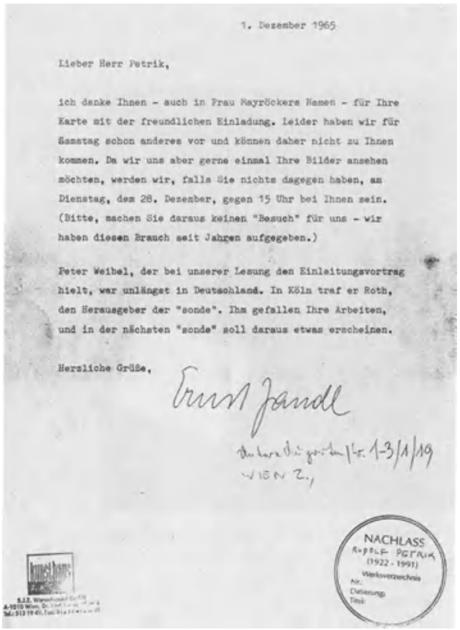
Concerning my script paintings (using non-materials):
Sometimes I imagine the loss of literature that belongs to the area of the science fiction novels: after the loss, the rediscovery of fragments that no one can interpret anymore...
If we don't show it, no one will be aware of it.

circa 1970
Rudolf Petrik. Paintings and Objects from 1945 to 1978 (Vienna: Kunsthaus Zacke, 1995) pp. 5, 7.



Rudolf Petrik, *Ja (Yes)*, c. 1960
Wall installation in the form of a drawer
47 × 47 × 7 cm

Rudolf Petrik, *Letter Composition Green*, c. 1968
Cloth mounted on board, 71 × 56 cm



1. Dezember 1965

Lieber Herr Petrik,

ich danke Ihnen - auch in Frau Mayröckers Namen - für Ihre Karte mit der freundlichen Einladung. Leider haben wir für Samstag schon anderes vor und können daher nicht zu Ihnen kommen. Da wir uns aber gerne einmal Ihre Bilder ansehen möchten, werden wir, falls Sie nichts dagegen haben, am Dienstag, dem 28. Dezember, gegen 15 Uhr bei Ihnen sein. (Bitte, machen Sie daraus keinen "Besuch" für uns - wir haben diesen Brauch seit Jahren aufgegeben.)

Peter Weibel, der bei unserer Lesung den Einleitungsvortrag hielt, war unlängst in Deutschland. In Köln traf er Roth, den Herausgeber der "sonde". Ihm gefallen Ihre Arbeiten, und in der nächsten "sonde" soll daraus etwas erscheinen.

Herzliche Grüße,

Ernst Jandl

WIEN 2.,

NACHLASS
Rudolf Petrik
(1922 - 1991)
Werkverzeichnis
Nr.
Datierung
Titel

I met Rudolf Petrik — a sympathetic and reserved person — many years ago, at the end of the 1950s, I think. During my visit to his studio, he taught me the technique he used for his montages. For me, it was particularly fascinating the way he nailed his ideas and thoughts about his current works in the form of a lot of little notes on Styrofoam boards. I took this technique from him, and I am very thankful to him for that. His poverty touched me; it was so intense that he satisfied his urge to paint by working on cloth instead of canvas. I remember his pictures as very beautiful abstract works, but unfortunately, over the course of time, I lost touch with this painter who had been so important to me.

Friederike Mayröcker, 1995

Wolfgang Ernst

Wolfgang Ernst
born in 1942 in Vienna. Lives in Vienna.

1968 Neue Galerie, Graz
1969 *Publikum(s)sprenger*, Munich (with V. Export, P. Weibel)
Museum des 20. Jahrhunderts, Vienna
1970, 1973, 1982 Galerie nächst St. Stephan, Vienna
1985 Mücszarnok, Budapest
1990 Galerie Gawlik/Schorm, Vienna
1995 Secession, Vienna

Group shows
1992 *Identität : Differenz*, Neue Galerie, Graz
1996 Kunstverein Paradigma, Linz
2000 *Re-Play. Anfänge der Medienkunst in Österreich*, Generali Foundation, Vienna
2002 *Fritz Wotruba bis Bruno Gironcoli – Österreichische Plastik*, Galerie bei der Albertina, Vienna
Beispiele aus der Sammlung Hellmut und Norli Czerny, Neue Galerie der Stadt Linz, Linz
2003 *M_ars. Kunst und Krieg*, Neue Galerie, Graz
2004 *Wiener Linien. Kunst und Stadtbeobachtung seit 1960*, Museum Karlsplatz, Vienna

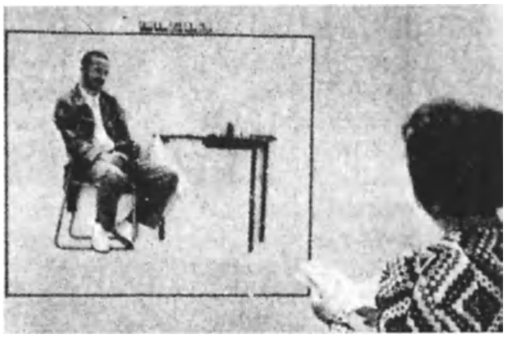
Wolfgang Ernst
object for taking off and taking away things, 1969

this object is to be screwed on to all conceivable things; one is supposed to try to take them away. e.g., trees, stones, houses, cupboards, tables, chairs, cars, gallery floors, roofs of museums, trains, boats, sculptures (of artists), tv sets, policemen, war machinery, streets, etc.
© VBK, Vienna, 2005

Wolfgang Ernst, *light lead & shadow*, 1970
Lead casting, 22 × 313 cm
© VBK, Vienna, 2005

Wolfgang Ernst, *art is uninteresting complete*, 1970
Lead casting, 39.5 × 50.5 × 3.5 cm
© VBK, Vienna, 2005

Richard Kriesche



Richard Kriesche, *Spectrum Exhibition*, 1971
Polaroid, installation view: Alexandra Palace, London
© VBK, Vienna, 2005

Richard Kriesche, *Here an Artwork Is Installed – Here an Artwork Was Installed*, 1973
Neon installation
© VBK, Vienna, 2005

Peter Weibel

Context Theory of Art (1971)

In order to control language, to investigate the use of language, and to elude linguistic control, the avant-garde movement, beginning with Fluxus & Co. Ltd., has availed itself of meta-linguistic means in order to deal with language. In doing so, it became clear that meta-linguistic means are themselves riddled with linguistic structures. This realization widened the universe of language — structures of language were expanded and new linguistic structures discovered. For example, the organization of language affects even the furthest reaches of our social organization. The organization of our sensory data, like the organization of administrative files, is closely related to the organization of words in language. (Consider a line drawn through a city and the body parts of the city's inhabitants skewered on this line, and you will have a sentence in which each body part constitutes a component of the sentence: hands are commas, torsos are nouns, limbs are verbs, etc. The various functions that these body parts exercise at that moment, be they social or intimate functions, are the meanings. It will not be difficult to make out, for the greater honor of society, the grammar of perception behind the monotony of this sentence, whose syntax is dictated by the state.) Just as certain formal symmetries are found in many things — from molecules and crystals to architectural design — there exists between language and perception, too, a continuous line of flesh and blood. Which, among other things, tells us that the way we divide things into architects and poets, media and materials, painters and musicians, etc., are superficial distinctions, arbitrarily made from a specific standpoint: the perspective of obfuscation.

A poet can compose poetry with stones or photos just as well as with numbers or words. The only important thing is how and to what extent he modifies the meaning of the materials he employs. In this respect, photo poems are a very small part of my ramified efforts to annul these divisions, so as to drive ahead the cause of poetry. The liberation of poetry, and thus the liberation of subjects that speak a language, is, of course, closely interwoven with a heightened interest in the semantics and pragmatics of language. The sensitization of perception and cognition, to which I have subscribed in film and literature, seems to me to be founded upon the knowledge that every text exists in a particular context.

This said, every context (environment) is a text for another, albeit more comprehensive, context. From this layered sequence of texts and contexts we can, for example, make the following selection: word (= text) – sentence (= context), sentence (text) – page (context), page (text) – book (context), book (text) – bookstore (context), bookstore (text) – publishing house (context), publishing house (text) – civilizational communication (context), etc. (This rendering of my context theory of text is simplified for better understanding.) A poet, then, can compose a poem at these various levels. "My sickness is not the compulsion to rhyme" (this is the proof, otherwise it would have to read "My sick compulsion is my compulsion to rhyme") is a poem at the text-context level of word-sentence. If we read on page twelve, "The sentence on page twenty-four is false," and on page twenty-four, "The sentence on page twelve is false," this is a poem at the sentence/page level. If the jacket of a book in a shop window displays a man in front of a shop window, this poem is at the book/bookstore level. If someone creates a book comprised solely of the publishing house's correspondence that was meant to have resulted in a book, this occurs at the publishing house/civilizational communication level, etc. I chose paradoxes as poems because they are so characteristic of a fundamental paradox, meaning that the liberation of the world from language goes hand in hand with the world being overrun by language. For as we come to recognize more and more text structures, as we discover text structures in areas where they were once concealed, the textualization of the world advances. Wherever we look, we see language. (By alphabetizing fish, E. Williams demonstrates the link between language and social organization, but also creates new text spaces in the universe: fish become letters. By adding texts to small and large sailboats, I. H. Finlay makes us see sailing texts instead of the sailboat).

In search of structures behind the linguistic structures, in search of the connections between linguistic and other structures, I was concerned with the context of texts, meaning with what is usually disregarded in poetry, and thus drifted further and further away from verse & sentence, to the far shore of media, to the tool of literature (the typewriter, the pen, and paper), to the quintessence of literature: communication. Conceiving behavior as the source of literature, I was interested in communication, in its non-verbal aspects. Prenatal origins of behavior, space and time as tools used to convey messages, habitats and territories, phylogenetic features, structures of meta-communication, and neurophysiological conditions of the knowledge of the world entered the realm of poetry as sources of message and need, as sources of creation, and as sources of understanding.

Peter Weibel, *Kritik der Kunst – Kunst der Kritik* (Vienna: Jugend & Volk, 1973).

Peter Weibel
Self portrait as Anonymus,
1967, photo-poem

Peter Weibel
Stamping on the Right with Feet
Text happening, Melk, 23 May 1968

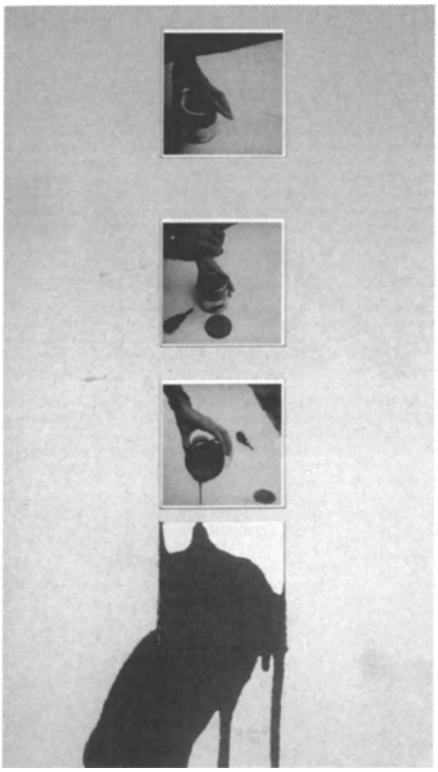
Valie Export

Gottfried Bechtold

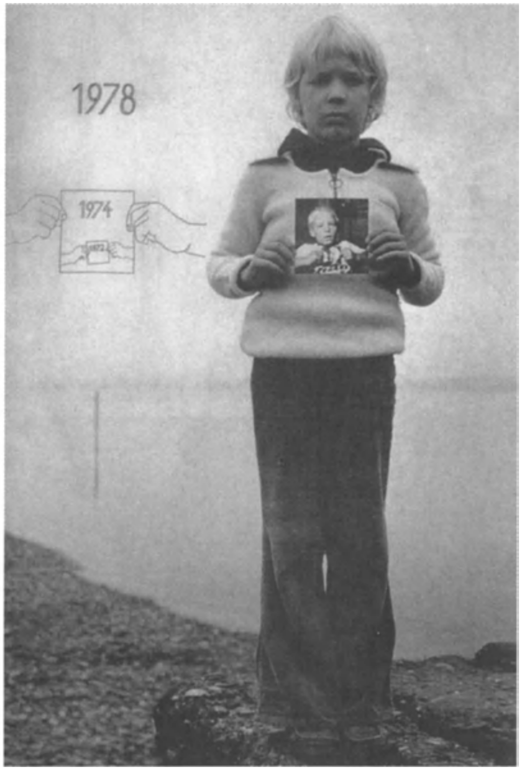
Valie Export, *Be"weg"ungs"spur" (Trace of a Movement)*, 1973
Isomorphous photograph, © VBK, Vienna, 2005

Gottfried Bechtold, *Fazilet I*, 1978
b/w photograph on chipboard, 221 × 120 cm

Gottfried Bechtold, *Fazilet Ia*, 1978
b/w photograph on chipboard, 221 × 120 cm



Gottfried Bechtold, *Untitled,* 1976
Polaroid, plastic resin, cardboard, 55.3 × 29.9 cm



Gottfried Bechtold, *Georg,* 1978
b/w photograph on chipboard, ink, 151 × 100 cm

What Sol LeWitt claims for concept art — no supremacy of any form or any medium — is also valid for Gottfried Bechtold's work, which, because of that, can be assigned to this contemporary tendency. However, it must refuse the conventional understanding of style, which up to now has been the art system's equivalent of patenting artists' copyrights. Bechtold is interested not only in certain contents (or topics), but, like information theory, also in the nature of information itself. When Douglas Huebler says that "the world is full of interesting objects." I do not want to add any. I prefer to note the existence of things in space and time," he makes an understated claim for demonstration that is also obligatory for Bechtold. Demonstration, however, is not the illustration of a theory; it is not linear elucidation, not the removal of paradox or contradictions, but an examination of reality and the experience of reality, which goes beyond mere optical perception. It is an investigation resembling basic research into the reality around us, its complexity and its systems. Unlike science, to which art is related through its epistemological claim, art does not answer questions, but poses them. Bechtold remarks pointedly, "art does not pose problems for us, but we pose problems for art." These problems are related to our relationship with reality and the categorization of the experience of reality itself. Bechtold is not interested in the psychological aspects of the experience of the world and its possible forms, but in the ontological dimension of this reality with the central theme of time. The change that has taken place in artistic practices since 1968 has been completely free of value judgement. Although surreal as well as constructive tendencies were noticeable in the primary colors of his coiled objects, which de-familiarized their surroundings, these minimalist objects (whose theme Bechtold took up in a completely different way only recently) made the transition to concept art, as he had intended. From the object, he shifted his interest to installations, environments, actionist art, video works, the analysis of book and film media, the telephone, the walkie-talkie, and verbal information as well as photography, either as single prints or in series. The strong linguistic character of this art is obvious, insofar as it is employed self-referentially, which means that he examines our relationship to reality, which is expressed through these media. The theme, therefore, is the medium itself, or the perception of reality we gain through the medium.

Peter Weiermair, *Gottfried Bechtold*, Oskar Sandner, ed. (Bregenzer Kunstverein, 1978).

Loys Egg

Loys Egg
born 1947 in Bern. In 1978 founder of Hotel Morphila Orchestra (with P. Weibel). In 1972-1984 lecturer at the Academy of Applied Arts, Vienna. In 1985-94 chief-graphic designer of Vereinigte Bühnen Wien in Vienna. Graphic design for ars electronica, Linz. Lives in Vienna.

1970 Secession, Vienna
Forum Stadtpark, Graz
1975 Galerie Ulysses, Vienna
1973/74/75/78 Galerie nächst St. Stephan, Vienna
1978 Galerie Bloch, Innsbruck
Neue Galerie, Graz
1979 Galerie Curtze, Vienna (with P. Weibel)
1981 Museum moderner Kunst, Vienna
1998 Crossings. Kunst zum Hören und zum Sehen, Kunsthalle and Flex, Vienna

References:
Loys Egg, Peter Weibel, *Lebenssehnsucht und Sucht* (Berlin: Merve 2002).

Loys Egg, *Works 1979/81*
Wood, tar, installation view:
Museum of Modern Art, Vienna 1981

Dominik Steiger

Dominik Steiger
born in 1940 in Vienna. Worked with "Gescheuten Otialen Tagtraumarbeiterpartei" and continual diverse musical works. Lives in Vienna.

1975 Galerie Grünangergasse, Vienna
1988 Rupertinum, Salzburg
1995 Galerie Heike Curtze, Vienna
2000 Galerie Hohenlohe & Kalb, Vienna
2003 Galerie & Edition Marlene Frei, Zurich
2004 galerie kunsthaus mürz, Mürzzuschlag

Group exhibitions
1985 *Alles und noch viel mehr,* Kunsthalle and Kunstmuseum, Bern
1986 ars electronica, Linz
1992 *Identität : Differenz,* Neue Galerie, Graz
1996 *Austria im Rosennetz,* MAK, Vienna
2002 *Figur/Gegenfigur,* Rupertinum, Salzburg
2004 *Wiener Linien,* Museum Karlsplatz, Vienna

References:
Dominik Steiger, *sink um i alle minuti* (Graz: Droschl, 2001).

Dominik Steiger
Knuckle-Drawing, 1973
Pencil, 22 × 30 cm

On My Knuckle-Drawings

The knuckle-drawings were my first pictures in 1972/73. They had followed a dissection phase in my written works, at a stage, where the writing practice pushed against my knuckles.

Then it completely stopped for a while, followed by a mere drawing of many little single sections in lines, which looked like lists. I got away from my knuckle-chains *(Knöchelchen-Ketten)* only through new ideas about the simmering *(köchelnde)* mind.

Dominik Steiger, 1996

Constanze Ruhm

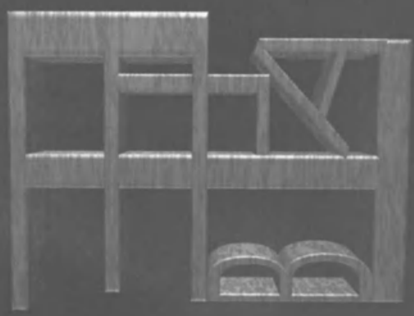
Letters and Constructions

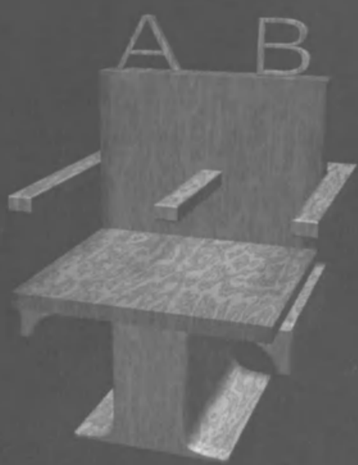
By replacing sculpture with objects on the one hand, and the spatial with significants of space on the other hand, a new relation of language and space, of word and world was created. It was exemplified in the relation of letters and constructions, of words and furniture. Photography, film, video, computer — in comparison with works of art still dealing with realities — have the advantage of demonstrating the actual radicality of this new connection between language and object world: the post-ontological status.

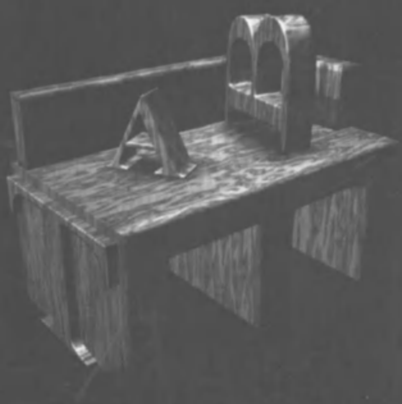
The word "table" can be shown as a three-dimensional table, as an object. But it is also possible to build the five letters T, A, B, L, E into three-dimensional objects. This does not make a functional table, but the five letters can at least display table-like qualities (e.g., as a place to put something), if the dimensions are large enough.
Such automorphisms — self-reproductions between language world and object world — can be continued in group automorphisms. In this case, the word "table" can take on the dimensional form of a chair or a shelf. The non-identity of the object world becomes evident in this separation of form and meaning, of appearance (e.g., shelf) and term (e.g., chair). The visual language related until now to two-dimensional media like paper and photography is expanded into the third dimension. Digital sculpture is following digital poetry, and both force each other to change. In the world of 0 and 1 especially, in electr0n1c p0etry, there is no bivalency (true, false). Instead, intuition wins, the mathematical model of a world of a non-excluded third.

Constanze Ruhm's hypothetical virtual objects also demonstrate a new relation of subject and object, which is appropriately expressed in the ironic title, give the self a shelf.

Peter Weibel, *Medienwerke aus Österreich. 1992-93* (Graz: Neue Galerie am Landesmuseum Joanneum, 1993).







Constanze Ruhm, *give the self a shelf*, 1993
Stills from the computer animation

Installation view, Academy for Applied Arts, Visual Media, Vienna 1993

Constanze Ruhm
born 1965 in Vienna. Academy of Applied Art Vienna (Prof. P. Weibel), 1987-1993. Postgraduate at the Institute for New Media at the Städelschule Frankfurt/Main, 1991-1994. Variuos stays in New York since 1995. Guest professor at the Academy of Design in Offenbach/Main, 1996/97. Vice president of Vienna Secession, 1999-2001. Lives in Vienna.

1990 Galerie Krinzinger, Vienna
1993 Neue Galerie, Graz
1996 *knot.project/N.Y.C.* (with P. Sandbichler)
1998 Galerie Menotti, Baden
2000 Basel Art Fair
2001 Galerie Kerstin Engholm, Vienna
Entwistle Gallery, London
2003 Galerija Remont, Belgrade

Group shows
1988 *Sampling*, Station Rose, Vienna
1991 Videofestival, Arnheim
Design zum Lieben, Museum for Applied Arts, Vienna
1992 *CVC – Computer Video Camera*, Galerie Grita Insam, Vienna
1994 ars electronica, Linz
1995 Venice Biennial
self construction, Museum des 20. Jahrhunderts, Vienna
1997 *Time is Man, Space is a Woman*, Viafarini, Milan
1998 MAK, Los Angeles
2000 *Never Alone Again*, la Panaderia, Mexico City
2001 *Im Buchstabenfeld*, Neue Galerie, Graz
2002 *The New Danube*, Massachusetts MOCA, North Adams, MA
Future Cinema, ZKM, Karlsruhe
2003 *Partly Truth, Partly Fiction*, Medienwerkstatt, Vienna
2004 Berlin Biennial
Virtual Frame by 3, Kunsthalle Wien, Vienna

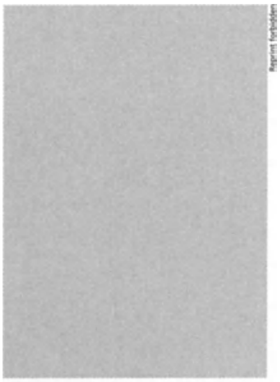
References:
Peter Weibel (ed.), *The Media Pavilion. Art and Architecture in the Age of Cyberspace*, (Vienna/New York: Springer, 1995).
Peter Weibel (ed.), *Im Buchstabenfeld* (Graz: Droschl, 2001).

7

Peter Weibel

Constructed Art History

Invited to do a retrospective of his work by the Museum of Applied Arts in Vienna (MAK), Peter Weibel chose an opposing strategy: a fictional exhibition. He seemed to make his appearance as a curator, who presented six different artists whose works represented typical examples of certain art discourses. In the catalogue, six authors wrote in six typical styles of thought. But it was really six fictitious artists and six fictitious authors whose works and texts all came from Peter Weibel himself. These hybrid works, copies without originals, discourse analysis as art, are meant to show how art and art history are social constructs.



This is not a reproduction of an original

W. The Last Painter

Marcel Rutschke, *Attack*, Berlin, 1971

As the history of art — especially that of the avant-garde — has shown, the dissolution of art into the work (for example the dematerialization of Minimal Art into Conceptual Art) is purely illusionary, as long as it takes place in institutions, like galleries and museums. That is why the institutional dissolution of art is the next step to be taken. In the end, the whole history of art would become a ghostly funeral procession. The challenge lies in presenting contemporary art at the end of the twentieth century as a corpse and, at the same time, reviving it or recalling it to existence by extremely creative, audacious means.

But this aesthetics of absence should also satisfy another challenge: that of obtaining the material used to produce it as far as possible from the very place where the history of art is to be found — the institution, the museum. The objects stored or used in cellars, showrooms, workshops, offices, and archives, etc., would acquire a new meaning by altering their contexts. With the help of museum readymades, works of art would be created that would sabotage the museum itself as an art historical institution. The meaning of functional objects that have been used to represent art history, and the presentation of works of art would be completely redefined by alienating the use of these objects. Cultural readymades serve to offend a symbolic order as it is represented by the core of architectural communication in a museum. All selected artists should work primarily with readymades to thus terminate the historically coded ontology of the work of art. Consequently, all artists would have one thing in common: to destroy — by altering the contextual meaning of cultural tools — the bourgeois ontology of the object, whose absolutization and defense has been the sole purpose of the history of art. The central, albeit somewhat veiled subject of this history-of-art production is the absolutely bourgeois ontology of the object as manifested and consolidated in the history of art. It is the more profound, problematic nature of the ontological status of the work of art that reveals the questions about the original, the reproduction, the readymade, the machine, the real, and the simulation.

Reproduction, readymade, mechanical production, simulation, etc., are elements of a strategy aiming at accelerating the "semiotization" of art, at discharging art from the sphere of tangibility, i.e., placing the ontological category of the possible before that of the necessary, or insisting that the possible is an ontological category. Applying the principle of possibility means to break out of the prison of the real. Totalitarian ideologies consider the realm of necessity to be real, to exist. Anything that is real is therefore necessary.

The way art history is made, presented, and produced is best analyzed and demonstrated on the very spot of history itself by incorporating the site — meaning the museum — where history is made. The set pieces lying scattered about in the museum and the objects of the code of the representative culture form an excellent treasure trove for the representation of this code, as well as for its alienation and deconstruction. Staging history on the spot of history itself is art.

As Heidegger's philosophy clearly shows, art has always moved within the triangle of work, truth, and being. The work relates to the concept of being, as does truth. Heidegger sums up the prerequisites of classical aesthetics, "in the artwork, the truth of being has put itself to work." To Heidegger, truth means the "unhiddenness of being." In this sense, "the essence of art" can be defined as "truth putting itself to work," a claim that Hegel had already called into question. From this basic triad, others, such as work, creator (author), and original can be deduced. Moreover, all of bourgeois society is based on this triad. "The object nature of the artwork" and "the concept of the original" are metaphysical disguises of the bourgeois notion of ownership. For this reason, all attacks on the object status of the artwork, on the myth of the original, all questioning of the concept of the author, as carried out by the most radical forms of anti-art — from Dada to action, media, and concept art — are rightly rejected or marginalized under the guise of ‚repressive tolerance' and excluded from the art market. It is precisely the art market, however, that produces art history in bourgeois society.

The classical ontological triad should be reworked today. Being should be replaced by the sign. The reference to being in the age of media, simulation, and reproducibility must be eliminated.

The dissolution of the ontological status of the works of art can jeopardize the codes of art, and the rules of the firm system of art can be broken. The frozen elements can be defrosted in order to circulate freely. The history of art as a formal development, which has become rigid in its exact definition of styles and epochs, is perforated by being stirred up. Rigid styles dissolve, formal elements contradict each other.

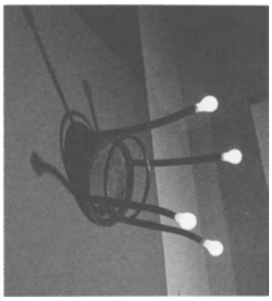
Therefore, different kinds of artistic messages are exhibited in a museum, the most contradictory ideological positions hang peacefully side by side, since the expressiveness of the work disappeared on the way to the museum. Does art get lost on the way to the museum? The true contemporary apocalypse would be Fordism in culture. The marketing of artistic products as a code, the substitution of art through cultural codes, has its point of departure in Fordism. Ford realized:

> *Today's machines, especially those of everyday life, used away from the workshop, absolutely must have exchangeable parts so that they can be repaired by even the most untrained worker.*[1]

1. Henry Ford, *Moving Forward* (1930) p. 128.

The cultural version reads: cultural products consumed away from everyday life, that is, without knowledge and no possibility of control, must be absolutely exchangeable so that they can be consumed by every untrained viewer. The subject of Ford's admonition is the machine built so that its individual parts can be exchanged without the worker having to understand the total context. This is precisely what is happening in the cultural colonialization perpetrated by our present cultural establishment. The consumer becomes able to consume individual cultural products, which are exchangeable clichés coded as culture, without understanding anything about art. Inversely, cultural products are put together out of simple, "exchangeable parts," props. The cultural landscape is strewn with exchangeable props. Exchangeable single parts are simplified by coding. The coding of culture transforms artistic products into exchangeable commodities.

The museum takes care to pass on certain data and certain codes, by selecting only certain works of art. Like any other history, the history of art is thus determined by a particular structure of power that selects only those data, codes, and works it finds convenient. The power structure controls the way these data are passed on. These hierarchies are modified by the casual approach to the historical elements of the history of art.



Otto W. Schimanovich
Chair Lamp, 1988

Louise Langford, *The Social Life of the Logos,* 1988
Exposed fresco, detail, church in New England

Cesare Carlo Capo, *The Wheel of Reality,* Museum of Applied Arts, Vienna, 1988

A new form of narrating and creating history can be introduced only after history is torn to pieces and dispossessed. The relation between word and object, between the symbolic and the real, between the descriptive subject and the described object can no longer be unilaterally dissolved. Narration and power, fiction and fact, the creation and narration of history are mixed into the texture of the real and the reality of the text. Thus, in the same way that societies make history or stories are told, every work of art rewrites the history of art whenever an artist attempts to inscribe himself in it. Anyone who makes art also wants to write the history of art. But which power decides whose name will be inscribed? Which power prescribes and rewrites? Which power makes art and the history of art? Which power says what art is and who makes art? Which power decides what art should tell? Who is Clio, the muse of history? The styles of the history of art are styles of narration, texts, and the discourses of power, which produce a subtext and drive another discourse into the background.

The issue is no longer what art produces or represents, as is reflected in this conflict of contemporary art discourses. Instead, art itself is being questioned. The course or discourse of art. Did the discourse lose its autonomy long ago? Is art itself only the simulation of what art and its functions once were?

True art is always found where it is not an article of merchandise, where it is not expected, where nobody thinks about it or knows its name. In this respect, the withdrawal from art may be the most sophisticated form of art.

Jan van Buygens, *Object-Resistance-Symphony, Four Gradual Shifts*
Kulturhaus, Graz, 1982

Peter Weibel, *Inszenierte Kunstgeschichte* (Vienna: Museum for Applied Arts, 1988) pp. 18-23.

7

Balázs Beöthy, Csaba Nemes, and Roland Pereszlényi

Milieu et l'ego. From Frame to Frame

Balázs Beöthy
born 1965 in Budapest. Lives in Budapest.
Roland Pereszlényi
born 1955 in Budapest. Lives in Budapest.

Co-projects
1989 *123456789+*, Liget Galéria, Budapest
1991 *Dimenzióugrás*, Tűzoltó u. 72, Budapest
1992 documenta IX, Kassel
1993 *The Play of Invisible (Kossuth in Venice)*, Beta SB
1994 *80-as évek*, Ernst Múzeum, Budapest
1995 *Fű alatt*, Bartók 32 Galéria, Budapest

Csaba Nemes
born 1966 in Kisvárda. Studied painting in Budapest. Adopted the pseudonym Veress Zsolt, 1995-1998. Lives in Budapest.

1993/94 Bartók 32 Galéria, Budapest
1997 *Szerződésszegés*, Liget Galéria, Budapest
1998 <rotor>, steirischer herbst, Graz
2004 Knoll Galerie, Vienna

Group shows
1991 *Sub voce*, Műcsarnok, Budapest
1996 Sao Paolo Biennial
1998 *Antológia*, Ludwig Museum, Budapest
1999 Istanbul Biennial
Zeit-Spiel, ifa-Galerie, Berlin
2001 Museum Leverkusen, Schloss Morsbroich
2002 Museum Sammlung Friedrichshof, Zurndorf

References:
Roland Barthes, *From Work to Text. Image Music Text* (London: Fontana Press, 1977).
Craig Owens, "From Work to Frame, or, is there Life after the Death of the Author?" *Power and Culture* (University of California Press, 1992).
Craig Owens, "Beyond Recognition, Representation," *Power and Culture*, see above.
Victor Burgin, *The End of Art Theory, Criticism and Postmodernity* (Humanities Press, 1986).
Arthur C. Danto, "Encounters and Reflections," *Art in the Historical Present* (New York: The Noonday Press, 1986)

A performance by László Beke and János Szirtes in Tűzoltó 72 Gallery; and the exhibition of a project by Balázs Beöthy, Csaba Nemes, and Roland Pereszlényi at the French Institute: two art events in 1993 in Budapest that focused on the institutional system of contemporary art. Those who consider these manifestations intellectual *l'art pour l'art*, methodical meta-text, internal affectation, or, occasionally, as an offensive joke, are wrong. If one tries to answer the questions raised by *Milieu et l'ego* ("How do artists work?" "How do art historians work?"), then it is not enough to understand the historical, aesthetic, and philosophical problems of contemporary art. One has to take sides as well. Beöthy, Nemes, and Pereszlényi stressed its importance 'from the artists' side,' while Beke's text has given answer expressis verbis from the side of the theoretician and the person who exercises power. The result is an obvious truism: artistic practice, as "the site of decisions and freedom" (R. Barthes) is not independent at all. It is closely connected to another site, where the decisions, judgments, and freedom from or /dependence upon the institutional system is found. This connection became highly important in the nineteen-eighties and nineties, from two points of view: a global and a so-called national.

"If we accept Barthes's argument, according to which the artist (author) cannot be considered the only one who determines the meaning and the value of a piece of art any more, then who — or what — is determining?" asks Craig Owens, who finds his answer in the institutional frame of art (following Barthes's example, he also calls it a "frame"). The phenomena of modern art, the readymade, and photography made the already implicitly acknowledged connection explicit: a piece of art is a collective product: the product of the artist and the frame (museum, gallery, art market, theory — history of art, theory of art, aesthetics, criticism — media, foundations, sponsors, and business companies). The artists who produced neutral, anonymous works (Marcel Duchamp, Marcel Broodthaers, Daniel Buren, Hans Haacke), concealing their names, acknowledged the institutional frame and, at the same time, also criticized art.

This knowledge became central in the 1980s. For example, appropriation art and its analytical theory legitimated themselves on the basis of this knowledge. Sherry Levine's case is exemplary. She took photos of well-known images (photos) and exhibited them as if they were her own works. Arthur C. Danto, art philosopher, who seeks the difference between the "original" image and the one "appropriated" by Levine, speaks of the end of art and theory in the traditional sense when he analyzes the frame. "We cannot say too much about the given work, but the frame in which it was born is worth analyzing." "We must realize that the meaning of a work has moved from the picture to the discursive information," writes V. Burgin, "the problem is not to answer the old questions but to recognize the new ones." The new theory of the 1980s simultaneously criticized the frame and supported artistic practice that employed what was known about the frame as a strategy.

In Hungary (as well as in the ex-socialist countries), the history of the institutional system contains such elements, besides the "global" history that makes the frame especially significant and, at the same time, very effective from the point of view of power. (An extreme example is the efficiency of the triumvirate of forbidding-tolerating-supporting.) Conservative and progressive aesthetics; the reception of "modern"; the totalitarian institutions saturated by politics and "style"; the "soft" 1980s and their terminology; the specific, local context and the problems of center and periphery: these issues are all covered by the questions of *Milieu et l'ego*, asked from the standpoint of art historians.

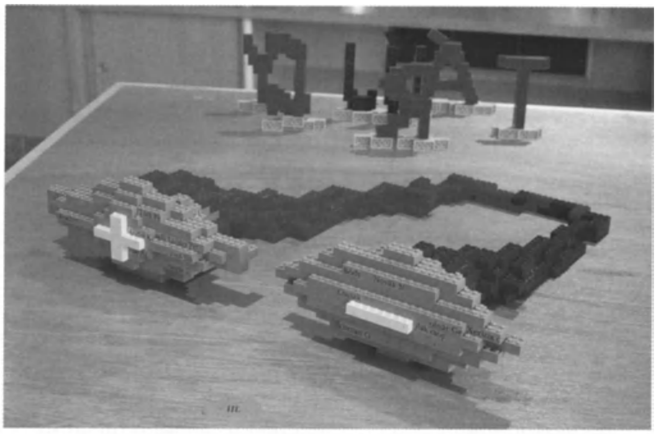
However, they not only refer to the past, since the reform of the inherited institutional system and the elaboration of a new one (in both a hardware and software sense) became possible at the beginning of the 1990s. The behavior of the frame will basically determine contemporary art. To acknowledge this fact, there is an excellent example: the almanac of the Studio of Young Artists in 1995. It is about the financial and self-managing potential of this generation of artists, as well as the strategies of appreciation — or non-appreciation — in the language of statistics. Those who regard this volume as the rhetoric of self-pity and lamentation are mistaken. The survey clearly proves that the essential changes in the artistic institutional system (in a broad sense), which were expected and anticipated at the beginning of the decade, have not yet taken place.

Milieu et l'ego, this complex and intermedial work of art, uses the medium of the "image" as a model (LEGO pieces) and as an illustration (still life with bank notes). The picture sends the viewer directly to the "author:" we might discover the meaning of the work if we start a discourse about the frame and keep this discourse in motion. We really hope that the project will not lose its original impetus, and that it will continue.

János Szoboszlai

Synopsis

1. Questionnaires for investigating the working methods of critics, curators, and art historians.
2. Sending these questionnaires to thirteen prominent art historians working in the field of contemporary art.
3. Building Lego models based on the answers received.
4. Art letter, reference to the Művészeti Sztrájk (art strike), 1990-1993.
5. Exhibition of the questionnaires, art letter, answers, models, a box with apples, a box with Lego pieces, a box with money, two pictures, and a gift, to be shown at the French Institute of Budapest.
6. Interviews with those collaborating on this project.



Dear
On 8 November 1993, our group exhibit will open at the gallery at the French Institute in Budapest. The following questionnaire serves to assist us in putting together the works we shall present here. Therefore, we kindly ask you to answer the following questions:

Q
About which (contemporary Hungarian) artists have you written:
a) a study
b) a critique
c) an opening speech
d) a preface for a catalogue / or about whom have you
e) organized an exhibit?

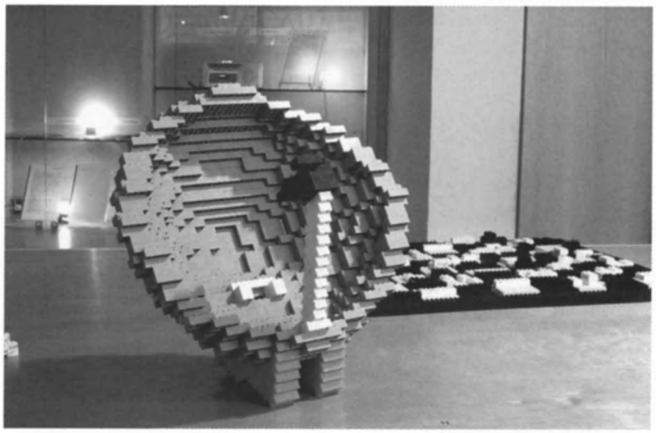
Q
Which trends have you noticed in the above-mentioned artists' work — or independent of their work?

Q
Which of these trends do you regard as significant? (If possible, illustrate these, using names.)

Please be brief and concise in your responses.
Due to the fact that the exhibition's opening is drawing near, we would very much appreciate if you could send us your answers as quickly as possible.

Sincerely,
Balázs Beöthy, Csaba Nemes, and Roland Pereszlényi
1 September 1993

This questionnaire was sent to the following persons:
Gábor Andrási, Jósef Bárdosi, László Beke, Péter György, István Hajdú, Loránd Hegyi, Katalin Keserü, Márta Kovalovszky, Éva Körner, Katalin Néray, Gábor Pataki, Géza Perneczky, Miklós Peternák.



Balázs Beöthy, Csaba Nemes, and Roland Pereszlényi, *Milieu et l'ego*, 1993
top to bottom: Miklós Peternák, Péter György, László Beke
© VBK, Vienna, 2005

7

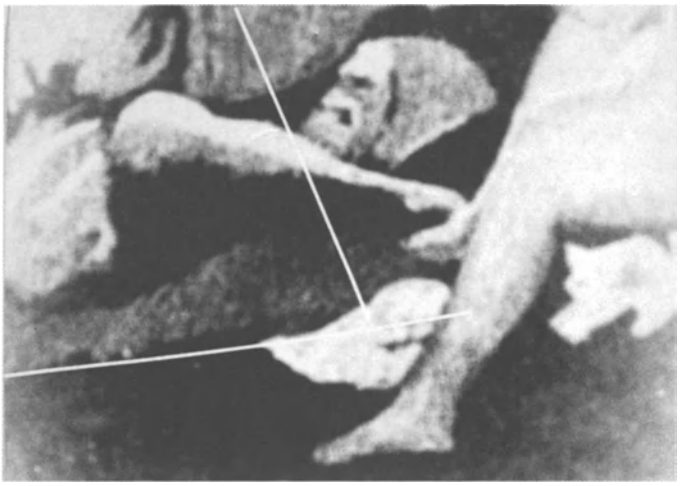
András Halász – ErnőTolvaly – György Jovánovics

György Jovánovics
born 1939 in Budapest. 1958-1960 studied at the Academy of Fine Arts, Budapest; in 1964 Academy of Applied Arts, Vienna; in 1965 Académie des Beaux-Arts, Paris. Since 1991 professor at the Academy of Fine Arts, Budapest. Lives in Budapest.

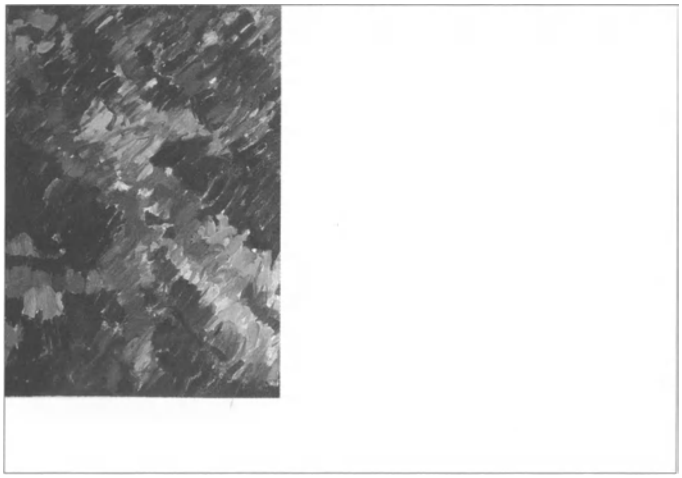
1971 Folkwang Museum, Essen
1980 Institut Français, Budapest
1985 Szent István Király Múzeum, Székesfehérvár
1989 Kiscelli Múzeum, Budapest
1995 Venice Biennial
1996 Fővárosi Képtár Kiscelli Múzeum, Budapest
1999 Goethe-Institut, Budapest
2000 Dovin Galéria, Budapest
2003 Fészek Galéria, Budapest

Group exhibitions
1967 Fiatal Művészek Club, Budapest
1972 Galerie Fóksal, Varsó
1977 *Osteuropäische konzeptuelle Fotografie*, Eindhoven
1980 *Künstler aus Ungarn*, Kunsthalle, Wilhelmshaven
1985 *Contemporary Visual Arts in Hungary*, Third Eye Centre, Glasgow
Drei Generationen ungarischer Künstler, Neue Galerie, Graz
1991 *Hatvanas évek*, Magyar Nemzeti Galéria, Budapest
1994 *A 80-as évek*, Ernst Múzeum, Budapest
1997 *Abstrakt/Real*, Museum moderner Kunst, Vienna
1998 *Sensitivities*, European Academy for the Arts, London
Ungarn. Avantgarde im 20. Jahrhundert, Neue Galerie der Stadt Linz
1999 *Ungarische Kunst der 90er Jahre*, Academie der Künste, Berlin

References:
László Beke, *Jovánovics*, Budapest 1980.



András Halász, *Catastrophe II*, 1977
(Giorgione, *Conzert in the Open*), 49.5 × 59.5 cm



ErnőTolvaly
Trees in Jas de Bouffan. A Cézanne Interpretation, 1978
Oil on canvas, 160 × 120 cm

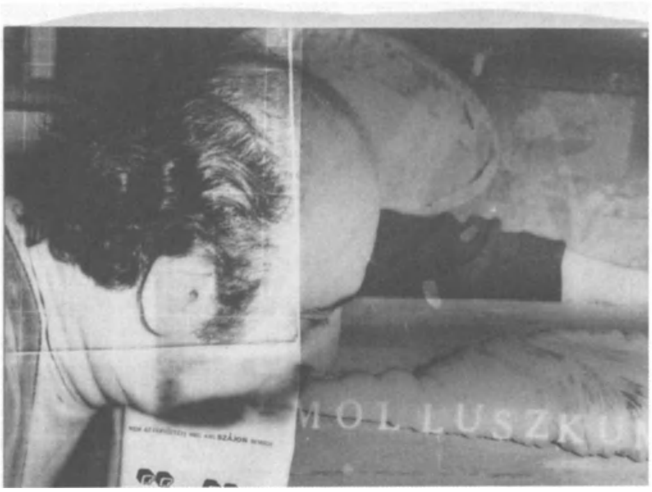
György Jovánovics
The Abduction from the Seraglio, 1986
Plaster cast on wood, 76 × 76 × 14 cm
© VBK, Vienna, 2005

András Halász
born 1946 in Budapest. Studied at the Academy of Fine Arts, Budapest. Co-organizer of the Rózsa Circle. Lives in New York and Budapest.

1978 *Érdek*, Ifjúsági ház, Székesfehévár
1979 *Felkészülés*, Budapest
1980 *Vallás*, Budapest
1995 Ernst Múzeum, Budapest

Ernő Tolvaly
born 1947 in Budapest. In 1973-1976 studied painting at the Academy of Fine Arts, Budapest. Since 1976 professor at the College for Designers in Budapest. Lives in Budapest.

1976 Barcsay-terem, Budapest
1977 *Víztükör*, Művelődési Ház, Budaörs
1978 Nemzetközi Diák Klub, Budapest (with László Herczeg)
1979 *Hová tűnt a menyasszony*, Bercsényi Klub, Budapest
1985 *Víz*, Fészek Klub, Budapest
1990 Óbuda Galéria, Budapest
1992 Budapest Galéria, Budapest
1995 Ernst Múzeum, Budapest
2000 Fészek Galéria, Budapest
Pécs Galéria, Pécs
2002 Dovin Galéria, Budapest
2004 Dovin Galéria, Budapest



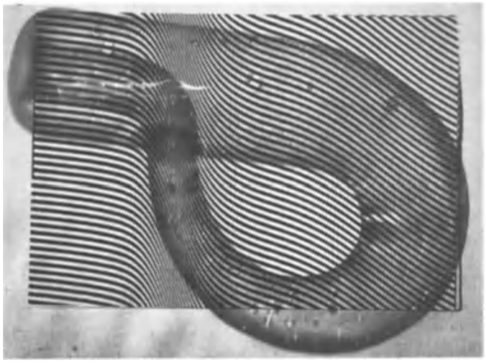
Miklós Erdély
Mollusk, 1967-1669
Photograph, 21 × 29 cm
© VBK, Vienna, 2005

Miklós Erdély
Three Quarks for King Marke, 1968
Performance, Iparterv Center, Budapest
© VBK, Vienna, 2005

Miklós Erdély
born 1928 in Budapest. 1946-1947 Academy of Fine Arts, Budapest. 1947-1951 Technical University, Budapest. Conceptual artist, filmmaker. Died in 1986 in Budapest.

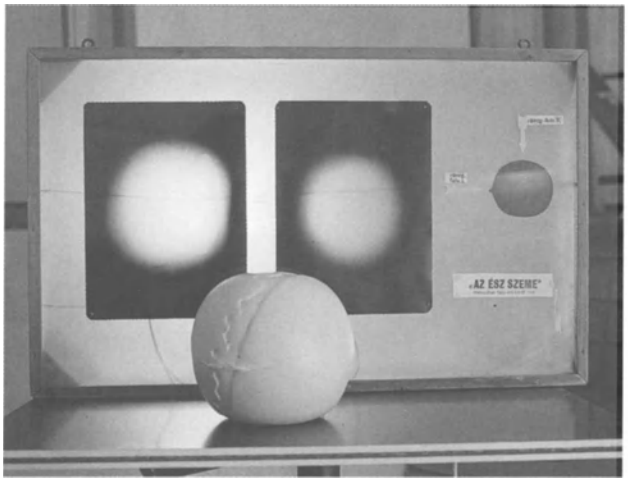
Exhibitions and actions
1966 *Golden Sunday,* (Action with A. Gábor), Budapest
1972 *C.E.T.I.* (Action), Ganz Mavag, Budapest
1980 Óbuda Galéria, Budapest
1984 *1984 – Orwell und die Gegenwart,* Museum des 20. Jahrhunderts, Vienna
Democratic Painting (Action), Kossuth Klub, Budapest
1985 *Drei Generationen ungarischer Künstler,* Neue Galerie, Graz
1986 *Eklektika 85,* Hungarian National Gallery, Budapest
Óbuda Galéria, Budapest
1987/1988 *Expressiv,* Museum des 20. Jahrhunderts, Vienna; Hirschhorn Museum and Sculpture Garden

References:
Miklós Peternák (ed.), *Miklós Erdély. Művészeti írasók* (Budapest: Képzőművészeti Kiadó, 1991).



Miklós Erdély, *Klein's Bottle,* 1975-76
Photo: readymade, glass, 17 × 10 cm, broken
© VBK, Vienna, 2005

Miklós Erdély, *New Yin-Yang-Symbols,* 1976
Graphic, c. 29.5 × 42 cm
© VBK, Vienna, 2005



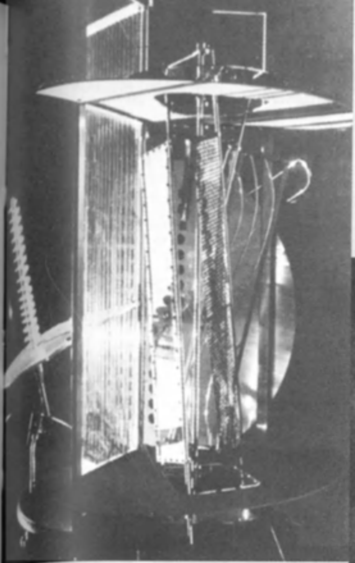
Miklós Erdély, *The Eye of Reason,* 1973
Plaster, X-ray
© VBK, Vienna, 2005

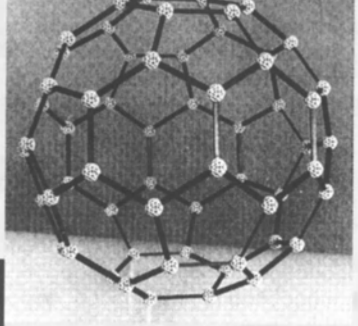
Miklós Erdély, *Kriegsgeheimnis,* 1984
Environment, mixed media, installation view Museum moderner Kunst, Vienna
© VBK, Vienna, 2005

psychoanalysis actionism

The close connection between Austria and Hungary once again becomes visible in the development of psychoanalysis. The dialogue between Sigmund Freud and Sándor Ferenczi is one of the most significant within the psychoanalytic school. A very important conference of the psychoanalytical movement therefore took place in 1918 in Budapest (Ferenc Erős). In general, psychoanalysis owed Hungary a great deal, intellectually as well as institutionally, before it found further support in France, England, and in America, particularly after the emigrations of the 1930s. The Hungarian psychoanalysts who had emigrated were just as many and as influential as their Austrian colleagues. Otto Fenichel's letters, written between 1934 and 1945 to German and Hungarian colleagues, give precise information about the internationalization of the movement (Johannes Reichmayr and Elke Mühlleitner). Biographical sketches (Peter Weibel) of various personalities from the Austrian and Hungarian psychoanalytic scenes show the amazing diversity of the psychoanalytical schools, from individual psychology through the psychology of the self to ego psychology; the intensive mental and human network; and the dynamic (as well as occasionally dramatic and tragic) biographies of those involved in the founding phase of psychoanalysis (Otto Gross, Viktor Tausk, Bruno Bettelheim, Hermine Hug-Hellmuth, Jakob Levy Moreno, Wilhelm Reich, Wilhelm Stekel, Lipót Szondi, and Fritz Wittels). The biographies go beyond the narrower psychoanalytical circle and also deal with experimental psychoanalysts, ethno psychoanalysts, etc.

Psychoanalysis had a worldwide, revolutionary influence on philosophy, literature, cultural theory, and art (such as Surrealism). In Hungarian art, the influence of psychoanalysis is particularly noticeable in the area of media art (Péter Forgács), but also in performance and action art (Tibor Hajas). It is almost superfluous to mention the fundamental influence of psychoanalysis on the founding and development of the Vienna Actionism ("Wiener Aktionismus," a term Peter Weibel created in 1969), where individual psychoanalytic schools — such as Wilhelm Reich's — and theoretical positions — such as the Oedipus complex — played a special role. Hermann Nitsch and Otto Muehl increasingly call on psychoanalytical concepts; Otto Muehl even developed his "action-analysis" as a special form of group therapy in the framework of a commune, where there was experimentation with new forms of cohabitation, from sexuality to economy. Another new art form, known as Body Art, arose because painting, under the influence of psychoanalysis, was urged on by body analysis. This new art form was given a feminist revision by Valie Export and other artists. Vienna Actionism as a whole contributed greatly to broadening our ideas of art and reality.





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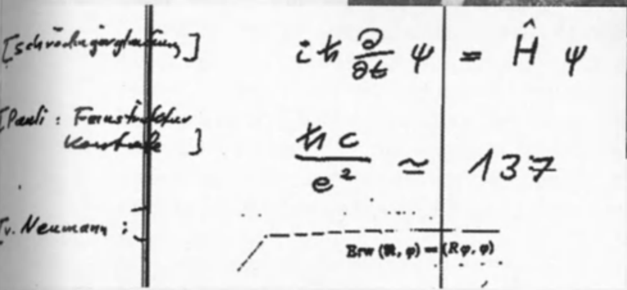
[Schrödingergleichung]
$i\hbar\frac{\partial}{\partial t}\psi = \hat{H}\psi$
[Pauli: Feinstrukturkonstante]
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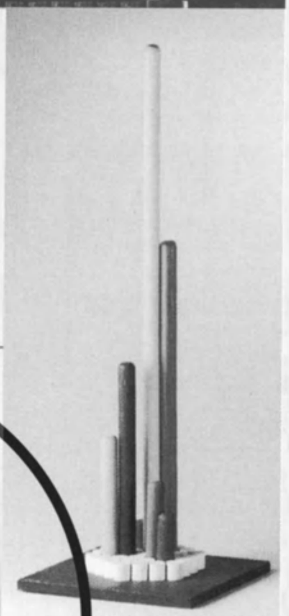
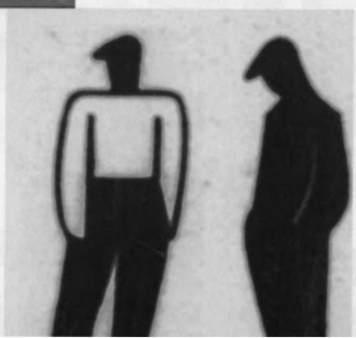
[v. Neumann:]
$\mathrm{Erw}(R,\psi) = (R\varphi,\varphi)$





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psychoanalysis
actionism

8

Ferenc Erős

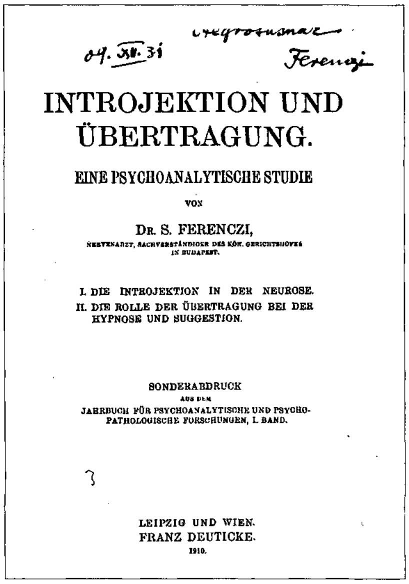
On the History of Hungarian Psychoanalysis

Ferenc Erős, born 1946 in Zalaegerszeg. Earned a graduate degree in psychology at the University of Budapest, 1969. Employed since 1973 at the Psychological Institute of the Hungarian Academy of Sciences. Postgraduate degree from the University of Budapest, 1996. He has taught at the universities of Budapest, Pécs, and Szeged. Professor at the Institute for Psychology at the Hungarian Academy of Sciences in Budapest. Numerous publications on issues of identity and resentment in his field of specialization, social psychology. Editor of *Thalassa* magazine; member of the editorial staff of *BUKSZ* (Budapest review of books) magazine.

An abundance of literature is available in Hungarian, as well as in German, English, and French, on the history, the most important stages of development, and the most significant personalities of Hungarian psychoanalysis. The key figure of this story is Sándor Ferenczi — considered the founder of the psychoanalytic movement in Hungary — whose personality and activities are nowadays being rediscovered all over the world. Ferenczi (1873-1933) was born in Miskolc, attended the School of Medicine of the University of Vienna, and from the last years of the nineteenth century, worked as a neurologist in Budapest. Although he had read some of Freud's writings during his university years, his interest only turned toward psychoanalysis around 1907. At the beginning of 1908 he became personally acquainted with Freud and soon became a devoted follower, colleague, and friend of the great master. In the next year, 1909, Ferenczi and Carl Jung accompanied Freud on his journey to America. The most important documentation of their relationship is their correspondence; two of the three collected volumes have been published so far. Ferenczi and Freud, these two great figures of psychoanalysis, exchanged more than twelve hundred letters in the period between 1908 and 1933. In 1933, shortly before the death of Ferenczi, Freud described their relationship as an "innige Lebens-, Gefühls- und Interessengemeinschaft," or an intimate community of life, feelings, and interests.

In 1913 Ferenczi founded the Hungarian Association of Psychoanalysis at a café. Founding members of the association were Sándor Radó, István Hollós, and Lajos Lévi — all analysts — as well as Ignotus, a renowned literary critic, the editor-in-chief of *Nyugat*, a periodical; and Antal Freund (Anton von Freund) of Tószeg, a wealthy beer manufacturer, one of the patrons of the Hungarian psychoanalytic movement.

In the first phase of his psychoanalytic career, until the outbreak of World War I, Ferenczi mainly published articles examining the adaptability of psychoanalysis to social problems (e.g., on psychoanalysis and pedagogy, or on psychoanalysis and its legal and social significance).



Ferenczi

INTROJEKTION UND ÜBERTRAGUNG.

EINE PSYCHOANALYTISCHE STUDIE

VON

DR. S. FERENCZI,

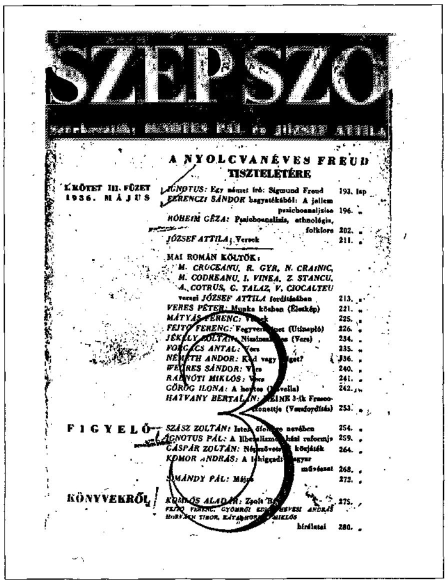
NERVENARZT, SACHVERSTÄNDIGER DES KÖN. GERICHTSHOFES IN BUDAPEST.

I. DIE INTROJEKTION IN DER NEUROSE.

II. DIE ROLLE DER ÜBERTRAGUNG BEI DER HYPNOSE UND SUGGESTION.

SONDERABDRUCK AUS DEM JAHRBUCH FÜR PSYCHOANALYTISCHE UND PSYCHOPATHOLOGISCHE FORSCHUNGEN, I. BAND.

LEIPZIG UND WIEN.
FRANZ DEUTICKE.
1910.



SZÉP SZÓ

A NYOLCVANÉVES FREUD TISZTELETÉRE

I. KÖTET III. FÜZET
1936. MÁJUS

IGNOTUS: Egy német író: Sigmund Freud 193. lap

FERENCZI SÁNDOR hagyatékából: A jellem psichoanalízise 196.

RÓHEIM GÉZA: Psichoanalízis, ethnológia, folklore 202.

JÓZSEF ATTILA: Versek 211.

MAI ROMÁN KÖLTŐK: M. CRUCEANU, R. GYR, N. CRAINIC, M. CODREANU, I. VINEA, Z. STANCU, A. COTRUS, G. TALAZ, V. CIOCALTEU versei JÓZSEF ATTILA fordításában 213.

VERES PÉTER: Munka közben (Életkép) 221.

FIGYELŐ

KÖNYVEKRŐL

Issue of the Hungarian literary magazine *Szépszó* (Good word), celebrating Sigmund Freud's eightieth birthday

During World War I, Ferenczi served as a military surgeon: first, as a member of the hussars in Pápa, where, as he wrote to Freud, he analyzed his commanding officer as he sat on his horse. Later he worked in the Neurology Department of the Mária Valéria Military Hospital in Budapest. As a military surgeon, he dealt mostly with psychic diseases occurring as a consequence of the war and endeavored to take a psychoanalytic approach to these types of traumas. The "war neurosis" and the problems of shocking traumas affecting the masses in general were the themes of the international psychoanalytic congress in 1918 in Budapest, which Freud attended. The congress elected Ferenczi as the chairman of the International Psychoanalytic Movement.

Freud expected great things from Ferenczi and his activity in the psychoanalytic movement. He wrote in 1914, "Hungary, which is so close to Austria in a geographical sense, but is so distant where science is concerned, has given only one colleague, Ferenczi, to psychoanalysis, but he alone equals a whole association." In the autumn of 1918, Freud considered making Budapest the center of the international psychoanalytic movement. This opportunity was based on Ferenczi's increasing popularity and the public appreciation of him; in the autumn of 1918 he was nominated for a university professorship of the newly founded psychoanalytic clinic of Budapest University, and the appointment was approved in the spring of 1919. The clinic was situated in the building of the Batizfalvy Sanatorium (Dózsa György Street 82/b, now a senior citizens' home). During the days of the bourgeois-democratic revolution in the autumn of 1918, a group of radical students initiated the introduction of psychoanalysis as a university subject and the invitation of Ferenczi to Budapest University, but Ferenczi was first appointed during the Hungarian Soviet Republic in 1919. The university's psychoanalytic clinic, which only existed for a couple of months, was the first such institution in the world, and Ferenczi was the first in the history of psychoanalysis to be appointed a university professor of psychoanalysis. The fall of the Hungarian Soviet Republic, followed by a counter-revolution and a wave of terrorism, abruptly cut short the dreams of Budapest becoming the new capitol of psychoanalysis. After August 1919, Ferenczi was dismissed from the university, the psychoanalytic clinic was closed down, and the ex-professor was excluded from the Budapest Medical Association due to his role in the revolutions.

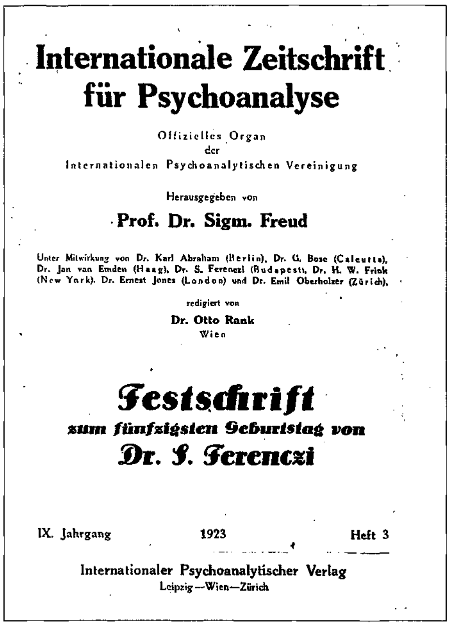
However, the university fiasco and the political repression did not mean the end of Ferenczi's career. Just the contrary: Ferenczi began a new period of therapeutic and theoretical activity after 1919. As his correspondence with Freud suggests, during the war Ferenczi already planned to reinterpret the theory of psychoanalysis from the standpoint of biological cognition. This is the topic of his most important book, *Thalassa: a Theory of Genitality*, first published in 1925. According to Ferenczi's bio-analytical theory, human sexuality is driven by the desire to return to the state of rest we experienced before birth. The desire for "thalassal regression" originates in the phylogenetic catastrophe that occurred as oceans dried up, which forced living creatures to adapt to life on firm ground. The same catastrophe is repeated in ontogenesis: the trauma of birth is nothing less than the replay of the natural catastrophe.

Apart from theoretical work, Ferenczi dealt a great deal with the technique and methodology of analytic therapy from the 1920s on. In his writings on methodology he recommends a more active and emphatic relationship between therapist and patient; at the end of his life he did experiments with a method he named "active therapy," which provided an opportunity to exchange roles, so that the patient could "analyze" the analyst.

Ferenczi strongly emphasized the significance of early mother-infant relationship and interaction, and, contradicting Freud, he taught that a baby is not a "primarily narcissistic" creature, but actively influences the environment from the first moment of his life. According to Ferenczi, the analyst, in certain cases, has to provide a substitute for the motherly love the patient misses. These considerations and technical experiments regarding the role and relationship of the therapist toward the patient had provoked criticism and repugnance from Freud, which led to the estrangement of the two.

This "debate of technique," which later became decisive in the development of psychoanalysis, can be followed in the Ferenczi-Freud correspondence, as well as in Ferenczi's *Klinikai Napló* (Clinical Diary) of 1932, the publication of which caused a real sensation in the history of psychoanalysis some years ago. The diary contains Ferenczi's most personal thoughts about Freud and the limits of his therapeutic attitude, Ferenczi's

***The Clinical Diary*, German reprint: (Frankfurt/Main: S. Fischer, 1988.**



Internationale Zeitschrift für Psychoanalyse

Offizielles Organ der Internationalen Psychoanalytischen Vereinigung

Herausgegeben von

Prof. Dr. Sigm. Freud

Unter Mitwirkung von Dr. Karl Abraham (Berlin), Dr. G. Bose (Calcutta), Dr. Jan van Emden (Haag), Dr. S. Ferenczi (Budapest), Dr. H. W. Frink (New York), Dr. Ernest Jones (London) und Dr. Emil Oberholzer (Zürich),

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Dr. Otto Rank
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Festschrift
zum fünfzigsten Geburtstag von
Dr. S. Ferenczi

IX. Jahrgang 1923 Heft 3

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interpretation of trauma, and his "active technique," the essence of which is a sympathetic, loving attitude toward the patient, opposing the neutral, reserved, therapeutic behavior prescribed by Freud. The diary contains details of those "mutual analyses" between Ferenczi and an American patient living in Budapest. The pseudonym of R. N. disguises Elisabeth Severn.

Ferenczi died of pernicious anemia in May 1933. Some people reported that he suffered from mental disorder before his death, and there were suspicions that his relationship with Freud became cool due to the progressively worsening state of his illness. Freud's "official" biographer, Ernest Jones, maintained the same opinion in his Freud biography, which consists of several volumes and was published in English in the 1950s. It took decades before Ferenczi received his due place in the history of psychoanalysis. One of his pupils, Mihály Bálint, who emigrated to Great Britain, played a key role in his rehabilitation — as did the great thinker, Erich Fromm, who moved from Germany to America.

The Ferenczi renaissance we are currently experiencing worldwide is mainly due to the publication of the Ferenczi-Freud correspondence and the *Clinical Diary*. Ferenczi's seventy-year-old ideas on therapy and theory, as well as his therapy and technical suggestions, can be considered to some extent the predecessors of those modern efforts to renew the psychoanalytic profession, to reinterpret the therapist-patient relationship, and to consider the social context of psychoanalysis. Ferenczi's œuvre is very important for modern developments and debates in psychoanalysis. At the same time, the publication of the Ferenczi-Freud correspondence drew attention to Freud's œuvre as well — new aspects of which can be continually discovered in the wavering of their intense relationship, which lasted for about two-and-a-half decades.

The Ferenczi renaissance has also raised interest in the context in which his œuvre was born, as well as in his colleagues, who also played important roles in the development of both Hungarian and international psychoanalysis.

Regarding the context, the history of Hungarian psychoanalysis is a basic cultural historical heritage. This heritage is closely connected to the Austro-Hungarian Monarchy at the turn of the century, which was a large-scale "laboratory," the source of modernity in philosophy, literature, fine arts, and — thanks to Freud — in psychology. Ferenczi and the Hungarian psychoanalytic movement represent another branch, characterized by the special Hungarian context. Above all, we must mention the historical fact that the developing psychoanalytic movement was closely connected with various progressive movements in Hungary: liberalism, bourgeois radicalism, Marxism, and socialist movements. Ferenczi is also a key figure from this point of view, since we know that he was in close contact with the circle of the most progressive literary periodical, the *Nyugat*. Psychoanalysis strongly influenced the writers of the *Nyugat*, as the writings by Géza Csáth, Dezső Kosztolányi, Frigyes Karinthy, and Mihály Babits prove. Apart from the *Nyugat* (which published several articles by Ferenczi, as well as by Freud), the social scientific periodicals of the bourgeois radicalism, the *Huszadik Század* and the *Szabadgondolat*, also gave space to psychoanalysis. Ferenczi himself was a patron member of the Galilei Circle, a forum of young radical intellectuals that proved to be open for Freud's ideas, especially thanks to its members who were medical students. In the theoretical orientation and the Hungarian reception of psychoanalysis, the Vasárnapi kör (Sunday Circle) also played a part. It counted philosophers György Lukács and Mihály Polányi, poet Béla Balázs, sociologist Károly Mannheim, and other famous intellectuals among its members.

The connection between psychoanalysis and literary and political progression was vital in the 1920s and also 1930s. The most remarkable chapter is represented by the œuvre of Attila József, the most significant poet of the era, who committed suicide in 1937 at the age of 32. Attila József's poetry was strongly influenced by psychoanalysis. In his theoretical writings, he attempted to synthesize Freud and Marx, parallel with Wilhelm Reich, who lived in Vienna at the time and later in Berlin. Attila József's analytic diary, *Szabad-ötletek jegyzéke* (List of free ideas), recorded during his psychoanalytic treatment, is both a psychoanalytic and a literary historical rarity at the same time.

This short summary does not allow detailed introduction of Ferenczi's colleagues. However, Hungarian psychoanalysis has several other personalities who became known throughout the world.

Géza Róheim (1891-1953) was both an ethnographer and psychoanalyst who, beside Bronislaw Malinowski, was among the founders of psychoanalytic anthropology or ethno psychoanalysis. Between 1928 and 1931, he made an ethnographic journey to Australia and Melanesia. The ethnographic material collected on this journey (tales, dreams, sexual customs of the aboriginals, characteristics of family life) as well as his psychoanalytic interpretation of the folklore of the Hungarians and other Eastern European peoples became the starting point of the theory that Róheim, following Freud, used in his explanation of the origin and nature of culture. At the end of the 1930s, threatened by fascism, Róheim immigrated to the United States; his most important theoretical works have already been published in English.

Sigmund Freud, born 1856 in Freiberg (Pribor), Moravia. In 1860, Freud's family moved to Vienna. Studies of medicine, zoology, and philosophy (with Brentano) at the university of Vienna. Graduated in 1881. Worked in Vienna General Hospital, 1882-1885. Studies under Jean-Martin Charcot at the Salpêtrière, Paris. In 1886 he set up a private practice. Marriage with Martha Bernays. First use of the term "psychoanalysis" in 1896. In 1900 his book *The Interpretation of Dreams* is published, introducing the fundamental principles of psychoanalysis, thus starting a new era of scientific treatment and investigation of the psyche and the unconscious. Foundation of the "International Psychoanalytical Movement" with C.G. Jung as first president, 1910. In 1933 the correspondance between Albert Einstein and Freud in the years 1931-32 was published under the title *Why War?* In 1933 Freud's books were publicly burned by the Nazis in Berlin. In 1936 honoured by the Royal Society in Britain who made him a Corresponding Fellow on occasion of his 80th anniversary. In 1938 Freud and his family managed to get exit visas to flee from the National Socialist's occupation of Austria. Emigrated to London, setting up there a new practice. Died in 1939 in London from cancer.

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S. Freud, *Civilization and Its Discontents* (1930, reprint: W.W. Norton & Company, 1989)

Sándor Ferenczi, born 1873 in Miskolc. Received his M.D. in Vienna, 1894. Worked at the Elizabeth poorhouse in Budapest as chief neurologist. Appointed to the Royal Court of Justice as an expert psychiatrist. First encounter with Freud in 1908. Exchange of many letters between 1908 and 1933 on various themes, ranging from psychoanalytic theories to sociology, culture and history; published as *The Correspondence between Sigmund Freud and Sándor Ferenczi*. In 1919 he became the first full professor of psychoanalysis in history at the university of Budapest. Great influence on many subsequent psychotherapists, especially with his special technique of analytical therapy. Died in 1933 in Budapest.

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A.W. Rochmann, *Sandor Ferenczi: The Psychoanalyst of Tenderness and Passion* (Jason Aronson, 1996).

The œuvre of Mihály Bálint (1896-1970) also became familiar to the immigrants. Bálint, one of Ferenczi's pupils, had already played an important part in Hungary: in the 1930s, he headed the medical office and training institute of the Psychoanalytic Association at Mészáros Street 12 in Budapest. He and his wife, Alice Bálint, also immigrated to the United States, escaping from fascism. Bálint mediated Ferenczi's theories to the international scientific scene, and, along with Melanie Klein, he strongly influenced the "object-connection" attitude of psychoanalysis, which first developed in Great Britain. Today, Bálint's name is mostly known for the so-called Bálint groups, a type of psychoanalytic and psychotherapeutic training for doctors, which he initiated and introduced.

Lipót Szondi (1893-1986) did not belong to the psychoanalytic movement in the narrow sense, but became internationally renowned by linking Freud's ideas with his own theory referring to the genetic determination of instincts. He elaborated the theory and therapy of the so-called fate-analysis, as well as the Szondi test, which is in use to this day in everyday psychoanalytic practice. Szondi was deported by the Germans to Bergen-Belsen in 1944, but fortunately he managed to escape to Switzerland; until the end of his life, he worked in the institute of fate-analysis therapy in Zurich, which he founded.

Among those analysts who remained in Hungary but became internationally famous, we must mention István Hollós (1872-1957) and Imre Hermann (1889-1984). István Hollós was primarily a psychiatrist; he had a pioneering role in the understanding and elaboration of psychoanalytic therapy of mental diseases. His most important work, *Búcsúm a sárga háztól cimű* (Behind the yellow wall), a book inspired by his own life, was published in 1927; in it, he urges a radical change in the traditional attitude toward mentally ill people, anticipating some central issues of the modern "anti-psychiatric" way of thinking.

The activity of Imre Hermann, who was still working at the beginning of the 1980s, was important in keeping the psychoanalytic movement alive after World War II. It was he who elaborated the concept of the "clinging instinct." His theoretical works cover biological and ethnological approaches, the continuity of psychoanalysis, and the analysis of the structure of logic thinking. His main work is *Az antiszemitizmus lélektana* (Psychology of anti-Semitism), published in 1945, in which he applied psychoanalytic theories in order to analyze the complex roots and manifestations of anti-Semitism.

Hungarian psychoanalysis had many other important personalities, in Hungary as well as abroad (mainly in Germany, Great Britain, America, France, Sweden, and Switzerland). Right-wing and fascist political systems forced Hungarian psychoanalysts to leave their homeland. Many of those who remained fell victim to the Holocaust. After World War II, apart from a short period between 1945-1947, it was forbidden to deal with psychoanalysis openly in Hungary; the movement was eliminated and Freud's followers were expelled from Hungarian public life. Nevertheless, Hungarian psychoanalysis preserved its continuity, and the movement, reorganized from the 1970s, gained full legitimization at the end of the 1980s.

The paths taken by the lives of Hungarian psychoanalysts actually represent personalized history. The historical path of Hungarian psychoanalysis, as well as the fate of its practitioners seem like a parable: Hungarian fate, Jewish fate, and Eastern and Central European fate apparently cannot be separated. The Freud-Ferenczi correspondence is an inexhaustible source of documentation of this.

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Johannes Reichmayr and Elke Mühlleitner

"The Internationality of the Unconscious" – Otto Fenichel's Circulars 1934-1945

Otto Fenichel (1897-1946), who was influenced by the Cultural Youth Movement centered around Siegfried Bernfeld, as well as by Sigmund Freud's lectures at the University of Vienna, came to psychoanalysis toward the end of World War I. He finished his medical studies and began his personal analysis in Vienna. In 1922 he moved to Berlin and began teaching at the city's Psychoanalytic Institute. In fall 1933 Fenichel fled to Oslo, and from 1935 until 1938 he was the head of the Prague Psychoanalytic Study Group. In the summer of 1938, Fenichel immigrated to Los Angeles. As the author of *The Psychoanalytic Theory of Neurosis*, published in 1945, he was described as the "encyclopedist of psychoanalysis," but this reputation had been conferred upon him even earlier, in the 1930s, while he was still living in Europe. Fenichel was the protagonist of a group of Marxist psychoanalysts who were conscious of the cultural and scientific importance of psychoanalysis, and who were trying to preserve, develop, and apply Freud's findings in the way they supposed to be best. Fenichel's secret circulars, written for and distributed almost monthly to a small circle of colleagues from 1934 until 1945, are a part of that project. The 119 circulars, which make up more than two thousand manuscript pages, can be described as the most important historical source for the history of the psychoanalytic movement so far.[1] Apart from that, these letters cover an important time. Between 1933 and 1945, psychoanalysis was expelled from its European centers. Psychoanalysis was successfully established in America during this period, but it also changed theoretically and organizationally. These fundamental changes and developments are still not fully understood even today.

The circulars' recipients were analysts who had been colleagues at the Berlin Psychoanalytic Institute and who knew each other from the so-called "Kinderseminar" (Children's seminar). Otto Fenichel had initiated this group as a forum for discussions for younger analysts in 1924. However, from 1932 onward, a few of these analysts met informally to discuss psychoanalytical and Marxist questions. From this smaller group, the inner circle of the circular recipients was formed. With the exception of Edith Jacobson, they all emigrated in 1933. From spring 1934 on, when the first circular was distributed, between six and nine people were members of this inner circle.[2]

From various viewpoints, "Budapest" was a topic of the circulars. Three recipients, Edith Gyömrői (1896-1937), Barbara Lantos (1894-1962), and Georg Gerő (1901-1993) were Hungarians. Gyömrői had moved from Berlin to Budapest in 1933. She reported to the circular on the psychoanalytic movement in Hungary, based on her own observation and experiences.

From 1934 until 1938, Fenichel included nineteen such reports about Budapest (compared to twenty-four reports on psychoanalysis in National Socialist Germany, for example). In these politically interesting reports on psychoanalysis in Hungary, which included, among other things, critiques on how psychoanalytic training was conducted at the Budapest Psychoanalytic Institute. There were also discussions about the theoretical developments of clinical and applied psychoanalysis. The concepts of Imre Hermann and Michael Bálint, for example, fueled the critique and stimulated discussion. One of the main interests of Fenichel's group was the application of psychoanalysis to the social sciences. The works of Hungarian anthropologists and psychoanalysts Géza Róheim (1891-1953) and Alice Bálint (1898-1939) were also criticized here. Discussions with Roheim and Bálint, as they were published in the circulars, were special for Budapest, and, at the same time, are rare documents of the psychoanalytic movement in general.

The Hungarian Jewish analysts had to deal with restrictive quota controls in the United States, and for them the "internationality of the unconscious" meant the longest and most complicated paths of immigration: Gyömrői fled to Colombo, Ceylon, before she could move to England after World War II; Gerő emigrated via Siberia to the United States; and Josef A. Storfer (1888-1944), the former director of the *International Psychoanalytic Press* in Vienna, was forced to emigrate to Shanghai before finally landing in Australia.

In the following text, we mainly offer quotes from the circulars — in particular, passages touching the topic of Budapest, which shed light on the state of psychoanalysis in Hungary between 1934 and 1940. These paragraphs are, at the same time, characteristic of the nature and variety of the historical material presented in the circulars.[3]

In his first circular of March 1934, Fenichel presented a general survey of the international psychoanalytic movement. About Hungary, he reported:

> *The Hungarian group has always been held together and represented by Ferenczi. Ferenczi's last works, in which he seemed to completely fall back from psychoanalysis to catharsis, caused some concerns; but still, no doubt remained that his was the greatest mind of the group by far. After his death, one feared that the whole group would decay, especially due to its neglect of scientific inquiry, for now men like Roheim and Hermann cannot be held back. We are familiar with Roheim's attempt to become acquainted with their culture by analyzing primitives. Hermann's gross analytical mistakes were excused by arguing that he at least understands*

Otto Fenichel, born 1897 in Vienna. Received his medical degree in Vienna, his psychoanalytical training in Vienna (Paul Federn) and Berlin (Sándor Radó); in 1924, he was appointed training analyst of the German Psychoanalytic Society, and in the same year, he founded the so-called "Kinderseminar" for younger colleagues in Berlin. In 1933, he emigrated to Oslo and became a member of the Dansk-Norsk Psychoanalytisk Foreningen; 1935-1938 he was the head of the Prague Psychoanalytic Study Group. In 1938 Fenichel fled to Los Angeles. He became a member of the Los Angeles Psychoanalytic Study Group, and in 1944 Vice-President of the San Francisco Psychoanalytic Society. In the U.S.A., he was one of the editors of *The Psychoanalytic Quarterly*, and his major work, *The Psychoanalytic Theory of Neurosis*, was published in 1945. He died in 1946.

1. Otto Fenichel, *119 Rundbriefe (1934-1945) vol. I, Europa 1934-1938*, Johannes Reichmayr, Elke Mühlleitner, eds.; vol. II, Amerika 1938-1945, Johannes Reichmayr, Elke Mühlleitner, eds. (Frankfurt/Main, Basel: Stroemfeld Verlag, 1997).
2. Otto Fenichel, Georg Gerő, Samuel Goldschein (as of 1935), Edith Gyömrői, Nic Hoel (until the beginning of 1935), Edith Jacobson, Barbara Lantos, Käthe Misch, Annie Reich, Wilhelm Reich (until the end of 1934).
3. Preprint from: *Otto Fenichel, 119 Rundbriefe (1934-1945)*, Johannes Reichmayr, Elke Mühlleitner (eds.), with the friendly permission of Stroemfeld Verlag, Frankfurt am Main/Basel (translation by the authors)

Otto Fenichel
The caricature is taken from *Psychoanalytiker in der Karikatur,* ed. by Helmut E.Lück and Elke Mühlleitner, Munich 1993.

something of psychology; and psychologists excused his mistakes by saying that he at least understands something of psychoanalysis. Among the younger generations of Hungarians, I noticed Hann-Kende, who denies the existence of penis envy. Some opinions about today's circumstances in Budapest:
Hermann seems to be completely impossible — not to mention Róheim. Bálint won much fame after Ferenczi's death and forces everybody to pay attention to his biological hobbyhorse. The coming generation is deplorable and plays the same tune...In the theoretical seminar, Ferenczi's genital theory is discussed ... Bálint casually commented that ever since the introduction of birth control methods, the symbolic return to the mother's body during the sexual act would be impossible, and, in more progressive circles — like the communist youth, for example — love is becoming old-fashioned. Against the argument that this could have other, probably social reasons, since the use of birth control is very limited in just these circles for economic reasons, the response was general indignation. Birth control methods were so cheap, everybody could afford them.
The prevailing scientific level is so low here that the Berlin seminars for beginners seem like highly qualified study groups in comparison ... cliques dominate, after Ferenczi's death the fights for the chair began ... Hollos is personally admired by some younger people, but, in general, not estimated highly at all; he is supposed to be superficial ... He considers Federn to be a genius, which is suspicious, at the least.

(Circular 1, Point 6, 1934)

The circulars were a forum for discussing issues of clinical and applied psychoanalysis. Gerö, living and practicing in Copenhagen, introduced one of these questions.

You write that you are preparing a study on national sentiment (which I am very interested in and would like to read). I am concerned with a different problem. Namely, what is national character? When one finds oneself suddenly analyzing good old Scandinavians, one is still surprised by the internationality of the unconscious, even though one is prepared for it. The repressions are the same, but there are differences in the defense mechanisms. As we know, this is, by the way, what is truly individual. The defense mechanism is often determined by the character, and there are characters typical for certain nations, therefore determined by the nation. The national character is certainly a thoroughly composed structure and doubtless determined in many different ways. This can also be observed from the view of sexual repression, and I have once ventured the aperçu: 'the Hungarian hot temper, equivalent to the Scandinavian cold temper, is a defense of sexual anxiety.' Accordingly, and in addition, one can observe that bourgeois education aims at sexual repression everywhere, but tries to attain it in different ways. In Hungary, Italy, and Germany, too, there is much more often the threat of brutal punishment; in the Scandinavian countries, there is more of an appeal to the conscience, accomplished by setting up an ideal hostile toward sexuality. In Hungary, the bourgeois father tells his fifteen-to-eighteen-year-old daughter, 'if I see you with boys in the evening, I will break your bones.' In Scandinavia, 'you are allowed to go out with boys, because I trust you; I know that you will not do anything wrong and disappoint your parents.' These different ways of repressing sexuality influence the formation of a character. In Scandinavia, certain compulsive characters are found more often. They are victims of 'good' parents and 'understanding' education. I therefore suggest, that the emigrant analysts, who now have the opportunity to treat patients in different nations, collect such comparable data about certain typical national character traits or formations and about different national forms of sexual suppression. You are right, the difficulty lies in the fact that historical and sociological knowledge is missing. I therefore want to mention something I consider especially interesting and important. I gained this knowledge from an article in the Frankfurter Zeitung: "The Gentleman as a Model." This article shows that the ideal of the gentleman, which, by the way, has certainly also influenced the Scandinavian national character, is based on a special historical situation and has served a special sociological function. This ideal was set up only about one hundred years ago, when the ruling aristocracy, which was not gentleman-like at all, was forced to share political power with the rising bourgeoisie. In order to create a kind of inhibition for the new class — obviously, it should not become too independent — the aristocrats demanded that the bourgeois become gentlemen, meaning 'modest,' and 'well-behaved.' The structure of the historical situation is interesting here: the class ruling without constraint until then has to allow the rise of a new class, but still has enough power to restrict it. However, it is even more interesting to see that they sought to implement this restriction by setting up a new ideal. Analyzing the ideal of the gentleman within the historical and sociological context would be a field of research where psychoanalysis and Marxist sociology could be very helpful to each other. Maybe such work could be done collectively.

(Circular 12, Point 2, 1935)

Following Gerő's statement, we quote the last paragraph from Fenichel's comprehensive answer:

'National characteristics' are, in any case, characteristics common to many members of the same nation. Therefore, the first idea of analysts was to observe psychological differences among the nations, which resembled those among individuals, and, depending on the distribution of partial drives, to speak of 'oral,' 'anal,' and 'genital' nations.
The problem remained of whether this prevailing distribution of energies is constituted (as narcissistic theory would have it), or 'collateral.' Róheim is of the first opinion, and he searches for 'a specific conflict for every culture' as the cause (not the effect) of a culture ... I can absolutely confirm the connection between the Scandinavian character and the attempt to prohibit drives by setting up an ideal. The calm and 'healthy' way of the Scandinavians is related to 'setting up an ideal,' and they first have to get drunk before 'deeper layers' are allowed to speak; their neuroses are — according to the severity of such ideals — grim, 'deeper,' more dissimulated than the neuroses of the Germans. Please, further discussion!

(Circular 12, Point 2, 1935)

From Budapest, Edith Gyömrői reported regularly about psychoanalysis:

With every lecture, the impression arises that our colleagues here have forgotten the existence of the 'unconscious.' (Róheim delivers a dream analysis and does not even think that the manifest dream is a secondary formation; he simply translates the story of the dream.) Further, attempts are made with a kind of psychotherapeutic help here: there are patients talking things over once or twice a week, and these treatments, a few hours long, with long intervals in between, sometimes appear partially successful, which can be explained by a kind of abreaction and transferential satisfaction. They are overestimated and confused with real analysis. In general, the danger of falling back into psychotherapy is extremely high in this group. A few weeks ago at the technical seminar, Lillian Rotter courageously attacked 'timeless analysis,' which is quite common here (technical seminars end with the refrain: the patient has been in analysis for five/six/seven years; I have already tried everything — one has to continue trying everything). Rotter explained that she did not feel like stealing patients' money out of their pockets for years (the attack was aimed at Hermann and Alice Bálint), and she reported about her attempts with Reich's character analysis, consequently carried out for years. I am surprised that Balint thinks that I have adjusted to the Budapest argot so quickly. I am making efforts to tackle what is, for me, the too-ingenious, Ferenczi-like ideas of the Budapest group, and I make these efforts using their own language, but I am not getting far with it. But maybe the fact that Balint and I constantly disapprove of death instinct explanations is leading to such an impression. The refusal of the death instinct is prevalent here, but not examined very much, and I am not prepared for it, either.

(Circular 12, Point 7, 1935)

...the Vierländertagung[4] was an important step toward protesting the Hungarian nonsense (people in Budapest think that everybody who has been analyzed deeply enough can themselves become active analysts and that it is not necessary to read Freud). It demonstrated the insufficiency of the Budapest 'love' theories and left the Hungarians thinking. Such conferences should be repeated, and lectures by Viennese analysts should be organized in Budapest (however, although did indeed I remark that this conference, with its 'Destrudo,' was problematical for me, I did not succeed in my request).

(Circular 19, Point 1d, 1935)

Quite a lot was published here on the occasion of Freud's birthday. Among other things, an editorial appeared in a highly reactionary journal, which was, unfortunately, a very good one. It observed connections that our people do not want to see, especially the connection between psychoanalysis and our philosophical direction, though it confused psychoanalysis with sexual politics (Sexpol) and somehow primitively explained it as belonging to the 'Jewish mind.' The article has to be taken seriously (1) because it can be very harmful for psychoanalytic work here, and (2) because colleagues here would be very strengthened in the refusal of all the tendencies we sympathize with, they are all extremely frightened.

(Circular 18, Point 5, 1936)

My two lectures for the social democratic women were very satisfying; I had the feeling that I was doing something meaningful, and I liked the contact with the audience, though it was not easy dealing with the topics

4. The first Vierländertagung (four-country conference) was held in Vienna during Pentecost week (8-10 June 1935). The participating countries were Austria, Hungary, Italy, and Czechoslovakia. The official report, edited by Edward Glover, secretary of the International Psychoanalytic Association, was published in the Internationale Zeitschrift für Psychoanalyse (21: 1935) 457-460.

tactfully. It will be hard to refuse the amount of requests in a friendly way — in the meantime, I am consoling them by promising to take care of them in the fall — I could not fulfill what should follow these two lectures.

(Circular 28, Point 11, 1936)

Fenichel gave pointed "grades" to the Hungarian speakers at the Fourteenth International Psychoanalytic Congress in Marienbad in 1936:

I was quite disappointed by Lillian Rotter[5] who was recommended by Edith G.[yömrői] in such a big way, and whose first work ("Girls' pride in causing erections in boys") seemed to be remarkable.[6] She talked about puberty in a way that combined theories of Hermann and Alfred Adler, but nothing of psychoanalysis was included. 'Clinging' is set aside, and puberty 'is on the lookout.' She presented this in a way that reminded one appallingly of individual psychology. Róheim announced no less than the 'psychology of mankind.'[7] He told parts of stories and myths from all kinds of cultures, but it did not become clear how they are related to each other, and only insiders could guess that he wanted to repeat his cultural theory already published in his Evolution of Culture,[8] which I criticized previously.[9] ... According to Imre Hermann,[10] not only monkeys and infants cling to their mothers, but psychological instances cling to each other as well.

(Circular 39, Point 2, 1936)

In the circular letters, the recipients have intense discussions about meetings, congresses, and symposia for which they are preparing. The second Vierländertagung, which included psychoanalytic groups from Austria, Hungary, Italy, and Czechoslovakia, took place in Budapest during the week of Pentecost, 1937. Fenichel's note and his following comment were:

There is already quite a lot of correspondence about the Vierländertagung and its program, planned for the week of Pentecost.[11] The Viennese group even insulted the Budapest group, and so on.

(Circular 30, Point 9, 1936)

The debate about control analysis will be more understandable if you hear the following story from Budapest: amid fierce battling, two new members were elected here, scientifically and humanly under 0. There was severe opposition for the first time in the history of the election of members at the Hungarian Society: a scandalous war was fought with all kinds of perfidious means ... The members were elected, but it also became clear that our system of education must be wrong. It is not good that only the analyst has information about the candidate and his qualities, therefore control! This question was intended to be discussed seriously during the period of Pentecost, and we ... hoped to finally succeed in making the necessary changes in that respect ... I think that this is indeed the beginning, and maybe one can still do something with this horrible society. The analyst of the one elected member fought like a lion (for a truly impossible person), and Alice Balint, as always, took over the reconciling function and suggested we discuss education. The analyst of the other candidate threatened to resign from the society if the woman was not elected; she did not have better arguments.

(Circular 36, Point 4, 1937)

In 1938/39, one-fourth of the members of the Hungarian Psychoanalytic Society emigrated. And Fenichel wrote:

First of all, some personal news:
Edith G.[yömrői] has embarked for Colombo (Ceylon) and — before beginning her work at the new home — will lecture at the Psychoanalytic Society in Calcutta. Gerő's case has, unfortunately, not yet been solved in a positive way. Interventions have taken place, and one hopes for a positive solution. For our Rumanian colleague W.[innik], it will, hopefully, be possible to guarantee him a position abroad.

(Circular 54, Point 11, 1939)

The Budapest Society seems to be completely baseless and scientifically useless now, after first losing Edith G.[yömrői] (who moved to Colombo) and now also both Balints,[12] who recently moved to Manchester. The report closes with the following sentence: 'the society is a dunghill!'

(Circular 54, Point 13, 1939)

5. Lillian Rotter-Kertész talked about "A pubertás dinamikájáról" in the Internationale Zeitschrift für Psychoanalyse (22: 1936) 168.
6. Lillian Rotter, "Zur Psychologie der weiblichen Sexualität," Internationale Zeitschrift für Psychoanalyse (20: 1934) 367-374.
7. Géza Róheim, "The Garden of Eden or the Psychology of Mankind," The Psychoanalytic Review (27: 1940) 1-26 and 177-199.
8. Géza Róheim, "The Evolution of Culture," The International Journal of Psycho-Analysis (15: 1934) 387-418.
9. Otto Fenichel, "Lecture on G. Róheim. The Evolution of Culture," Internationale Zeitschrift für Psychoanalyse (21: 1935) 300-304.
10. Imré Hermann, "Sich-Anklammern, Auf-Suche-Gehen," Internationale Zeitschrift für Psychoanalyse (221: 1936) 349-370.
11. A report is to be found in Internationale Zeitschrift für Psychoanalyse (23: 1937) 233-237.
12. Alice Bálint (1898-1939) and Michael Bálint (1896-1970) were elected members of the British Psycho-Analytical Society in 1939, and were fundamentally involved in building the psychoanalytic group in Manchester.

About personal matters, the only thing to report is that Edith G.[yömrői] has, in the meantime, arrived in Colombo. I think some facts from her first letter are generally interesting:
We came here during the hottest season ... The heat is horrible; one does not dare to leave the house between 9 a.m. and 4 p.m. In the evening, it is quite pleasant ... Our hosts were a very pleasant surprise. They were not patients of Schmiedeberg, but are treated by both Eitingon and a young Englishman ... Apart from that, we quite soon found in our first conversation that we share very important interests. He is a very active and busy person, even apart from his profession as a farmer, and his interests are the same as our inner circle's. He brings to mind a little bit of the naive and self-sacrificing devotion of Weil of the Malik Press,[13] but more sympathetic, somehow naïve, like everybody here. My first patient will be a boy of twelve years, who is very shy and skeptical, but very lively at school. I have only caught a glimpse of him and therefore cannot make up my mind yet. The second will probably be a young physician, a Tamil, who wants to start training ... The Singhalese are extraordinarily sympathetic, quiet, and refined people. Even the poorest coolie displays 'noble' behavior. They are very poor; the property is concentrated only in a few hands. I am having long conversations with the administrator of the plantation, a Singhalese farmer, who is able to give me extremely precise answers on all the questions concerning the country. Our intellectuals at home would have to hide themselves in shame in the face of his knowledge ... I am told that a 'wild' analyst is working here; he studied analysis in London for six months. He owns a clinic and conducts seminars. I will take a look at the man and try to avoid hostility.

(Circular 56, Point 11, 1939)

One of the exponents applying psychoanalysis to anthropology was Géza Róheim; Fenichel strongly criticized him throughout the circulars.

Our other old opponent, Róheim, did not publish a new book, but his entire primitive way of thinking revealed itself in a review about W.[eston] La Barre's "The Peyote Cult," published in the Psychoanalytic Quarterly.[14] La Barre discusses the fact that the way the individual thinks and acts is dependent upon his cultural milieu and especially explains (what we have unfortunately noticed very often, too) that the deficit of knowledge about the history of primitive cultures interferes greatly with the results of anthropology. 'In practice,' he then writes, 'we can never know enough history, either biographical or cultural, to explain [the] present culture as it functions in individual acting.' Róheim considers this welcome insight of an anthropologist to be absolutely wrong. And he comments, 'the culture gives the individual a certain frame for his action or attitudes. Certainly nobody can choose the vocation of a university professor if he happens to be born an Andaman Islander. But within this frame the character and life of the individual is determined by the unconscious, by his own ontogenetic past; moreover, a historical sequence of cultural patterns and forms is one thing and the psychological explanation of these cultural patterns is another.'

(Circular 61, Point 10, 1939)

Only a few obituaries were included in the circular letters, but three of them referred to Hungarian colleagues and former members of the Budapest Psychoanalytic Society.

Again, one of the few psychoanalysts who realized that the application of Freud's findings to sociology is more important than the successful treatment of a few neurotics, died: Alice Balint. She was never a member of our 'circle,' and objected to the theories of Marx and Engels; on the whole, she considered them to be incompatible with Freud. But at least she had read their works, recognized their importance, and examined them seriously. Her own sociological opinions were even more 'dialectic-materialistic' than she knew and admitted — curiously, she always stopped at acknowledging the primary nature of material needs. It was a pity that she later neglected her actual field, anthropology, and we had hoped that her recent interest in sociology would bring her back there again. But this did not happen. Her last published work, 'Love of the mother and motherly love' was a lecture she delivered in Prague, where I had to defend her against too sharp criticism. It was clinical, but doubtless of sociological importance. Our private discussions about basic questions, which we have repeatedly printed in these circulars, were of interest to me.[15]

(Circular 66, Point 7, 1940)

I learned that Professor Malinowski has died at a relatively young age. We will not forget what a correct application of psychoanalysis to sociology owes to Malinowski. His fieldwork with the Trobrianders was not only actually done according to psychoanalytic principles — and to better ones than Róheim's — but his paper,

13. Felix José Weil (1898-1975), social scientist and economist; in 1924, he offered the financial means for founding the Frankfurter Institut für Sozialforschung. In Berlin, he worked with the Malik Press. In 1936, he emigrated to the United States.
14. Géza Róheim, "Weston La Barre. The Peyote Cult," The Psychoanalytic Quarterly (8: 1939) 248-249.
15. Alice Bálint, "Liebe zur Mutter und Mutterliebe," Internationale Zeitschrift für Psychoanalyse (1939) 24 and 33-48. Alice Bálint died at the end of 1939 in Manchester.

'Matriarchal Family and the Oedipus Complex,' was the first to actually criticize in a positive way the wrong 'biological' conception of the Oedipus complex, which blocked any materialistic psychoanalytic anthropology.[16]

(Circular 90, Point 16, 1942)

I learned that A.J. Storfer died in Melbourne, Australia. I am no good at writing obituaries. Storfer was a neurotic Bohemian, but a very likable one, whose life was not dedicated, like that of other Bohemians, to art, but rather to science. Besides, he understood psychoanalysis. He knew that it is not a psychiatric method, but rather the science of the human mind, which has to be fitted into the science of human society. I remember how he once laughed at my suspecting him of holding back my paper on 'The Open Work-Colony of Bolschevo' from being published, for political reasons. I was wrong. Storfer was always 'left,' and between the lines of his excellent books on language it can be read that — and how — language — like everything else in human society — is born out of the reality of human society, of its institutions, and its class struggles. Storfer has had arguments and fights with most psychoanalysts; nevertheless, by leading the Internationaler Psychoanalytischer Verlag through its most difficult times, he has done more for psychoanalysis than most psychoanalysts. His last journal, 'Die Gelbe Post' [The yellow mail], edited in Shanghai, was reviewed and discussed in these Circulars. His first leitartikel on the Chinese coolie we will not forget.

(Circular 116, Point 1, 1945).

16. Bronislaw Malinowski (1882-1942) studied natural sciences and philosophy in Krakow, then studied with Wilhelm Wundt in Leipzig before training as an anthropologist in London. Malinowski was author of "Mutterrechtliche Familie und Ödipus-Komplex," Imago (1924) 10 and 228-277; *The Sexual Life of Savages in North-Western Melanesia. An Ethnographic Account of Courtship, Marriage and Family Life among the Natives of the Trobriand Islands* (London/ New York: Routledge & Sons, H. Liveright, 1929).

References:

O. Fenichel, *The Psychoanalytical Theory of Neurosis* (W W Norton & Company, 1995).

O. Fenichel, *Problems of Psychoanalytic Technique* (Psychoanalytic Quarterly, 1969).

H. Feichel, D. Rapaport, *The Collected Papers of Otto Fenichel / First Series & Second Series* (W W Norton & Company, 1987).

R. Jacoby, *The Repression of Psychoanalysis: Otto Fenichel and the Political Freudians* (University of Chicago Press, 1986).

Elke Mühlleitner, born 1966, psychologist. Studied at the Universities of Vienna and Klagenfurt and at the New School for Social Research, New York (Psychoanalytical Studies Program). Publications focusing on the history of psychology, psychoanalysis, and psychotherapy.

Johannes Reichmayr, born 1947 in Gmünd. Studied psychology at the University of Salzburg. Lecturer for psychology, specializing in psychoanalysis. Taught at the University of Costa Rica, Faculty of Psychology, 1995. Professor at the University of Klagenfurt, since 1997. Publications focusing on the history of psychology, psychoanalysis, and ethnopsychoanalysis.

8

Peter Weibel

Biographical Sketches of the Psychoanalytical Movement

Alfred Adler (1870-1937)


Alfred Adler and his wife, Raissa, New York, 1936

Alfred Adler was born in Vienna on 7 February 1870. He was the second child of Leopold Adler, a Jewish immigrant grain farmer from Burgenland (then Hungary). He completed secondary school in 1888 and studied medicine at the University of Vienna until 1895. He married Raissa Epstein, a student from Odessa. In 1911 he left the Vienna Psychoanalytical Association and was baptized as a Protestant. In 1913 he founded the *Zeitschrift für Individualpsychologie* (Journal of individual psychology). In 1920 he published *Praxis und Theorie der Individualpsychologie* (Praxis and theory of individual psychology). In 1927 he published *Menschenkenntnis* (Human knowledge); in 1932, *Der Sinn des Lebens* (The meaning of life). He immigrated to the U.S.A. in 1932. His most prominent student and colleague was the writer Manès Sperber. He died on 28 May 1937 in Aberdeen, Scotland.

References: H.L. Ansbacher, ed., *Individual Psychology of Alfred Adler: A Systematic Presentation in Selections from His Writings* (HarperCollins, 1989); A. Adler, *Understanding Human Nature* (Hazelden Information Education, 1998); A. Adler, *Understanding Life* (Hazelden Information Education, 1998); A. Adler, *What Life Could Mean to You* (Hazelden Information Education, 1998); C. Brett, ed., *Alfred Adler, Social Interest* (Oxford: Oneworld Publications 1998; L. Grey, *Alfred Adler, the Forgotten Prophet: A Vision for the 21st Century* (Westport, CT: Praeger Publications, 1998); B. Hanebauer, *The Freud-Adler Controversy* (Oxford: Oneworld Publications, 1998).

August Aichhorn (1878-1949)

August Aichhorn, the son of a Viennese banker and local Christian-Socialist politician, was born in 1878. From 1918 until its closing in 1923, Aichhorn led the Institute for Welfare and Education in Oberhollabrunn (which moved to St. Andrä in 1921), where he worked with delinquent youths. Aichhorn was analyzed by Paul Federn. In 1925 he published his central works, *Verwahrloste Jugend* (Wayward Youth) and *Die Psychoanalyse in der Fürsorgeerziehung* (Psychoanalysis in public welfare education). He became a training analyst with the Vienna Psychoanalytical Association and director of the educational advisors. During World War II, Aichhorn stayed in Vienna and, as "acting psychologist" for the German Institute for Psychological Research, he was able to train psychotherapists. After the war, he was involved in reestablishing the Vienna Psychoanalytical Association and became its president in 1946. He died in Vienna in 1949.

References: August Aichhorn, S. Freud, *Wayward Youth* (Northwestern UP, 1984); K. R. Eissler, P. Federn, eds., *Searchlights on Delinquency: New Psychoanalytical Studies Dedicated to Prof. August Aichhorn on the Occasion of his 70th Birthday* [1949] (Guilford, CT: International UP, 2000); O. Fleischmann, ed., *Delinquency and Child Guidance. Selected Papers of August Aichhorn* (Guilford, CT: International UP, 1976).

Franz Gabriel Alexander (1891-1964)

Franz Gabriel Alexander was born in 1891. He was the son of the well-known philosopher, Bernhard Alexander. He studied medicine in Göttingen and Budapest and led brain physiological studies. He received his psychoanalytical education from Sigmund Freud. His training analysis was done by Hanns Sachs in Berlin. He worked as an analyst, first as a student, then as assistant at the Berlin Psychoanalytic Institute. In 1930 Alexander was invited to the U.S.A. by the University of Chicago and received the first teaching position for psychoanalysis. In 1932 he founded the Institute for Psychoanalysis in Chicago, which he chaired until 1956. That year, he was appointed director of the Psychiatric Research Department of the Mount Sinai Hospital in Los Angeles. His contributions to psychoanalytic theory lie in the area of psychosomatics. Franz Alexander died in 1964 in Palm Springs, California.

References: F.G. Alexander, Hugo Staub, *Der Verbrecher und sein Richter* (1929); F.G. Alexander, *Psychoanalytic Therapy: Principles and Application* (University of Nebraska Press, 1980); F.G. Alexander, *Fundamentals of Psychoanalysis* (W.W. Norton and Company, 1963); F.G. Alexander, *Roots of Crime* (Patterson Smith, 1969).


Alice Bálint

Alice Bálint (1898-1939)


Vilma Kovács

Alice Bálint was born in Budapest in 1898. She was the daughter of training analyst Vilma Kovács. She became a mathematician and ethnologist and after World War I, began her psychoanalytical education at the Berlin Training Institute. In 1923 she became an associate member of the Berlin Psychoanalytic Society and at the beginning of 1926, she became a member of the Hungarian Association. In Budapest, she completed her psychoanalytical training with Sándor Ferenczi. In 1939 she and her husband, Michael Bálint, were accepted into the British Psycho-Analytical Society. She was involved with founding a psychoanalytical society in Manchester. On 9 August 1939, only a few months after her emigration to Manchester, she died of a brain vessel aneurysm.

References: A. Balint, *Early Years of Life: A Psychoanalytical Study* (Basic Books, 1954); A. Balint, *The Psychoanalysis of the Nursery* (London: Routledge, 1953).

Michael (Mihály) Bálint (1896-1992)


Michael Bálint

Michael Bálint was born Michael Bergsmann in 1896 in Budapest and was raised an orthodox Jew. His father was a general practitioner and Bálint also studied medicine. In 1920 he changed his name to Bálint (Hungarian: Valentine). At age 21, he became interested in psychoanalysis and in 1919, he met the psychoanalyst Imre Hermann. In 1920 he married Alice Kovács and moved to Berlin in 1921. He worked in the chemistry laboratory run by Nobel Prize winner Otto Warburg and at Karl Abraham's psychoanalytical institute. In 1924 he returned to Hungary. He and his wife began a training analysis with Sándor Ferenczi. Bálint was friends with István Hollos and Géza Róheim. Ferenczi died in 1933. Bálint became administrator of his estate, as well as his successor as director of the Budapest Polyclinic. At the beginning of 1939, the Bálints moved to Manchester, where Alice Bálint died the same year. In 1944 Bálint's parents committed suicide in order to escape capture by Hungarian Nazis. After the end of the war, he married Enid Eichholz and together they introduced the so-called Bálint Group. He died in 1992.

References: M. Bálint, *Problems of Human Pleasure and Behavior* (1973); M. Bálint, *The Basic Fault: Therapeutic Aspects of Repression* (Northwestern UP, 1968); M. Bálint, *The Doctor, the Patient and His Illness* (Guilford, CT: International UP, 2002); E. Bálint, *Before I Was I: Psychoanalysis and the Imagination* (Other Press, 1998).

Therese Benedek (1892-1977)

Therese Benedek (née Friedmann) was born in 1892 in Eger, Hungary. During her medical studies, she attended Sándor Ferenczi's lectures, with whom she probably completed her analysis. Benedek specialized in pediatrics. In 1919 she married her colleague Tibor Benedek. A few months after her marriage, due to the political instability in Hungary, the couple moved to Leipzig, where they lived from 1920 until 1936. From 1933 until their departure from the German Psychoanalytical Society in 1935, they were training and supervisory analysts at the Berlin Psychoanalytical Institute and spent a few days of each week in Berlin. In 1936 Benedek emigrated with her family to the U.S.A., where she accepted Franz Gabriel Alexander's invitation to join the Chicago Institute for Psychoanalysis. Therese Benedek lived and worked in Chicago until her death in 1977.

References: Therese Benedek, J. Fleming, *Psychoanalytical Supervision: A Method of Clinical Training* (Guilford, CT: International UP, 1983); Therese Benedek, *Parenthood: Its Psychology and Psychopathology* (Jason Aronson, 1996).

Bruno Bettelheim (1903-1990)


Bruno Bettelheim

Bruno Bettelheim was born to a well-situated Jewish family in Vienna in 1903. In 1921 he began studying philosophy at the University of Vienna, although he had to stop for ten years due to the death of his father in 1926. During this time he managed his father's building and wood trade. In 1930 he married Regina Altstedt. In 1938 he graduated with his doctoral thesis, *Das Problem des Naturschönen und die moderne Ästhetik* (The problem of natural beauty and modern aesthetics). Bettelheim completed psychoanalytic therapy with Richard Sterba. In 1938 he was sent to Dachau concentration camp. In May of 1939 he was released and emigrated to the U.S.A. In 1941 he married Trude Weisfeld. From 1944 to 1973 he headed the Sonja Shankman Orthogenic School in Chicago, where he was professor of child and youth psychology, psychiatry, and pedagogy from 1947 to 1973. His scientific and practical work with disturbed children on autism and extreme situations brought him worldwide recognition. On 3 March 1990, in a home for the aged, he committed suicide by suffocating himself with a plastic bag.

References: Bruno Bettelheim, *The Uses of Enchantment: The Meaning and Importance of Fairy Tales* (Vintage Books, 1989); Bruno Bettelheim, *The Children of the Dream* (The MacMillan Company, 1997); Bruno Bettelheim, *The Truants from Life: The Rehabilitation of Emotionally Disturbed Children* (New York: Free Press, 1964), Bruno Bettelheim, *Freud and Man's Soul* (Random House, 1984); Bruno Bettelheim, *The Empty Fortress: Infantile Autism and the Birth of the Self* (New York: Free Press, 1972).

Siegfried Bernfeld (1892-1953)

Siegfried Bernfeld was born on 7 May 1892 in Lemberg, Galicia. His parents, Jewish business people, were residents of Vienna. From 1911 to 1914 he pursued philosophical studies at the University of Vienna. In 1912 he founded and chaired the Academic Committee for School Reform; from 1914 to 1915 he studied pedagogy and psychology in Freiburg. In 1915 he married Anne Solomon. On 12 May 1915, he visited the Vienna Psychoanalytical Association for the first time. He became a member in 1919. In 1918 he founded the journal

Jerrubbaal (last issue in 1919) and in 1919, founded the Baumgarten children's home in Vienna, where he instituted a concept for a new type of child pedagogy for Jewish war orphans, but which ended in 1920. In 1920 he became editor of the journal *Der Jude* (The Jew), published by Martin Buber in Heppenheim and Heidelberg. In 1921 he returned to Vienna. Encouraged by Sigmund Freud and with no psychoanalytic experience of his own, he began his psychoanalytic practice. He worked as secretary and librarian for the Association and in 1925 he represented Helene Deutsch at the newly opened training institute. In autumn 1925, he moved to Berlin to live with Elisabeth Neumann. They married in 1930. Member of the German Psychoanalytic Society. Returned to Vienna in 1932. Married Suzanne Cassirer-Paret in 1934. Moved to Menton, southern France. In 1937, after a short time in London, he moved to America (New York, Chicago, Los Angeles, San Francisco). In 1944 he published *Freud's Earliest Theories and the School of Helmholtz*. Bernfeld died on 2 April 1953 in San Francisco.

References: Siegfried Bernfeld, *Die Neue Jugend und die Frauen* (1914); S. Bernfeld, *Das jüdische Volk und seine Jugend* (1919); S. Bernfeld, *Vom Gemeinschaftsleben der Jugend. Beiträge zur Jugendforschung* (1922); S. Bernfeld, *Sisyphos oder die Grenzen der Erziehung* (1925); S. Bernfeld, *Psychologie des Säuglings* (1925); S. Bernfeld, *Die heutige Psychologie der Pubertät. Zur Kritik ihrer Wissenschaftlichkeit* (1927); S. Bernfeld, *Trieb und Tradition im Jugendalter. Kulturpsychologische Studien an Tagebüchern* (1931); K. Fallend, J. Reichmayr, eds., *Siegfried Bernfeld oder Die Grenzen der Psychoanalyse. Materialien zu Leben und Werk* (Basel: Stroemfeld/Nexus, 1992); S. Bernfeld, *Sisyphus: Or, the Limits of Education* (University of California Press, 1973); S. Bernfeld, *The Psychology of the Infant* (London: Routledge, 1999).

Helene Deutsch (1884-1982)

Helene Deutsch (née Rosenbach) was born in 1884 in the Galician city of Przemysl, the daughter of a well-known Jewish lawyer. Even in her youth she was committed to the aims of socialism and founded the first organization of women workers in Przemysl in 1905. Deutsch went to Vienna, where she began her medical studies. In 1911 she spent a semester in Munich and graduated in 1912 from the University of Vienna. The same year, she married Felix Deutsch in Vienna. She was accepted into the Vienna Psychoanalytical Association in 1918. She had one analysis by Sigmund Freud. In 1923 she went to Berlin to complete her psychoanalytic training with Karl Abraham. After 1924 she was occupied with the founding and administration of the training institute in Vienna, where she became the first chair in 1925 and remained so until her emigration. In 1925 Deutsch published her work, *Zur Psychologie der weiblichen Sexualfunktion*. In 1934 she emigrated with her family to the United States and opened her psychoanalytic practice in Boston. She died in 1982 in Cambridge, Massachusetts.


Helene Deutsch

References: Helene Deutsch, *Psychoanalysis of the Sexual Functions of Women* (Karnac Books, 1991); H. Deutsch, *Neuroses and Character Types: Clinical Psychoanalytical Studies* (Guilford, CT: International UP, 1965); J. Sayers, *Mothers of Psychoanalysis: Helene Deutsch, Karen Horney, Anna Freud, and Melanie Klein* (W.W. Norton and Company, 1993); H. Deutsch, *Confrontations with Myself* (W.W. Norton and Company, 1973); P. Roazen, *Helene Deutsch: A Psychoanalyst's Life* (Transactions Publishers, 1992).

Felix Deutsch (1884-1964)

Felix Deutsch was born in Vienna in 1884, the son of a Jewish bank official. He studied at the University of Vienna medical school, graduated in 1909, and became a professor in 1919 in the field of internal medicine. He finished his last university year in Munich, where he met his future wife, Helene Rosenbach. They married in Vienna in 1912. Deutsch had already decided to emigrate in 1934 when the fascist militant government took power in Austria. He and his wife were Social Democrats; their son took part in the resistance against the Dollfuß regime. Deutsch accepted an invitation from the Massachusetts General Hospital in Boston. He became a training analyst at the Boston Psychoanalytic Institute. From 1951 to 1954 he was President of the Boston Psychoanalytic Society. He died in 1964 in Cambridge, Massachusetts.


Helene and Felix Deutsch

References: Felix Deutsch, ed., *On the Mysterious Leap from the Mind to the Body: A Workshop Study on the Theory of Conversation* (Guilford, CT: International UP, 1998); F. Deutsch, W.F. Murphy, *The Clinical Interview: Diagnosis: A Method of Teaching Associative Exploration* (Guilford, CT: International UP, 1997); F. Deutsch, W.F. Murphy, *The Clinical Interview: Therapy: A Method of Teaching Sector Psychotherapy* (Guilford, CT: International UP, 1997).

Rudolf Ekstein (1912-2005)

Rudolf Ekstein was born in 1912 in Vienna. In 1937 he received his PhD in philosophy and psychology (M. Schlick, F. Waismann, R. Carnap, and C. Bühler). From 1935 to 1938 he studied psychoanalytic pedagogy at

Rudolf Ekstein

the Vienna Psychoanalytic Institute. Ekstein emigrated to the U.S.A. in 1938. He was a training analyst for ten years at the Menninger Foundation in Topeka, Kansas, and for several years in Los Angeles, California. He gave regular guest lectures in Vienna from 1970 on. He was active as coordinator of the Childhood Psychosis Project for the Reiss-Davis Child Study Center, as clinical professor of medical psychology at UCLA, and as a training analyst for both the Los Angeles Society and the Institute for Psychoanalysis. Author of books and more than one hundred papers in the area of psychology and psychoanalysis. He died in 2005 in Los Angeles.

References: Rudolf Ekstein, R. Wallerstein, *The Teaching and Learning of Psychotherapy* (Guilford, CT: International UP, 1972); R. Ekstein, *Children of Time and Space, of Action and Impulse. Clinical Studies in the Psychoanalytic Treatment of Severely Disturbed Children* (Jason Aronson, 1983); R. Ekstein, R. L. Motto, eds., *From Learning for Love to Love of Learning, Essays on Psychoanalysis* (Brunner/Mazel); R. Ekstein, *The Language of Psychotherapy* (John Benjamins Publishers, 1989).

Kurt R. Eissler (1908-1998)

Kurt R. Eissler was born in Vienna in 1908 and was trained there as a psychoanalyst. In 1938 he emigrated to the U.S.A. Eissler spent three years in the American army. A manuscript about his experiences in the American army went unpublished. Trained by August Aichhorn, he dedicated himself to psychoanalysis of the neglected, and later, of schizophrenics. His contributions to research on Freud were a study of Freud's relationship to the University of Vienna and a study of Freud as an expert witness in a postwar investigation against Wagner-Jauregg. Eissler is the founder of the Sigmund Freud Archive. He lived until his death in New York.

References: Kurt Eissler, *Psychiatrist and the Dying Patient* (Guilford, CT: International UP, 1970); K. Eissler, *Leonardo da Vinci: Psychoanalytical Notes on the Enigma* (Guilford, CT: International UP, 1961); K. Eissler, *Discourse on Hamlet* and *Hamlet: A Psychoanalytical Inquiry* (Guilford, CT: International UP, 1971); K. Eissler, *Victor Tausk's Suicide* (Guilford, CT: International UP, 1983).

Paul Federn (1871-1950)

Paul Federn

Paul Federn was born in Vienna in 1871. In 1895 he completed his medical studies and became an assistant at the General Hospital (H. Nothnagl). He specialized in internal medicine. In 1902 Federn opened a private practice. In 1903 he was taken into the Sigmund Freud circle. He was a member of the Social Democratic Worker's Party in Austria from 1918 to 1934. In 1924 he and Heinrich Meng published the *Ärztliches Volksbuch* (Peoples' physician's book), as well as the *Psychoanalytisches Volksbuch* (Peoples' psychoanalytical book) in 1926. Primarily after World War I, Federn was the leading analyst in the Vienna Psychoanalytical Association. He became the chairman of the trainers' advisory committee and was the vice-chairman from 1924 to 1938. His scientific merit lay in the field of ego psychology, as well as the theory and therapy of psychoses. In 1932 two of his works, *Das Ich-Gefühl im Traume* (The ego feeling in dreams) and *Die Psychoanalyse* (Psychoanalysis) were published in 1933. In 1938 he emigrated via Sweden to the U.S.A., where he became a honorary member of the New York Psychoanalytic Society and a training and private analyst. He committed suicide in 1950. In 1952 his student, Edoardo Weiss, first published Federn's work, *Ego Psychology and the Psychoses* in English.

References: Paul Federn, *Ego Psychology and the Psychoses* (Basic Books, 1955).

Anna Freud (1895-1982)

Anna and Sigmund Freud on their way to exile, 1938

Anna Freud was born in Vienna in 1895, the youngest child of Sigmund Freud. In 1911 she finished her school education and began a training analysis with her father. In 1920 she became a member of the Committee, the smaller circle of the psychoanalytical movement. In 1923 she began her analytic activities. She was especially involved with the analysis of children. In 1927 she published her *Einführung in die Technik der Kinder-analyse* (Introduction to the technique of the analysis of children). In 1925 she began a lifelong friendship with Dorothy Burlingham. Anna Freud remained active for her father in numerous ways for her entire life. *Das Ich und die Abwehrmechanismen* was published in 1936. She immigrated to England in 1938. In 1947 Freud founded the "Hampstead Child Therapy Courses" in Hampstead. The concentration of her work lay in the analysis of children and the application of psychoanalytic findings in pedagogy. She died in London on 9 October 1982.

References: Anna Freud, *Ego and the Mechanisms of Defense* (Guilford, CT: International UP, 1971); R. Ekins, ed., *Anna Freud: Selected Writings* (Trafalgar Square, 2001); R. Edgcumbe, *A. Freud, A View of Development, Disturbance and Therapeutic Techniques* (London: Routledge, 2000); E. Young-Bruehl, *Anna Freud: A Biography* (New York: W.W. Norton and Company, 1994).

Eugen Gendlin (1926)

Eugen Gendlin was born in Vienna in 1926. He emigrated to Washington in 1938. Gendlin received his PhD in philosophy in 1958 in Chicago. From 1958 to 1963 he was research director at the Wisconsin Psychiatric Institute. In 1963 he succeeded Carl R. Rogers at the Department of Behavioral Sciences of the University of Chicago. He developed the method of focusing, a form of self-discovery. Focusing therapy was expanded to partner and group therapy. *Experiencing and the Creation of Meaning* was published in 1962; in 1978, *Focusing*; and in 1986, *Let Your Body Interpret Your Dreams*.

References: Eugen Gendlin, P. Gendlin, *Focusing* (Bantam Books, 1982); E. Gendlin, *Let Your Body Interpret Your Dreams* (New York: Chiron Publications, 1986); E. Gendlin, *Experiencing and the Creation of Meaning: A Philosophical and Psychological Approach to the Subjective* (Chicago: Northwestern UP, 1997).

Otto Gross (1877-1920)


Otto Gross

On 17 March 1877, Otto Gross was born in Gniebing bei Feldbach in Styria. His father, Hans Gross (1847-1915), was a state attorney and head of the Institute for Criminology in Graz; as the author of *Handbuch der Kriminalistik* (Handbook of criminology), he was considered the father of modern criminology. Gross finished school in Graz and his medical studies in Vienna. He first worked as a ship's doctor and made several journeys to South America; his lifelong drug dependency (cocaine, morphine, and opium) dates back to this time. Gross underwent his first treatment for withdrawal from 1901 to 1902 in Burghölzli, Zurich. As a devotee of Freud, he attempted to bring psychoanalytic methods into clinical psychiatry as early as 1902, yet encountered great resistance from established medicine. In 1903 he married Frieda Schloffer in Graz. Freud, who at first supported him and had called him his best student, took opposition after 1907 to his socially critical approach to psychoanalysis. After becoming an assistant professor, Gross held the position for two semesters, teaching neuropathology at the University of Graz. Gross traveled through all of Europe and, in 1905, founded the anarchist Commune on Monte Verità in Ascona where he came into contact with Erich Mühsam, Max Weber, Hugo Ball, Gustav Landauer, Rilke, and Hesse, among others.

From 1907, deep friendship with the Richthofen sisters (Else Jaffé and Frieda Weerly) and through them, indirect influence on D.H. Lawrence *(Lady Chatterly's Lover)*, also a friend of theirs. Birth of his son, Peter. In 1908 Gross began, at Freud's urging, his second drug withdrawal treatment at C.G. Jung's therapy clinic in Burghölzli in Zurich. After four weeks, however, Gross withdrew from analysis by fleeing. Jung declared the therapy a failure and diagnosed him with schizophrenia. In 1911, after Gross' friend, painter Sophie Benz, committed suicide, he was interned in the Steinhof psychiatric institute in Vienna, and Hans Gross began a procedure to legally incapacitate his son. In 1913 Otto Gross was arrested in his friend Franz Jung's apartment in Berlin and taken first to Tulln insane asylum and later to Troppau. After active public protests by his friends, he was pronounced cured and released in 1914, but remained legally incapacitated. At the end of 1915, Gross's father died and Gross lost his hold for good. During the next few years, he moved from Vienna to Budapest to Prague to Berlin and published additional essays on psychoanalytic questions and his theory of a maternalistic, anti-authoritarian society. On 13 February 1920, he died in Berlin, half-starved, of pneumonia.

References: Otto Gross, *Über psychotherapeutische Minderwertigkeiten* (Vienna/Leipzig, 1909); Kurt Kreiler, ed., O. Gross, *Von geschlechtlicher Not zur sozialen Katastrophe* (Frankfurt/Main: Robinson, 1980); M. B. Green, *Otto Gross: Freudian Psychoanalyst, 1877-1920: Literature and Ideas* (Lewiston, NY: Edwin Mellen Press, 1999); J.E. Michaels, *Anarchy, Eros: Otto Gross' Impact on German Expressionist Writers* (Bern/Frankfurt/Brussels/New York: Peter Lang Publishing Group, 1983); M. Green, *The Von Richthofen Sisters: The Triumphant and the Tragic Models of Love: Else and Frieda Richthofen, Otto Gross, Max Weber, and D.H. Lawrence* (Albuquerque: University of New Mexico Press, 1988).

Jenö Hárnik

Jenö Hárnik was born in Hungary. As early as 1911 he published his first work in the journal *Zentralblatt für Psychoanalyse* (Central paper for psychoanalysis) and was involved with the symbolism and interpretation of art works. In 1912 he applied for admission to the Vienna Psychoanalytical Association, Sigmund Freud requested information from Sándor Ferenczi about him. Hárnik probably completed his analysis with Ferenczi. In 1918 Hárnik took part in the sessions of the Vienna Association, but as a non-member. In Budapest, as a member of the Galilei Circle, he came into contact with socialist and communist ideas. After the defeat of the Hungarian Soviet Republic, he emigrated to Berlin and became a member of the German Psychoanalytic Society. In 1933 he emigrated from Berlin to the U.S.A.

Heinz Hartmann (1894-1970)

Heinz Hartmann was born into a famous family on 4 November 1894 in Vienna. His father, the diplomat Moritz Hartmann (1856-1924), also taught history at the University of Vienna. His mother was a sculptor and pianist. In 1920 Hartmann graduated with a degree in medicine from the University of Vienna. He completed his training analysis with Sándor Radó in Berlin and Vienna. In 1927 he published *Die Grundlagen der Psychoanalyse* (The foundations of psychoanalysis), the first scientific study of psychoanalytic theory. In 1938 Hartmann emigrated to Paris and Switzerland, then in 1941 to the U.S.A. In 1939 he published *Ich-Psychologie und Anpassungsproblem*. With this, he introduced the object-relationship theory and self psychology (Heinz Kohut) to psychoanalysis. Counted alongside Freud's drive and conflict psychology, this constituted a fourth large theoretical field, ego psychology. He died in 1970 in New York.

References: Heinz Hartmann, *Ego Psychology and the Problem of Adaption* (Guilford, CT: International UP, 1964); H. Hartmann, *Once a Doctor, Always a Doctor: The Memoirs of a German-Jewish Immigrant Physician* (Prometheus Books, 1986).

Imre Hermann (1889-1984)

Imre Hermann

Imre Hermann was born in Budapest in 1889. His father was a civil servant in the department of railway transport. In school he was interested in botany, and later mathematics and psychology. As a medical student, he worked in the laboratory overseen by experimental psychologist Géza Révész. Hermann came to psychoanalysis through one of Sándor Ferenczi's seminars. In Révesz's laboratory, Hermann met his later wife, Alice Cziner (1895-1975). She likewise became an analyst, training kindergarten teachers. In 1925 Hermann became the secretary of the Hungarian Psychoanalytic Association and president of the association in 1945. He died on 22 February 1984.

References: Imre Hermann, *Die Psychoanalyse als Methode* (Westdeutscher Verlag, 1963); I. Hermann, *Psychoanalyse und Logik* (Imago Books VIII, 1924).

Eduard Hitschmann (1871-1957)

Eduard Hitschmann

Eduard Hitschmann was born in 1871 into a Jewish banker's family. He was at school and university with Paul Federn in Vienna. After his medical studies, he worked for eight years in Vienna's hospitals before becoming a private practitioner. He was introduced to the Mittwoch Gesellschaft (Wednesday Society), a meeting of psychoanalysts, by Paul Federn. In 1911 Hitschmann authored the first summary of the theory of psychoanalysis. The Vienna Association considered him highly educated in literature and the arts. In 1922 he became director of the newly founded Psychoanalytic Clinic in Vienna, for whose foundation he had made a considerable effort. He held the position of director until his emigration in the year 1938. He first went to England, and two years later he took his family to the U.S.A., where he settled in Cambridge. He became a training analyst at the Boston Psychoanalytic Institute. He died in Gloucester, Massachusetts in 1957.

References: E. Hitschmann, *Freud's Neurosenlehre* (Franz Deuticke, 1911, 1913); E. Hitschmann, *Swedenborg's Paranoia, The Yearbook of Psychoanalysis* (Guilford, CT: International UP, 1950).

Willi Hoffer (1897-1967)

Willi Hoffer was born in Luditz, Bohemia, on 12 September 1897, the son of a Jewish businessman. After his military service during World War I, he studied first at the Veterinary College in Vienna, changed then to the Department of Philosophy, where he received his PhD with a dissertation titled *Über die wissenschaftlichen Grundlagen der Pädagogik* (On the scientific foundations of pedagogy) in 1922. In 1919 Hofer worked with Siegfried Bernfeld at the children's home in Baumgarten. He completed an analysis with Hermann Nunberg and became a member of the Vienna Psychoanalytical Association. In 1938 he and his wife, analyst Hedwig Hoffer-Schaxel, immigrated to England. Both became members of the British Psycho-Analytical Society. Hoffer worked as a medical advisor at the Hampstead Clinic, which was founded by Anna Freud. From 1945 onward, he was one of the publishers of a journal called *Psychoanalytic Study of the Child*, and between 1949 and 1960, the *International Journal of Psycho-Analysis*. From 1959 to 1962, Hofer was President of the British Psycho-Analytical Society. He died on 25 October 1967 in London.

Stephan (István) Hollós (1872-1957)

István Hollós was born in Budapest in 1872. He was a friend and comrade of Sándor Ferenczi and in 1913 became vice-president of the newly founded Hungarian Psychoanalytic Association. He began his analysis first with Ferenczi, then continued with Paul Federn. After World War I, he was in analysis with Sigmund Freud. Together with Ferenczi, Hollós worked on paralytic dementia. Hollós included the nurses in his patients' therapy and was the first in Hungary to practice the open door system of psychiatry, which also led to a reduction in escape attempts and suicides. He described his medical experiences and disappointments in 1928 in *Búcsúm a sárga háztól* (Behind the yellow wall). After Ferenczi's death, he became president of the Hungarian Psychoanalytic Association. During World War II, Hollós remained in Budapest. At the end of 1944, he and his wife were interned by the fascists collaborating with the Nazis (the Pfeilkreuzler). They managed to escape and after the war returned to Budapest. From 1950 to 1952 he was active in the psychiatric-neurological department of the Budapest Hospital. He died on 2 February 1957 in Budapest.

István Hollós

References: I. Hollós, *Adatok a paralysis progressivához Magyarországon* (Budapest 1903); I. Hollós, *Búcsúm a sárga háztol*, J. Engel, ed. (Cserépfalvi, 1990).

Hermine Hug-Hellmuth (1871-1924)

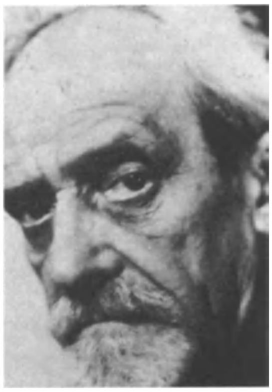
Hermine Hug-Hellmuth was born in Vienna in 1871, the daughter of Hugo Hug, Knight of Hugenstein. She attended the Women's Pedagogic Institute in Vienna and became a primary and later a secondary school teacher. After qualifying to study at the university, she enrolled in philosophy studies at the University of Vienna. In 1909 she received her PhD in physics. Hug-Hellmuth became a patient of Isidor Sadgers, and in 1913 she became a member of the Vienna Psychoanalytical Association. She headed the first counseling office for pedagogy at the Vienna Psychoanalytical Association. On 9 September 1924, she was murdered by her nephew, who was a patient of hers.

References: Hermine Hug-Hellmuth, *Aus dem Seelenleben des Kindes. Eine psychoanalytische Studie* (Franz Deuticke, 1913); H. Hug-Hellmuth, *Tagebuch eines halbwüchsigen Mädchens. Quellenschriften zur seelischen Entwicklung* (Internationaler psychoanalytischer Verlag, 1921); G. MacLean, U. Rappen, *Hermine Hug-Hellmuth: Her Life and Work* (London/New York: Routledge, 1991).

Ludwig Jekels (1867-1954)

Ludwig Jekels was born in Lemberg, Galicia, on 15 August 1867. He went to Vienna to study medicine, received his PhD in 1872 and worked for the University Clinic, specializing in neurology and psychiatry. In 1910 Jekels became a member of the Vienna Psychoanalytical Association. He was active in expanding psychoanalysis in Poland and translated some of Freud's works into Polish. In 1934 Sigmund Freud suggested he should go to Stockholm as an analyst trainer in order to support the work of the newly formed psychoanalytic group there. In 1937 he returned to Vienna and then emigrated to New York in 1938, where he opened a psychoanalytic practice. In 1952 his selected essays were published in English. Jekels died in New York in April, 1954.

References: L. Jekels, *Selected Papers* (Guilford, CT: International UP, 1998).



Ludwig Jekels

Robert Hans Jokl (1890-1975)

Robert Hans Jokl was born in 1890 in Székélyfalic, Hungary. After completing school in Bratislava, he studied medicine, first in Vienna and then in Prague, where he received his doctoral degree in 1915. After World War I, Jokl came to Vienna where he was a patient of Sigmund Freud's. In 1921 Jokl was admitted to the Vienna Psychoanalytical Association. In 1938 he fled, first to Switzerland, then to France. After the German invasion, Jokl and his wife were arrested and interned in a concentration camp, where Jokl worked as a doctor. In 1946 he returned to Austria as a training analyst. He worked with August Aichhorn on reestablishing the Vienna Psychoanalytical Association, yet he could not find a base. In 1947 he emigrated permanently to the U.S.A. and became a training analyst at the Topeka Psychoanalytic Institute. In 1950 he moved to Los Angeles, where he died in 1975.

Otto F. Kernberg (1928)

Otto F. Kernberg was born in Vienna in 1928. His uncle was Manfred Sakel, who discovered the insulin treatment for schizophrenia in 1935. In 1939 Kernberg immigrated to Chile, where he studied medicine in Santiago from 1947 to 1957. He trained as an analyst between 1954 and 1960 and later carried out a psychoanalytic research project at the Menninger Foundation in Topeka, Kansas, from 1961 to 1973. Kernberg developed therapies for borderline patients. He became a friend of Edith Jacobson. Since 1974 he has been a training analyst at the Columbia University Center for Psychoanalytic Training and Research and professor of psychiatry at Cornell University Medical College since 1976.

References: O. Kernberg, *Severe Personality Disorders: Psychotherapeutic Strategies* (New Haven: Yale UP, 1993); O. Kernberg, *Object Relations Theory and Clinical Psychoanalysis* (Jason Aronson, 1995); O. Kernberg, *Borderline Conditions and Pathological Narcissism* (Jason Aronson, 1985); O. Kernberg, *Aggression in Personality Disorders and Perversions* (New Haven: Yale UP, 1995).

Melanie Klein (1882-1960)

Melanie Klein was born in 1882 in Vienna, the youngest of physician Moritz Reize and his wife Libussa Deutsch's four children. She wanted to become a physician, yet her early marriage at age 21 to chemist Arthur Klein changed her professional plans. Klein studied art and history but did not complete her studies. Shortly before the start of World War I, her family moved to Budapest, and during this time she read Sigmund Freud's book, *Interpretation of Dreams*, which immediately awoke Klein's interest in psychoanalysis. In Budapest she became a patient of Sándor Ferenczi's, who introduced her to the analysis of children. She then began to analyze her own children and publish her work. In 1919 she was admitted to the Hungarian Psychoanalytic Association. In 1921, by invitation of Karl Abraham, whose student she became, she moved to Berlin and was admitted to the Berlin Psychoanalytic Society. With the help of Alix Strachey and the support of Ernest Jones, Melanie Klein went to London in the summer of 1925. A year later, she moved there and founded her own school, which was known as the "Kleinian" or "English School" of psychoanalysis. In 1927 she became a member of the British Psycho-Analytical Society and that year had a controversy with Anna Freud. In 1932 she published her book, *The Analysis of the Child*, and in 1937, she and Joan Riviere published *Seelische Urkonflikte* (Early conflicts of the soul). Klein died in London in 1960.

References: Melanie Klein, J. Riviere, *Love, Hate, and Reparation* (W.W. Norton and Company, 1964); S. Robinson, *Introducing Melanie Klein* (Guilford, CT: International UP, 1976); Juliet Mitchell, ed., *The Selected Melanie Klein* (New York: Free Press, 1987; R.D. Hinshelwood, *A Dictionary of Kleinian Thought* (Jason Aronson, 1991).

Heinz Kohut (1913-1981)

Heinz Kohut was born in Vienna in 1913. In 1932 he enrolled in medical school at the University of Vienna. In 1936 Kohut worked in Paris for one year. Analysis with August Aichhorn. Graduated in 1938, emigrated to England in 1939, left for the U.S.A. in 1940. He worked at the Institute for Psychoanalysis in Chicago and was president of the American Psychoanalytic Association. With his books *Narcissism* (1971) and *The Restoration of the Self* (1976), he created a new branch of psychoanalysis — the psychology of the self. He died in 1981 in Chicago.

References: Heinz Kohut, *The Analysis of the Self: A Systematic Approach to the Psychoanalytical Treatment of Narcissistic Personality Disorders*, Guilford, CT: International UP, 1971); H. Kohut, *The Restoration of the Self* (Guilford, CT: International UP, 1976).

Ernst Kris (1900-1957)

Ernst Kris

Ernst Kris was born on 26 April 1900, in Vienna, the son of a lawyer. He received his PhD in art history in 1922. Kris married the physician of Freud's children, Marianne Rie, who introduced him to Freud in 1924. He began training analysis with Helene Deutsch and became a member of the Vienna Psychoanalytic Institute in 1927. After 1932 he was the co-publisher of *Imago*. In 1929 Kris worked at the Metropolitan Museum of Art in New York. He returned to Vienna for eight years as curator of the Museum of History of Arts in Vienna and at the same time was a training analyst at the Vienna Psychoanalytic Institute. He and Otto Kurz (1907-1975) published *Die Legende vom Künstler*. In 1938 he immigrated to England and in 1940 to New York. He published *German Radio Propaganda*. Together with Anna Freud and Marie Bonaparte, he published *Sigmund Freud's Letters to Wilhelm Fleiß*. Kris died in exile in New York in 1957.

References: Ernst Kris, *Psychoanalytic Exploration in Art* (Guilford, CT: International UP, 2000); E. Kris, *Legend, Myth, and Magic in the Image of the Artist: A Historical Experiment* (New Haven: Yale UP, 1981); E. Kris, *The Selected Papers* (New Haven: Yale UP, 1975).

Lajos Lévy (1875-1961)

Lajos Lévy was born in Budapest in 1875. He studied medicine in Budapest, Vienna, and Tübingen, and was active as a physician for several years in Heidelberg. He had already read Freud's studies on aphasia in 1898 and was later analyzed by Sándor Ferenczi. In 1913 Lévy became a founding member and treasurer of the Budapest Psychoanalytic Society. Lévy was not a practicing psychoanalyst but rather, was interested in the psychoanalytic interpretation of biblical texts. In 1926 he consulted Freud about his heart problems. Lévy was married to Katá Lévy (née Tószegh), the sister of Anton von Freund, a brewery owner from Budapest and one of Freud's benefactors. After the Soviet invasion of Hungary in 1956, the couple immigrated to Great Britain, where Katá Lévy was guaranteed a position in Anna Freud's Hampstead Clinic. Lévy became a member of the British Psycho-Analytical Society. He died in 1961 in London.

Jakob Levy Moreno (1890-1974)


Jakob Levy Moreno

Also known as J.M. Levy or Jakob Levy, he was born in Bucharest in 1890. His family moved to Vienna before the turn of the century. In 1917 he graduated from the medical school at the University of Vienna. He worked as a doctor in the refugee camp in Mitterndorf near Vienna, and, after 1919, as a factory doctor and municipal doctor in Vöslau until November 1925. In 1915 his poem, a flight report entitled *Einladung zu einer Begegnung* (Invitation to an encounter) was published by the Anzengruber Verlag, owned by the brothers Suschitzky in Vienna. In 1918 Moreno published a monthly, *Daimon*, with contributions by Max Brod, Albert Paris Gütersloh, Kornfeld, E.A. Reinhardt, Jakob Wassermann, Ernst Weiss, Franz Werfel, Wolfenstein, Paul Claudel, Bèla Balazs, Blei, Ivan Goll, Schnack, and Egon Wellesz. Its sequel, the *Neue Daimon* (12 issues), appeared in 1919, distributed by the Genossenschaftsverlag in Vienna, Prague, and Leipzig, with contributions by Alfred Adler, Albert Ehrenstein, Fritz Lampl, J.M. Levy, Hugo Sonnenschein, and Franz Werfel. They also published Ernst Bloch, Mynona, Martin Buber, Otto Stoessl, and Albert Ehrenstein, among others. In 1920-21, another magazine, *Die Gefährtin* (The companion), appeared, with the same publisher and contributions by Oskar Kokoschka, J.M. Levy, Heinrich Mann, Döblin, Lampl, Quartner, and others. Moreno was thus one of the spokesmen of Viennese Expressionism, and his bibliography as a writer contains sixteen small volumes. The idea of communication was the basis for Moreno's studies in the area of group therapy, group theater, and the psychodrama, of which he can be considered one of the founders. His experiences over the years with group interaction (as a student working with children, as a doctor in a refugee camp and as a factory doctor) led to the founding of the private association, Stegreiftheater (Theater of spontaneity), located at Maysedergasse 2, 1010 Vienna in 1922. The theater could seat thirty to forty persons, admission was free, and actors such as Elisabeth Berger and Peter Lorre participated without financial reward. This spontaneous theater, in which the audience was encouraged to intervene in the development of the plot and whose themes were taken from current newspaper articles, became very well known. A model of the stage of this "theater without an audience" was made by architect Rudolf Hönigsfeld and exhibited at the International Exhibition of New Theater Techniques, which took place in 1924 in Vienna and was organized by the architect Kiesler. Since Kiesler also came up with a similar design, which he used later for other buildings, an enormous plagiarism dispute took place in the press. In 1923 Moreno published his book, *Das Stegreiftheater*, with Kiepenheuer in Potsdam, near Berlin. It was a milestone for revolutionary theater; without it, group theater such as the Living Theater or the Open Theater would never have emerged. Some of the aspects of this theater are the disengagement of the author and the written piece, everyone is both actor and audience, everything is improvised, the open stage is the living room. During this time, Moreno also attempted *The Living Newspaper*, a synthesis of theater, newspaper, and therapeutic theater. This work contains a wealth of inspiration whose effectivity has held until the present. In this work, for example, he already mentions the "theater ad absurdum." From the Theater of Spontaneity, Moreno developed the psychodrama. In 1925 he moved to America, where he continued his experiments. From 1950 to 1960, his ideas influenced the Group Theater, the Actor's Studio, the Living Theater, and in 1963, the Open Theater. In Germany, he influenced Paul Pörtner's Mitspiele (Participations). Pörtner dedicated himself to the rediscovery of Moreno in several articles. Xanti Schwawinski stated that Moreno's Theater of Spontaneity influenced the stage designs of the Bauhaus. In his own plays, Moreno followed therapeutic intentions. In America, he could test his ideas about psychodrama and group psychotherapy methods in schools, institutes, and prisons. His research on ranking within groups led to the discovery of sociometry and a method of depicting social interaction in graphs (the sociogram). This idea of the psychodrama was further developed into group psychotherapy. "The psychodrama," according to Moreno, "can be described as the method that finds a base for the truth of the soul through action. The catharsis that it brings about is therefore an active catharsis. The stage space is an expansion of living, beyond real life." In Beacon, New York, he founded the Psychodrama Institute; the Beacon House Press published many of his works.

After his idea of the psychodrama established itself in the U.S.A. and was used by many psychiatrists, he traveled to several European countries, taking part in group psychotherapy and psychodrama congresses. He died in New York in 1974.

References: J.L. Moreno, *The Theater of Spontaneity* (Beacon, NY: Beacon House, 1946); J.L. Moreno, "Reflections on My Method of Group Psychotherapy and Psychodrama," *Active Psychotherapy* (New York, 1967); J.L. Moreno, *The First Psychodramatic Family* (Beacon, NY: Beacon House, 1964); J.L. Moreno, *The First Book of Group Psychotherapy* (Beacon, NY: Beacon House); J.L. Moreno, *Who Shall Survive* (Beacon, NY: Beacon House, 1934); J.L. Moreno, *Psychodrama, vols. 1-3* (Beacon, NY: Beacon House, 1972); J.L. Moreno, *The Words of the Father* (Beacon, NY: Beacon House); J.L. Moreno, *Sociometry, vols 1-6* (Beacon, NY: Beacon House, 1936-1946); P. Holmes, M. Karp, M. Watson, *Psychodrama since Moreno: Innovations in Theory and Practice* (London: Routledge, 1994); J. Fox, ed., *The Essential Moreno: Writings on Psychodrama, Group Method and Spontaneity* (Springer, 1988).

Hermann Nunberg (1884-1970)

Hermann Nunberg was born in the Galician town of Bendzin on 23 January 1884. His family, who later moved to Tschenstochau, was Jewish. Nunberg attended school in Krakow and began to study medicine there. He moved to Zurich, where he received his doctoral degree in 1910. Jekels introduced him to the Vienna Psychoanalytical Association, of which he became a member in 1915. In Vienna he began his analytic training with Paul Federn. In 1931 Nunberg accepted an invitation from the University of Pennsylvania, and in 1938 his most important work was published, *Neurosenlehre auf psychoanalytischer Grundlage* (A psychoanalytic base for the findings in neuroses), which included an introduction by Sigmund Freud. Nunberg moved permanently to the U.S.A. in 1933, where he became one of the most memorable representatives of the psychoanalytic movement. Federn entrusted him and his son Ernst with the publication of the protocols of the Vienna Psychoanalytical Organization. Nunberg died in New York in 1970.

References: Hermann Nunberg, *Allgemeine Neurosenlehre auf psychoanalytischer Grundlage* (Hans Huber Verlag, 1932).

Sándor Radó (1890-1972)

Sándor Radó

Sándor Radó was born in 1890 in Kisvárda, Hungary. He was a student of Sándor Ferenczi. Radó was a founding member of the Hungarian Psychoanalytic Association and its first secretary in 1913. In 1923 he went to Berlin for psychoanalytic training with K. Abraham and became a member and training analyst of the Berlin Psychoanalytic Association. Among his patients were O. Fenichel, H. Hartmann, and W. Reich. Radó assumed the spokesmanship of the *Internationale Zeitschrift für Psychoanalyse* (International magazine of psychoanalysis) for several years. In the 1920s his main research was in the areas of melancholia, psychoanalysis, epistemology, totemism, and sodomy. In 1931 he went as director to the New York Psychoanalytic Institute. In 1941 he resigned, and he and G. Daniels, A. Kardiner, and D. Levy founded the Psychoanalytic Institute at Columbia University. From 1944 to 1957 he directed the training of psychoanalysts there. He died in New York in 1972.

References: H. Klein, J. Jameson, eds., *Sandor Radó, Adaptational Psychoanalysis* (Jason Aronson, 1995); P. Roazen, *Sandor Radó and the Psychoanalytical Movement* (Jason Aronson, 1995).

Beate Rank (1896-1967)

Beate Rank

Beate Rank was born in Neusandec, Galicia, in 1896. She studied psychology at the University of Krakow. She worked alongside her husband, Otto Rank, who supervised the publication of the magazine Imago. In 1919 she was employed by Internationaler Psychoanalytischer Verlag, a publishing company in Vienna. After 1920 she became involved with the writings of Freud and translated several of his works into Polish. In 1923 Rank became a member of the Vienna Psychoanalytic Association. She completed her own analysis with M. Oberholzer-Gincburg in Switzerland. In 1924 she and Hitschmann organized the International Psychoanalytic Congress in Salzburg. In 1926 she moved to Paris, where she was active as a child psychoanalyst. In 1934 she separated from Otto Rank and in 1936 moved to Boston, where she worked as a training and supervisory analyst at the Boston Psychoanalytic Society. Her work concentrated on the treatment of psychotic and behaviorally disturbed children. She co-directed the Judge-Baker-Guidance Center. She died in Cambridge in 1967.

Otto Rank (1884-1939)

Otto Rank was born in Vienna in 1884. He introduced himself to the Wednesday Society in 1906 with his work *Der Künstler* (The artist) and became a member and the first secretary of this group. Sigmund Freud financially supported his philosophy studies. In 1912 he received his PhD from the University of Vienna. He and H. Sachs assumed the editing of Imago magazine and in 1919 directed the publishing house Internationaler Psychoanalytischer Verlag, becoming the association's president in 1922. He published *Das Trauma der Geburt* (The trauma of birth). In 1924 another book, written with Sándor Ferenczi, was published: *Entwicklung der Psychoanalyse* (The development of psychoanalysis). In 1926 he moved to Paris. In 1928 he announced his departure from the Vienna Psychoanalytic Association. With his book, *Wahrheit und Wirklichkeit* (Truth and reality), he achieved a breakthrough in independent thought in 1929. Moving away from the basic psychoanalytic premise of the drive-mechanism, he devised a philosophically oriented concept of individuality, desire, and consciousness, and developed a type of short-term therapy. In 1935 Rank moved to New York, opened a private practice and founded a school for social workers. He died in New York in 1939.

Otto Rank

References: Otto Rank, *Der Doppelgänger. Eine psychoanalytische Studie* [Vienna, 1925] (reprint, Vienna: Turia + Kant, 1993); O. Rank, *Beyond Psychology* (New York: Dover Publications, 1966); O. Rank, *The Trauma of Birth* (New York: Dover Publications, 1994); O. Rank, *Truth and Reality* (New York: W.W. Norton & Company, 1978); O. Rank, *Art and Artists: Creative Urge and Personality Development* (New York: W.W. Norton & Company, 1989); E.J. Liebermann, *Acts of Will: The Life and Work of Otto Rank* (New York: Free Press, 1985).

Wilhelm Reich (1897-1957)

Wilhelm Reich

Wilhelm Reich was born in Dobrzanica, Galicia, in 1897. He completed his medical studies in Vienna and participated in the Studentenseminar für Sexuologie (Student's seminar for sexology), initiated by O. Fenichel in Vienna. He was admitted to the Vienna Psychoanalytical Association in 1920. After analysis by I. Sadger and P. Federn, he became the secondary doctor at the newly founded clinic of the Vienna Association in 1922. Reich was trained in psychiatry by P. Schilder at the Wagner-Jauregg Clinic. Reich directed the technical-therapeutic seminar from 1924 to 1930. After 1925 he was a member of the trainee advisory committee of the Vienna Association. In 1928 he and M. Frischauf-Pappenheim founded the Sozialistische Gesellschaft für Sexualberatung und Sexualforschung (Socialist society for sexual counseling and research). In 1927, his work, *Die Funktion des Orgasmus* (The function of the orgasm) was published. 1933 saw the publication of *Charakteranalyse* (Character analysis). Reich joined the Communist Party in 1929 and was expelled in 1933. At the end of 1930, he moved to Berlin. He founded the Deutscher Reichsverband für proletarische Sexualpolitik (German federal association for proletariat sexual politics), also known as "Sexpol" for short, and later published *Sexualpolitik* (Sexual policy). He was a member of the German Psychoanalytical Society. After Hitler's rise to power, Reich immigrated via Denmark and Sweden to Norway. In 1934 he was expelled from the International Psychoanalytic Association. He founded the Institute for Sexual-Economic Life Research in Oslo. He moved to the U.S.A., where he worked on his orgone theory. He started a laboratory in Maine, an observatory, and a publishing house, the Orgone Press. In 1954 a lawsuit was filed against his selling orgone accumulators, and he was sentenced to two years in prison. He died on 3 November 1957 in prison.

References: Wilhelm Reich, *The Sexual Revolution: Toward a Self-Governing Character Structure* (New York: Farrar, Straus and Giroux, 1971); W. Reich, *The Function of the Orgasm: Sex-Economic Problems of Biological Energy, vol.1, Discovery of the Orgone* (New York: Noonday Press, 1986; W. Reich, *Listen, Little Man!* (New York: Noonday Press, 1985); W. Reich, *The Mass Psychology of Fascism* (New York: Noonday Press, 1980); W. Reich, *The Bioelectrical Investigation of Sexuality and Anxiety* (New York: Noonday Press, 1982).

Theodor Reik (1888-1969)

Theodor Reik

Theodor Reik was born in 1888 in Vienna. His first contact with Freud, whose protegé he became, was in 1910. In 1912 Reik received his PhD in philosophy from the University of Vienna with his work *Die Psychoanalyse von Flaubert's 'Versuchung des hl. Antonius'* (The psychoanalysis of Flaubert's 'Temptation of St. Anthony'), which was considered the first psychoanalytic doctoral thesis. In 1911 he was admitted to the Vienna Psychoanalytical Association. He was analyzed by K. Abraham in Berlin; co-operation with Hanns Sachs and Otto Rank. Reik became the secretary and librarian of the Vienna Psychoanalytical Association. He opened his psychoanalytical practice in Vienna. In 1925 he was the subject of a lawsuit. In 1928 Reik moved to Berlin to give lectures. He immigrated to the Netherlands in 1933, where he practiced psychoanalysis in The Hague. In 1938 he went to New York, where he was given an honorary membership in the New York Psychoanalytic Society. In 1948 Reik founded his own psychoanalytic association and clinic, the National Psychological Association for Psychoanalysis, which also accepted students who were not medical doctors. He received acclaim for his works on criminal and religious psychology. He died in New York in 1969.

References: Theodor Reik, *Geständniszwang und Strafbedürfnis* (1925); T. Reik, *Compulsions to Confess: On the Psychoanalysis of Crime and Punishment* (Manchester, NH: Ayer Company Publishers, 1977); T. Reik, *Hören mit dem dritten Ohr* (1948); T. Reik, *The Secret Self: Psychoanalytic Experiences in Life and Literature* (Westport, CT: Greenwood Publishing Group, 1973); T. Reik, *The Haunting Melody* (New York: Farrar, Straus and Young, 1953); T. Reik, *The Unknown Murder* (Guilford, CT: International UP, 1998); T. Reik, *Love and Lust: On the Psychoanalysis of Romantic and Sexual Emotions* (Somerset, NJ: Transaction Publishers, 2002).

Géza Révész (1878-1955)

The psychologist worked mainly in the fields of music and sound psychology. Révész studied in Budapest and Göttingen. In 1908 he became an assistant professor at the University of Budapest. He became a professor in 1918, during the Hungarian Soviet Republic. After the fall of the Republic, he emigrated in 1921 to Amsterdam, where he was professor of psychology at Amsterdam University after 1932. His uncle was the mathematician Alféd Renyi.

References: Géza Révész, *Zur Grundlegung der Tonpsychologie* (Leipzig, 1913); G. Révész, *A tehetség korai felismerése* (Budapest, 1918); G. Révész, *The Psychology of a Musical Prodigy* (Westport, CT: Greenwood Publishing Group, 1925); G. Révész, *Die Formenwelt des Tastsinns I und II* (The Hague: 1937); G. Révész, *Das Problem der Sprache* (1942); G. Révész, *Die menschliche Hand. Eine psychologische Studie* (Basel, 1944); G. Révész, *Talent und Genie. Grundzüge einer Begabungspsychologie* (Bern: Francke, 1952); G. Révész, *Introduction to the Psychology of Music* (New York: Dover Publications, 2001); G. Révész, *The Origins and Prehistory of Language* (Westport: Greenwood Publishing Group, 1978).

Paul Roazen (1936)

Paul Roazen, born in 1936 in Boston, Massachusetts, received his PhD from Harvard University and worked at the University of Chicago and at Magdelen College in Oxford. He taught political theory at Harvard and at York University in Toronto, Ontario. He wrote numerous articles for scientific journals and published more than a dozen books, which were translated into many languages.

References: Paul Roazen, *How Freud Worked: First-Hand Accounts of Patients* (Jason Aronson, 1995); P. Roazen, *Brother Animal: The Story of Freud und Tausk* (Somerset, NJ: Transaction Publishers, 1990); P. Roazen, *The Trauma of Freud: Controversies in Psychoanalysis* (Somerset: Transaction Publishers, 2002); P. Roazen, *The Historiography of Psychoanalysis* (Somerset: Transaction Publishers, 2000).

Géza Róheim (1881-1953)

Géza Róheim was born on 12 September 1881 in Hungary. He was an ethnologist and studied geography and ethnology in Leipzig and Berlin. Róheim trained as a psychoanalyst with S. Ferenczi and V. Kovács. From 1928 to 1931 he did field studies in Somalia, Central Australia (among the Aranda), and on Normanby Island (Melanesia) among the Yuma, as well as among the Navaho in 1947. From 1932 to 1938 he was active as a psychoanalyst in Budapest and in the U.S.A. after 1938. Róheim applied methods and concepts of psychoanalysis to ethnological field studies or ethnopsychoanalysis.

References: Géza Róheim, *The Two Gates of the Dream* (Guilford, CT: International UP, 1969); H. Zinzer, *Mythos und Arbeit. Psychoanalytische Mytheninterpretationen bei Géza Róheim* (Wiesbaden, 1976); G. Róheim, *Psychoanalysis and Anthropology* (Guilford, CT: International UP, 1968); G. Róheim, *Fire in the Dragon and Other Psychoanalytical Essays on Folklore* (Princeton: Princeton UP, 1992).

Hanns Sachs (1881-1947)


Hanns Sachs

Hanns Sachs was an imperial and judicial advocate in Vienna until 1918, but above all he was interested in literature and psychology. He attended Sigmund Freud's lectures at the University of Vienna and was admitted to the Vienna Psychoanalytic Association in 1910. Together with Otto Rank, Sachs was one of the first non-medical analysts. In 1912 he founded the journal *Imago*, which he later continued in exile under the title *American Imago*. Together with Rank, in 1913, Sachs published *Die Bedeutung der Psychoanalyse für die Geisteswissenschaften* (The meaning of psychoanalysis for the humanities). He accepted an invitation to the Berlin Institute in 1920 and became its first training analyst. In cooperation with Karl Abraham in Berlin, he worked on, among other things, a film project, which was intended to popularize psychoanalysis. The film, *Geheimnisse einer Seele* (Secrets of a soul) directed by G.W. Pabst, debuted in 1926. Sachs moved to Boston in 1932 and became a training analyst of the Boston Psychoanalytical Society. He died in Boston in 1947.

References: Hanns Sachs, *Freud, Master and Friend* (Manchester, NH: Ayer Company Publishers, 1944); H. Sachs, "The Delay of the Machine Age," Psychoanalytical Quarterly (11: 1933).

Paul Schilder (1886-1940)

Paul Schilder was born in 1886 in Vienna, the son of a Jewish silk trader. He completed his studies in both medicine and philosophy. From 1912 to 1914 he was an assistant at the psychiatric clinic in Leipzig. In 1920 Schilder's work *Wahn und Erkenntnis* (Insanity and knowledge) brought him a professorship in Vienna in the disciplines of psychiatry and neurology. In 1919 he became a member of the Vienna Psychoanalytic Association. Schilder became director of the department for the treatment of psychosis at the Association's clinic in 1929. He moved to New York in October 1929, where he became director of the Psychiatric Division at Bellevue Hospital. Schilder died in a car crash in New York in 1940.

References: P. Schilder, *Contribution to Developmental Neuropsychiatry* (Guilford, CT: International UP, 1964); P. Schilder, *On Neurosis* (Guilford, CT: International UP, 1979); P. Schilder, *On Psychosis* (Guilford, CT: International UP, 1975); D. Shaskan, W. Roller, *Paul Schilder: Mind Explorer* (New York: Human Sciences Press, 1985).

Wilhelm Stekel (1868-1940)

Wilhelm Stekel, one of Freud's first colleagues, formed an independent school with A. Adler and C.G. Jung. He was born in a small Austrian town and went to Vienna to study medicine. The title of his first book, *Die Sprache der Träume* (The language of dreams, 1911), and his lifelong occupation with writing poetry, testify to his love of language. After a short term as an army doctor, he worked briefly as a neural scientist at the renowned Krafft-Ebing clinic, which assured him a splendid future. For professional reasons, however, Stekel opened a private practice, where he soon found recognition as a general practitioner. He adopted electrical therapy and hypnosis from Krafft-Ebing for treating neurosis, and hydrotherapy from Winternitz. With his article, "Das Sexualleben in Kindern" (Sex life of children), Freud became aware of Stekel and his practice. Stekel, who was analyzed by Freud, suggested the founding of the Wednesday Society. Reported to have analyzed more than one thousand patients, Stekel believed more strongly than Freud did in the sexual cause of psychological disorders. Stekel accepted Freud's ideas, but could only partially share them, and they went separate ways, also due to personal conflicts that troubled Stekel greatly. In 1938, Stekel, who was primarily known for his dream interpretations, moved with his second wife to London, where he ran a successful private practice. As a result of his diabetes and an inoperable prostate condition, he suffered from severe depression. He committed suicide in London in 1940. His main work is considered to be the ten volumes on the *Störung des Trieb- und Affektlebens* (Disturbances of drive and emotional life); after 1908 he published *Nervöse Angstzustände und ihre Behandlung* (Nervous anxiety and its treatment); *Onanie und Homosexualität* (Masturbation and homosexuality); *Die Geschlechtskälte der Frau* (The frigidity of woman); *Die Impotenz des Mannes* (The impotence of man); *Psychosexueller Infantilismus* (Psychosexual infantilism); *Impulshandlungen* (Impulsive acts); *Der Fetischismus* (Fetischism); *Sadismus und Masochismus* (Sadism and masochism); and *Zwangsneurosen* (Obsessive neuroses).

Wilhelm Stekel

References: Wilhelm Stekel, *Unser Seelenleben im Kriege. Psychologische Betrachtungen eines Nervenarztes* (Berlin, 1916); W. Stekel, *Der Wille zum Leben. Neue und alte Wege zum Glück* (1930); Walter Schindler, ed., *Wilhelm Stekel. Aktive Psychoanalyse. Ein Lesebuch* (Bern: Hans Huber, 1980); W. Stekel, *Compulsion and Doubt* (New York: W.W. Norton and Company, 1949); W. Stekel, *Sadism and Masochism* (New York: W.W. Norton and Company, 1953); W. Stekel, *Psychoanalysis and Suggestion Therapy* (London: Routledge, 1999); W. Stekel, *Sexual Aberrations* (New York: Liveright Publications, 1996); W. Stekel, *Autobiography* (New York: W.W. Norton and Company, 1950).

Richard and Edita Sterba

Richard Sterba was born on 6 May 1898 in Vienna. He studied medicine with Wagner-Jauregg and his assistant, Paul Schilder. Edita Sterba, born Edita von Radanovicz-Harttmann, studied psychology and musicology. After 1918 she worked at Internationaler Psychoanalytischer Verlag, a publishing house in Vienna. The couple married in 1926. Friendship with Wilhelm Reich. In 1938, emigration to Ascona; later moved to Detroit in 1939.

References: R. Sterba, *Reminiscences of a Vienna Psychoanalyst* (Detroit: Wayne State UP, 1981); H. Daldin, ed., *Richard Sterba: The Collected Papers* (Great Barrington, MA: North River Press, 1986).

Edita Sterba

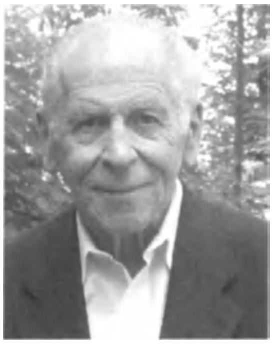
Adolf Josef Storfer (1888-1944)

Adolf Josef Storfer was born in 1888 in Bukovina, the son of a lumber merchant. He went to school in Klausenburg and began his law studies there, which he then continued in Zurich. In Zurich Storfer worked as a journalist, and there he became aware of psychoanalysis. In 1910, he sent Sigmund Freud his manuscript

Adolf Josef Storfer

Zur Sonderstellung des Vatermordes (On a special case of patricide), which was published in 1911 in the series *Schriften zur angewandten Seelenkunde* (Writings on applied soul work). After military service in Hungary and the fall of the Hungarian Soviet Republic, Storfer moved to Vienna. Moving from the Psychoanalytic Society in Budapest, he was accepted for membership in the Vienna Psychoanalytic Association in 1919. From 1925 to 1932 he was director of the Internationaler Psychoanalytischer Verlag in Vienna. His emigration in 1938 proved difficult, yet he managed to finally flee to Shanghai, where he also published the German-language newsmagazine, *Die Gelbe Post* (The yellow mail) for émigrés. In 1940 he had to end his activities and fled from the Japanese troops in 1941 to Australia, where he died in 1944.

References: A.J. Storfer, *Zur Sonderstellung des Vatermordes: Eine rechtsgeschichtliche und völkerpsychologische Studie* (Franz Deuticke, 1911); A.J. Storfer, *Wörter und ihre Schicksale* (Atlantis, 1935).



Thomas S. Szasz

Thomas S. Szasz (1920)

Thomas S. Szasz was born in Budapest in 1920. In 1938 he emigrated to the U.S.A. He studied medicine in Cincinnati, received his psychiatric training at the University of Chicago and his psychoanalytic training at the Chicago Institute for Psychoanalysis. He began his practice of psychoanalysis in 1948. Since 1955 he has been professor of psychiatry at the State University of New York in Syracuse. In 1973 the Humanistic Association of America named him "Humanist of the Year." He is considered a radical critic of psychiatry and psychoanalysis.

References: Thomas S. Szasz, *The Manufacture of Madness: A Comparative Study of the Inquisition and the Mental Health Movement* (Syracuse UP, 1997); Thomas S. Szasz, *The Myth of Mental Illness; Foundations of a Theory of Personal Conduct* (New York: HarperCollins, 1984); Thomas S. Szasz, *Law, Liberty, and Psychiatry: An Inquiry into the Social Uses of Mental Health Practices* (Syracuse UP, 1989); T.S. Szasz, *Pharmacracy. Medicine and Politics in America* (Westport, CT: Praeger Publications, 2001); T.S. Szasz, *Our Right to Drugs: The Case for a Free Market* (Syracuse UP, 1996); T.S. Szasz, *Psychiatric Justice* (Syracuse UP, 1989); T.S. Szasz, *Insanity: The Idea and Its Consequences* (Syracuse UP, 1977).

Lipót Szondi

Leopold (Lipót) Szondi (1893-1986)

Leopold Szondi was born on 11 March 1893 in Neutra. He became a psychotherapist. From 1927 to 1941 he was professor of psychopathology at the School of Therapeutic Pedagogy in Budapest and later, after 1962, in Zurich. Szondi was interned in Bergen-Belsen concentration camp for half-a-year. In 1944 he fled to Switzerland. His work concentrated especially on drive pathology and therapy. He developed Schicksalsanalyse (fate analysis) as a special field of psychology of the unconscious, and a test, the Szondi Test, was named after him. He died on 24 January 1986 in Küsnacht.

References: Leopold Szondi, *Analysis of Marriages* (1937); L. Szondi, *Schicksalsanalyse, 5 vols.* (1944-1963); L. Szondi, *Freiheit und Zwang im Schicksal des Einzelnen* (1968); L. Szondi, *Kain. Gestalten des Bösen* (1969); L. Szondi, *Moses. Antwort auf Kain* (1973); L. Szondi, *Lehrbuch der experimentalen Triebdiagnostik, 3 vols.* (Huben, 1972); L. Szondi, *Triebpathologie, 2 vols.* (1956); L. Szondi, *Die Triebentwicklung* (1980); L. Szondi, *Szondi Test: In Diagnosis, Prognosis, and Treatment* (Lippincott, 1959).

Victor Tausk (1879-1919)

Victor Tausk was born on 12 March 1879 in Sillein, Slovakia. From 1897 to 1902, he studied law at the University of Vienna. In 1900 he married Martha Frisch, with whom he had two sons. They divorced in 1908. He began his first attempts at writing after 1905. In 1906, Tausk moved to Berlin. He worked as a journalist and writer, but broke down mentally and physically in 1907. His interest in Freudian psychoanalysis began in 1907 or 1908, after which he moved to Vienna. He studied medicine from 1908 to 1914, financially supported by Freud and the Vienna Psychoanalytic Association, which he joined in 1909. In 1912 Tausk became friends with writer and psychoanalyst Lou Andreas-Salomé. During World War I, he served in the military between 1915 and 1918. Numerous lectures at the Psychoanalytic Association, author of psychoanalytical essays, including *Zur Psychologie der Kindersexualität* (On the psychology of children's sexuality), *Psychoanalyse der Philosophie* (Psychoanalysis of philosophy), *Psychoanalytische Philosophie* (Psychoanalytic philosophy), *Zur Psychopathologie des Alltagslebens* (On the psychopathology of everyday life), *Zur Psychologie des Deserteurs* (On the psychology of the deserter), as well as literary works (poems, ballads, novellas, plays, and translations of Slovakian literature). Tausk wanted to be analyzed by Freud, who declined. Tausk received this with much irritation. Helene Deutsch broke off her analysis of him in 1919 because it put a heavy strain on Deutsch's own analysis with Freud. Tausk's life was characterized by his great reverence for Freud, although he did not feel that Freud appreciated him as an independent thinker. On 3 July 1919, the same day that official notice of his wedding with concert pianist Hilde Loewi was to be published, he committed suicide by gunshot and hanging.

References: Victor Tausk, *Sexuality, War, and Schizophrenia: Collected Psychoanalytical Papers* (Somerset, NJ: Transaction Publishers, 1991); V. Tausk, "Über die Entstehung des 'Beeinflussungsapparates' in der Schizophrenie" (On the development of influencing mechanism in schizophrenia), Internationale Zeitschrift für Psychoanalyse (5: 1919); P. Roazen, K.R. Eissler, *Talent and Genius. The Fictitious Case of Tausk contra Freud,* Chicago: Quadrangle Books, 1971); P. Roazen, *Brother Animal: The Story of Freud und Tausk* (Somerset, NJ: Transaction Publishers, 1990); K.R. Eissler, *Victor Tausk's Suicide* (Guilford, CT: International UP, 1983).

Edoardo Weiss (1889-1970)

Edoardo Weiss was born in Trieste in 1889. He studied medicine in Vienna. In 1919 he came into contact with Freud, whose lectures he attended at the University of Vienna. Weiss was admitted to the Vienna Psychoanalytic Association in 1913. He underwent analysis with Paul Federn. After completing his studies, he returned to Trieste, where he opened up a psychoanalytic practice. Weiss translated Freud's writings into Italian. He gave up his employment at the Psychiatric Hospital in Trieste in 1927 and moved to Rome in 1931, where he organized the psychoanalytic society, Società Psicoanalitica Italiana, serving as president in 1932. In 1936 he was given the right to teach, since the Italian group had dissolved. In 1939 Weiss immigrated to Chicago and became a member of the Psychoanalytic Association there. He published Federn's writings, and as his friend and student, continued Federn's ego psychology. He died in Chicago in 1970.

References: Edoardo Weiss, *Sigmund Freud as a Consultant: Recollections of a Pioneer in Psychoanalysis* (Somerset, NJ: Transaction Publishers, 1991).

Edoardo Weiss

Fritz Wittels (1880-1950)

Fritz Wittels was a shining figure in Viennese literary and psychoanalytic circles (Adolf Loos was one of his patients). He published the first Freud biography in 1923, which was criticized because it sided with Wilhelm Stekel. His essay about Karl Kraus's longtime lover, Irma Karczwska, "Das Kindweib" (The child-woman), which appeared in July 1907 in the magazine, *Die Fackel* (The torch, issue 230-31, pp. 14-33) initiated the cult of the child-woman, whose influence supposedly extended as far as Billy Wilder's *Irma La Douce*. The child-woman Irma and the novel published about her, *Ezechiel, der Zugereiste* (Ezekiel the newcomer, 1910) were the subjects of a scandal as well as a personal quarrel with Kraus, which strengthened Kraus's negative opinion of psychoanalysis. In 1910 Wittels took part in the Psychoanalytic Congress in Nuremberg, yet thereafter distanced himself from the Vienna group of psychoanalysts and worked in connection with Wilhelm Stekel until 1924. In World War I, he served as an officer in Turkey and in Syria, after which he advocated Joseph Popper-Lynkeus's notion of "allgemeine Nährpflicht" or compulsory nutritional service. In 1925 Wittels again became active in the Vienna Psychoanalytical Association. He immigrated to New York in 1928, where he died in 1950.

References: Fritz Wittels, *Der Taufjude* (1904); F. Wittels, *Die sexuelle Not* (1909); F. Wittels, *Alte Liebeshändel* (1909); F. Wittels, *Die Technik der Psychoanalyse* (1926); F. Wittels, *Die Psychoanalyse. Neue Wege der Seelenkunde* (1927); F. Wittels, *Die Befreiung des Kindes* (1927); F. Wittels, *Die Welt ohne Zuchthaus* (1928); F. Wittels, *Critique of Love* (1929); F. Wittels, *Interpreting Your Dreams* (1936); F. Wittels, *Sex Habits of American Women* (1951); F. Wittels, *Freud and the Child Woman: The Memoirs of Fritz Wittels*, E. Timms, ed. (New Haven: Yale UP, 1996); F. Wittels, *Sigmund Freud: His Personality, His Teaching, and His School*, [originally published in German, 1923] English translation (Manchester, NH: Ayer Company Publishers, 1924).

Fritz Wittels

Compiled mainly from Oskar Frischenschlage, ed., *Wien, wo sonst! Die Entstehung der Psychoanalyse und ihrer Schulen* (Vienna/Cologne/Weimar: Böhlau, 1994).

The caricatures are taken from *Psychoanalytiker in der Karikatur*, Helmut E. Lück and Elke Mühlleitner, eds. (Munich: Quintessenz Verlag, 1993). The drawings were done by Hungarian artists Olga Székely-Kovács (1900-1971) and Róbert Berény (1887-1953) on the occasion of the VII International Psychoanalytic Congress in 1924 in Salzburg.

8

Péter Forgács

Dream Inventory

Péter Forgács
born 1950 in Budapest. Studied at the Academy of Fine Arts in Budapest. Works in film, video, installation, and performance. Lives in Budapest.

1979 Fiatal Müveszek Klub, Budapest
1985 Ernst Múzeum, Budapest
1988 Galerie Fotohof, Salzburg
1995 Fővárosi Képtár, Kicselli Múzeum, Budapest
1996 Postmaster Gallery, New York
1997 Budapest Galéria, Budapest
2001 *Regards sur la Hongrie*, Le Forum des images, Paris (with Béla Tarr)

Group shows
1984 *Új képek*, Plánum Festival, Budapest
1987 *Partenope*, Hungarian Academy, Rome
1992 *Sub voce*, Műcszarnok, Budapest
1996 *The Butterfly Effect*, Műcszarnok, Budapest
1997 Goethe-Institut, Budapest
1999 Akademie der Künste, Berlin
2000 San Francisco International Film Festival, San Francisco
Viennale, Vienna
2001 Dresdner Schmalfilmtage, Dresden
2003 *Future Cinema*, ZKM, Karlsruhe

Films
Privát Magyarország I-XII, 1986
Szondi Lipót portréfilm, 1986
Dusi and Jenő, 1989
Either-Or, 1989
The Bartos Family, 1988
The Diary of Mr. N: 1938-1967, 1990
Wittgenstein, Freud és a pszichoanalizis I-V, 1992
Bourgeois Dictionaries, 1992
Totem, 1993
Meanwhile Somewhere, 1940-43, 1994
Free Fall, 1997
The Maelstrom – A Family Chronicle, 1997
The Danube Exodus, 1998;
Angelos' Film, 1999.
A Bibó Reader, 2002

Another dream in the rehearsal of Group 180. It begins at nine a.m. I arrive at the theater earlier, there are only a few of us there, I leave with K., for we are going to visit his school where the pupil...in the room the children are eating lunch with such tiny, tiny, tiny knives and forks. The dining hall can be extended where the gas cylinders are. This is my advice. K., my son, a...he gives me an eraser but he cannot...finish the meal; I rush back to the rehearsal...oh, dear...yes.

Can I say it?...I had another dream, yes, this...was ten years ago, a giant house...we are in a house with bits of debris and...this house is vast...we live here, women, children, servant, servant who gets killed. Then we are chased by giant predatory people. There is one scene where I shrink and start shaking like in a scene from a novel by Hajnóczy. I could never, never decide. Once, I recall, at that point, my father, my father came home to us at Christmas, someone brought him of course. They had to bring him, and slowly, very slowly, he undressed, perhaps waiting for me to help him. He does not wash, perhaps waiting for me to wash him. Like a child. I could never decide...if this was a game or...if it was real...his paranoia was real, but...I remember him relating one of his dreams when he was having an operation, and how he woke up from his light sleep...And of course he ran after her, he died three days later.

I had, I had another dream with M., but...somehow I do not remember what it was about...yes...I had a frightening dream, too, in which M. said goodbye and I mistook her for Kati. Well, I was just coming from the West train station, from somewhere or other, I am exhausted. We had met earlier, for half an hour, and what if the family does not come? It is constantly changing its appearance. Hmm, yes, the girl...I do not understand either, suddenly everything becomes confused; in the taxi I notice that I am heading towards the East train station although we want to meet at the West train station, and I am driving in the taxi to the West train station; the taxi turns, I see her and my heart is filled with pain...Yes. She was incredible. She had an incredible body. Incredible eyes. Incredible hair...She was very strange...Yes.

And then I had a very strange dream. Suddenly, suddenly I do not remember where I lost my clothes, but I am sure that, that I am only wearing a vest, and I am walking around wrapped in a blanket, I walk over to Szentendre, hoping that, that Krajcso is in his shop. Evening lights, I am creeping along, which may be quite conspicuous, for...I am wrapped in a blanket, the whole surroundings are slightly reminiscent of somewhere in a foreign country, although I know, I know exactly that I am in Szentendre, I hope to get there as quickly as possible, I am freezing my ass off, two smiling policemen dressed in gray stop me in a subway...they ask me questions...both of them are young and funny in a way; ah you, please show me your identity card, suddenly the subway fills up with youngsters and children; they look at me; of course I have not got any papers, I start explaining myself

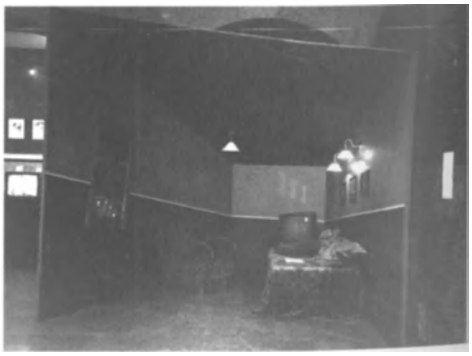
— I'm just passing by, I'm on my way to meet a friend of mine

— so...you've had a bath, that's not allowed.

— No, I haven't had a bath.

Text excerpt from the video film of the installation *Dream Inventory*, 1995

Péter Forgács, *Dream Inventory*, 1995
Installation view, *Fővárosi Képtár*, Kiscelli Museum, Budapest 1995



Péter Forgács, *Dream Inventory*, 1995
Installation view, *Beyond Art*, Budapest 1996

Peter Weibel

Vienna Actionism: Direct Art, Body Art, Material Art

Fine Arts Expanded into Reality in the 1960s

"art developed a tendency to use reality as its direct means of creation" (Hermann Nitsch, *das lamm* / the lamb, manifesto 1964). Nitsch, 1970: "the essence of (the o. m. theater's) action is the penetration into reality, demonstratively forming and setting fields of reality in relation to each other." The starting point for this expansion was painting.

1969 brochure announcing Peter Weibel's *Wien. Bildkompendium Wiener Aktionismus und Film* (Frankfurt am Main, 1970).

Hermann Nitsch (1965):
my action theater developed from informal action painting, from tachism.

Rudolf Schwarzkogler (1965):
the total act
instead of constructing an image on a surface, the construction of conditions for the painting represents a particular field of action (the space around the actor — the real objects found in the environment); the act of painting itself can be liberated from the coercion of having to create relicts by putting it in front of the reproducing apparatus, which takes over the information; the time it takes to paint and the time it takes to present become one; variable montages are created out of the movement of and confrontation with the selected elements, and their transformation and sequencing leads to the temporal, dynamic progression of the action; it is extended to the point of the totally synaesthetic act that can be perceived by all senses and shared by others; as a real process, it reveals its form to the sculptural image created by multiple registration using various tools.

Günter Brus (1965):
BODY PAINTING is a development of painting. The surface of the image has lost its function as a generally accepted way of conveying messages. It is taken back to its origin, the wall, the object, the life form, the human body. If I include my body as a message carrier, the result is an event whose progression is captured by the camera, which the audience can share. The space, my body, and all objects in the space are transformed. Everything is painted white, everything becomes a "picture surface": office, museum, storage room, café, machine hall, operation room, prison cell, toilet, slaughterhouse, greenhouse, bathroom, American kitchen, sewer, sauna, soccer stadium, conference room, police station, crematorium, cemetery, dissecting room (even corpses can be used), empty room, etc.
BODY PAINTING = controlled SELF-MUTILATION
To paint oneself, strangle, pinch and twist, sit on a white toilet and torture oneself to a bloody pulp, I can never have enough knives, chopping knives, butcher's knives, razor blades, scalpels, eyelash trimmers, knitting needles, pliers, weeding rakes, crescent knives, pimple suckers, blackhead squeezers, poultry scissors, crab claws, grafting knives, drawing compasses, anesthesia forceps, needle compasses, gravers, shoe tacks, lacing needles, wire tacks, staples, piercing irons, thumbtacks, screw points, razor knives, claw clippers, drill bits, skin scissors, dough cutters, wire snares, barbed wire, glass shards, slaughter guns, bone scrapers, snare needles, pad-saws, pins, safety pins and little knives, pen-knives, lobster tongs, crosscut saws, chiseling instruments, cookie cutters, jigsaws, pick axes, finger incision knives, clips, clamps, prying tools, mincing knives, bee stingers, wasp stingers, hornet stingers, ear wax spoons, firing bolts, etc.
BODY PAINTING = endlessly savored SELF-DISEMBODIMENT

Otto Muehl (1965)
material action is painting on show, visible auto-therapy with food. it works like a psychosis, caused by the mixing of human bodies, objects, and material. everything is planned for, everything can be used as material. everything is used as substance.
paint is not a means of coloration, but a pulp, liquid, dust, the egg is not an egg, but a slimy substance.
a symphony orchestra plays naked in a swimming pool, which slowly fills up with jam.
paint and food are sprayed, dumped, and thrown onto an opera performance. the singers must carry on until the end.
events are transformed, material penetrates reality, it loses its common associations, butter becomes pus, jam becomes blood, they become symbols for another event.
the associative takes up a great deal of space among the given possibilities.
if an audience participates, it becomes an accomplice or material; in order to avoid eruptions of drives, the sequence of events will be similar to a gym lesson.

Otto Muehl (1968)
if painting is defined as action with paint on a surface, then material action is action with materials and bodies in spaces.
painting is extended beyond the surface of the image into the space.
MATERIAL ACTION DOES NOT TRY TO RECONSTRUCT REALITY; IT PRESENTS IT DIRECTLY.

The extension of the image surface also implies an extension of both the medium and material of expression with the animal and human body and real things.

The definition of art as a two-dimensional painting was considered too narrow. The two-dimensional painting placed itself in front of reality, between art and reality. That is why it was referred to as 'penetration into reality.' In the form of two-dimensional painting, art presented reality only indirectly. That was why we wanted direct art, a direct presentation of reality, where "paint is not a means of coloration, but a pulp, liquid, dust," (Muehl) and eggs, jam, and animal blood were used instead of paints. The human or animal body assumed the position of the canvas, and food functioned as paint. "Art" appeared as a detour, brush and canvas became superfluous: "not art as in painting pictures, but direct presentation; not carving and painting, but instead throwing dirt in people's faces. to cure them of art. no detours, but direct provocation, twisting their limbs, mixing them with other materials, turning them into objects" (Muehl, 1966).

In Vienna Actionism, the expansion of the artistic medium (body) and material (food, guts, bandages, razor blades, etc.) is about the invasion into reality or, respectively, the penetration of reality into the traditionally closed art system. "material action is a method of expanding reality, creating realities, and expanding the dimension of experience" (Muehl, 1965). Compare also the related movements, Pop Art, Happening, and Fluxus.

Due to this expansion into reality, the roll of the art observer is altered. First, the audience is exposed to an intensified and unusual registry of "realities arranged by art" (Nitsch, 1964) and the chains of associations thereby released ("all possible associations that are set off by the parts of reality quoted by art, are revived, systematically dismantled, and made conscious," Nitsch 1964). "the associations tied to certain materials, whether due to their form, their normal use, or meaning, are used. within the given possibilities, association takes up a great deal of space" (Muehl 1965). "...to allow an insight into the unconscious, wild, chaotic animal instincts. those vitalities are felt for a short time, which, when liberated...drive you to excess" (Nitsch 1965). "to avoid eruptions of drives, the sequence of events will be similar to a gym lesson" (Muehl 1965).

Second, the audience also tends to be turned into material. "if an audience participates, it becomes an accomplice or material" (Muehl 1965). The expansion of the artistic material extends beyond the body and the materials to take in the audience as an element of the artwork. The action's intended effect on the spectators, the psychic activation of the observer (as accomplice or material) provides us with a clear reference to the concept of reality held by the action.

Unmediated (Psychological or Sensual) Reality

Beyond the battle cry of "Direct Reality! Direct Representation!" can be heard, "we become aware that every real object is loaded with symbols. the supposedly concrete objects are only ciphers of an inner-psychic reality" (Nitsch 1964). Apparently this is not about actual reality, but rather the reality in the viewer and artist, about inner-psychic reality. Behind the question of attaining direct access to reality by means of concrete materials and the body, we can decipher psychic reality as the real target: "working with concrete means challenges, more than ever, the contact with the deeper layers of the psyche whose conditions become the actual issue of representation" (Nitsch 1964). This is the heritage of abstract-expressionist painting. Permeating reality means having access to deeper layers of the psyche. This is why we speak so often about an eruption of drives and an insight into animal instincts, because the action taking place in real space, real time, with real objects aims at the imaginary source of emotions and the consciousness. Thus actionism tends less to affect a real change in reality than to find a new "politics of experience."

The heritage of expressionist art nouveau (Klimt, Schiele, Gerstl) and of abstract expressionism (as well as l'art informel and tachism) has set certain limits to the actionist expansion of art into reality. The reality of the action is an inner reality, i.e., of the experience, the sensation. In actionist thinking, traditional painting obstructs our access to this pure reality, impedes the development of the pure sensual experience. In order to find the way to this, to pure experience, to an inner-psychic reality, art as painting of pictures has to be abolished and transcended. One turns to the body to have a hold on direct stimulation. For every other medium apart from this original one would obstruct this synaesthetically understandable reality (Nitsch 1970), would be a simultaneously obstructing and distorting mediation. Therefore we need direct art in order to experience an unmediated reality, the actual sensual reality, the reality of the senses and the soul, and to help it to break through. In his preface to Herman Nitsch's book *Orgien Mysterien Theater* (Orgies mysteries theater, 1969), Oswald Wiener criticized the actionist notion of reality by summarizing the theories of Nitsch in a hypothetical conditional: "culture seems to obstruct our view of sensual reality. form would impede experience...we would have to break the conventions of our sensuality in order to have a share of reality. we would have to operate outside of language in order to replace human communication with a type of communication involving actual reality...the arousal of our sensibility...would achieve that holy state which...is pure sensation." He objects to this "unio mystica" of stimulus and reaction, which is actually the basis of behaviorism: "culture does not hide reality, it creates it. it is it. form is experience...and if grammar is a machine that stamps sensations out of consciousness, the downfall of grammar is the downfall of sensations: where communication is only an experiment for exploring the constraints on consciousness, the identity of consciousness and communication is lost and reality ceases to exist"(Wiener 1969).

Art and Revolution, HS I, University of Vienna, 1968
Left: Franz Kaltenbäck giving his lecture; next to him is Peter Weibel wearing protective glasses; the speaker in the middle is Oswald Wiener; Günter Brus masturbates in front; Laurids is bandaged; Muehl and colleagues in action.

Nevertheless, the reality revealed by actionism questioned seemingly objective reality and "brought into awareness and deciphered collective basic conditions of the soul" (Nitsch), so much so that the state persecuted actionism in order to retain the claim to objective reality and to hide suppressed reality. The state did not want to give up its monopoly on reality (the construction and representation of reality). With the actionist expansion of its definition, art could gain access to new social areas (and thus also to new realities). Expanding the material used in art expanded the social strategies and effects of art. Besides its innovation and the way it grasped "reality," this was the greatest achievement of actionism. Art as a "new style of human communication...extends the borders of social reality" (Weibel 1970).

The following generations owe major impulses to actionism's transgressions of the limits of traditional and normal art. With its transgressive expansions of art, actionism was the first, most intense example of trans art and border art, although, due to their notion of reality and their origins in painting, the actionists themselves would not allow or participate in any further expansion. After all their transgressions, they would even regress to pure painting in the 1970s. Although Muehl had written "everything can be used as material" (1965), only materials that could not deny their roots in painting appeared in his material actions, however. Tomatoes, eggs, and other groceries were only a substitute for paints. Balloons, tweezers, and razors were substitutes for chisel and paint-brush. Cardboard, scarves, paper plates, and skin were used as canvas. The material art of action, which was of fundamental importance for the material aesthetics of Bruno Gironcoli, Walter Pichler, and others, remains essentially a painterly art. The expansion of the base for artistic operation aimed at natural, sensual objects. Despite its all-encompassing promise, the limitation of actionist material art to mostly painterly material is repeated in actionist body art, since the body is treated as material. "bodies, objects, and material mix with each other" (Muehl 1965). The body and the brain become the objects of an (associative) material art; the body serves neither another person nor an embodiment of the spirit. In an action, the body is either a mobile or a shell for the inner-psychic reality, which as a cipher of the same or a closed volume, must penetrate to the guts. The body does not appear as subject but as object. For the physical aesthetics of successive artists, this dilemma is the decisive starting point.

Thus, with its transgressive expansion into reality, actionism acquired two new areas: material art and body art. But its origins in painting left actionism with some aspects of artistic immanence. The transgressive impulse therefore stopped before certain expansions, and Brus and Nitsch distanced themselves outright from further expansions, although they were the first to introduce expansive erosions. They have especially refrained from including technological media. Which, on the one hand, is obvious, because someone who wants to achieve a direct sensual experience will naturally be hostile toward a reproductive medium that stands between pure sensation and unmediated reality. A technical apparatus for creating images will seem like a regression to the traditional frame of a painting, which they had, after all, set out to abandon and break. On the other hand, if it is true that all material can be worked with, then technical elements can also serve as material. The claim to a universal notion of media would include also the technological media.

Otto Breicha, Reinhard Urbach, eds., *Österreich zum Beispiel* (Salzburg: Residenz Verlag, 1982, pp. 36-65).

Günter Brus

Günter Brus
born 1938 in Ardning. In 1960 action painting. In 1964 first action. Lives in Graz.

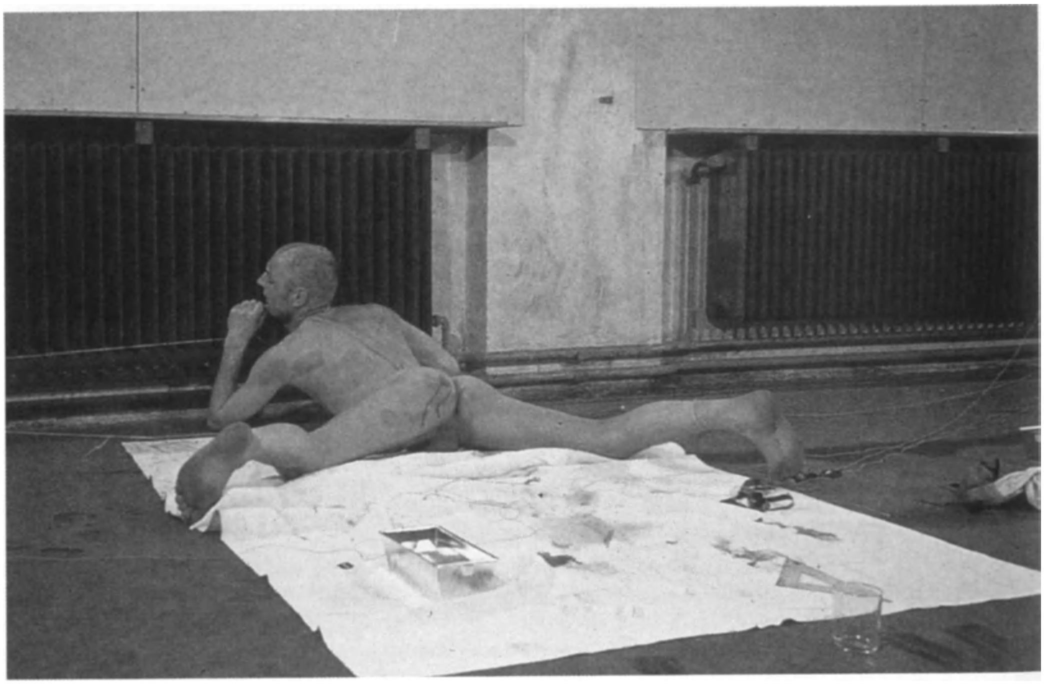
1961 Galerie Junge Generation, Vienna (with A. Schilling)
1976 Kunsthalle, Bern
1979 Whitechapel Art Gallery, London; Kunstverein Hamburg; Kunstmuseum, Luzern
1983 Rupertinum, Salzburg
1986 Museum des 20. Jahrhunderts, Vienna; Kunsthalle, Düsseldorf
1993 Centre Georges Pompidou, Paris
1996 Neue Galerie, Graz
1998 Essl Collection, Klosterneuburg
2000 Arte Giani, Frankfurt
2001 Galerie Heike Curtze, Vienna
2003/2005 *Werkumkreisung*, Albertina, Vienna; Neue Galerie, Graz; Kunsthaus, Zug; Galleria d'arte moderna, Bologna

Group shows
1972 documenta V, Kassel
1973 *Bodyworks*, Museum of Contemporary Art, Chicago
1980 Venice Biennial
1981 *Westkunst*, Rheinhallen, Cologne
1982 documenta VII, Kassel Sydney Biennial
1983 Tate Gallery, London
1987 *Berlinart 1961-1987*, Museum of Modern Art, New York
1989 *Der zertrümmerte Spiegel*, Albertina, Vienna; Ludwig Museum, Cologne
1992 *Identität : Differenz*, Neue Galerie, Graz
1995 *Pittura Immedia*, Neue Galerie, Graz, Venice Biennial
1999 *Der anagrammatische Körper*, Kunsthaus, Mürzzuschlag; ZKM Karlruhe
2001 *Die Cabinette des Dr. Czerny*, Neue Galerie, Graz

References:
Günter Brus. Blitzartige Einfälle in vorgegebene Ideen (Ostfildern: Cantz, 1996).
Günter Brus. Werkumkreisung (Köln: Walther König, 2003).

Günter Brus
Self-Mutilation, 1965
Film frame: Kurt Kren, *10/65 Self-Mutilation*

Günter Brus, *Strangulation*, 1968
Photo: L. Hoffenreich, 23.5 × 18 cm
Film: Ch. Stenzel

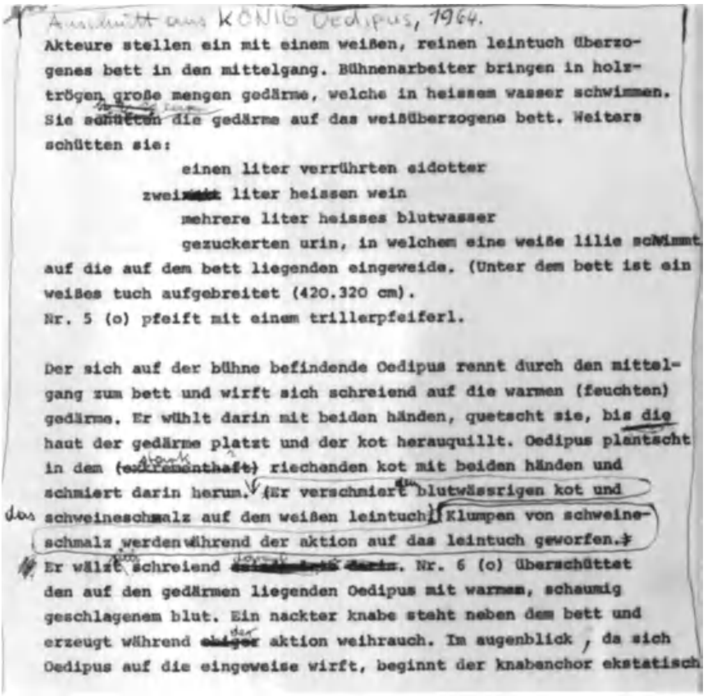


Günter Brus, *Test of Endurance*, 1970
Photo: K. Escher
Film: W. Schulz

Hermann Nitsch, *31st Action*, 1969
Action with Hanel in Munich
© VBK, Vienna, 2005

Hermann Nitsch, *50th Action*, 1975
© VBK, Vienna, 2005

Hermann Nitsch, *Oedipus*, 199
Plaster head
© VBK, Vienna, 2005



Ausschnitt aus KÖNIG Oedipus, 1964.

Akteure stellen ein mit einem weißen, reinen leintuch überzogenes bett in den mittelgang. Bühnenarbeiter bringen in holztrögen große mengen gedärme, welche in heissem wasser schwimmen. Sie ~~schütten~~ die gedärme auf das weißüberzogene bett. Weiters schütten sie:

einen liter verrührten eidotter
zwei~~[illegible]~~ liter heissen wein
mehrere liter heisses blutwasser
gezuckerten urin, in welchem eine weiße lilie schwimmt

auf die auf dem bett liegenden eingeweide. (Unter dem bett ist ein weißes tuch aufgebreitet (420.320 cm).
Nr. 5 (o) pfeift mit einem trillerpfeiferl.

Der sich auf der bühne befindende Oedipus rennt durch den mittelgang zum bett und wirft sich schreiend auf die warmen (feuchten) gedärme. Er wühlt darin mit beiden händen, quetscht sie, bis die haut der gedärme platzt und der kot herauquillt. Oedipus plantscht in dem stark ~~(exkrementhaft)~~ riechenden kot mit beiden händen und schmiert darin herum. (Er verschmiert den blutwässrigen kot und das schweineschmalz auf dem weißen leintuch.) (Klumpen von schweineschmalz werden während der aktion auf das leintuch geworfen.) Er wälzt sich schreiend ~~[illegible] darin~~. Nr. 6 (o) überschüttet den auf den gedärmen liegenden Oedipus mit warmem, schaumig geschlagenem blut. Ein nackter knabe steht neben dem bett und erzeugt während der ~~obiger~~ aktion weihrauch. Im augenblick, da sich Oedipus auf die eingeweise wirft, beginnt der knabenchor ekstatisch

Hermann Nitsch, Detail from *König Ödipus (King Oedipus)*, 1964
© VBK, Vienna, 2005

Hermann Nitsch
born 1938 in Vienna. Studied at the Graphische Lehr- und Versuchsanstalt, Vienna. Since 1989 professor of interdisziplinary art at the Städelschule in Frankfurt. Lives in Vienna.

1964 Galerie Junge Generation, Vienna
1973 Galerie Klewan, Vienna
1975 Galerie Krinzinger, Vienna
1976 Kunstverein, Kassel
1989 Museum des 20. Jahrhunderts, Vienna
1993 National Gallery, Prague
1999 White Box Gallery, New York
2000 Galerie Heike Curtze, Vienna
2002 Whitechapel Art Gallery, London
2004 Galerie Heike Curtze, Vienna
Mike Weiss Gallery, New York

Group shows
1972 documenta V, Kassel
1981 *Westkunst*, Rheinhallen, Cologne
1982 documenta VII, Kassel
1988 Sydney Biennial
1997 ICA, London
1998 *Out of Actions*, MOCA, Los Angeles
2000 *Chaim Soutine*, Jewish Museum, Vienna
2004 Kunst und Revolte, MUMOK, Vienna

Actions
1960 *1. Painting Action*, Atelier Nitsch in the Technical Museum, Vienna
1962 *1. Action*, apartment of Muehl
1968 *25. und 26. Action*, Cinematheque, New York
1970 *7. Game of Abreaction*, Aktionsraum 1, Munich
1975 *50. Action*, Prinzendorf castle, (24 hours)
1980 *66. Action*, Städelschule, Frankfurt/Main
1983 *77. Action*, Stedelijk Van Abbe Museum, Eindhoven
1987 *85. Action*, Kasematten am Schloßberg, Graz
20. Painting Action, Secession, Vienna

References:
Malcolm Green (ed.), *Writings of the Vienna Actionists*, Atlas Press, 1999.

Otto Muehl

Otto Muehl
born 1925 in Grodnau, Burgenland. In the 1970's and 1980's leader of a commune (Friedrichshof, Gomera). Lives in Portugal and Vienna.

1960 Galerie Junge Generation, Vienna
1969 Galleria Milano, Milan
1984 Galerie Hummel, Vienna
1992 Galerie Hubert Klocker, Vienna
2002 Galerie Claudine Papillon, Paris
2004 Museum für Angewandte Kunst, Vienna

Group exhibitions
1981 *Westkunst*, Rheinhallen, Cologne
1988/89 *Aktionsmalerei – Aktionismus 1960-65*, Fridericianum, Kassel; MAK, Vienna
1989 *Der zertrümmerte Spiegel*, Albertina, Vienna; Ludwig Museum, Cologne
1995 *Europa nach der Flut. Kunst 1945-1965*, Künstlerhaus, Vienna
1996 *Kunst aus Österreich 1896-1996*, Kunsthalle, Bonn
1998 *Out of Actions*, MOCA, Los Angeles

Actions
1963 *The Marshing of a Female Body*, Atelier Muehl, Vienna
1964 *Still Life – Action with a Female and a Male Head, and a Bull's Head* Lauhus Gallery, Düsseldorf
1966 *Action Concert for Al Hansen*, (with H. Nitsch, R. Schwarzkogler, P. Weibel), Galerie nächst St. Stephan, Vienna
1968 *Art and Revolution* (with G. Brus, O. Wiener, P. Weibel), HS I, University of Vienna
1970 *Manopsychotic 1. Happening and Fluxus*, Kölnischer Kunstverein, Cologne
O Sensibility, Wet Dream Festival, Amsterdam

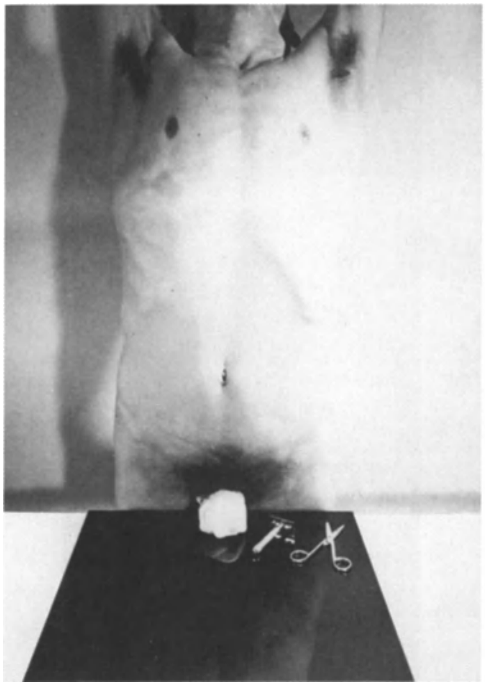
References:
Otto Muehl (Ostfildern: Hatje Cantz, 1992).
Toni E. Altenberg, *Mein Leben in der Mühlkommune. Freie Sexualität und kollektiver Gehorsam*, (Vienna: Böhlau, 1998).

Otto Muehl, *Mama and Papa*, 1964
Photo: L. Hoffenreich, 23 × 30 cm
Film: K. Kren, © VBK, Vienna, 2005

Otto Muehl, *Bodybuilding*, 1965
Photo: L. Hoffenreich, 39.5 × 29.5 cm
Film: E. Schmidt jun., © VBK, Vienna, 2005

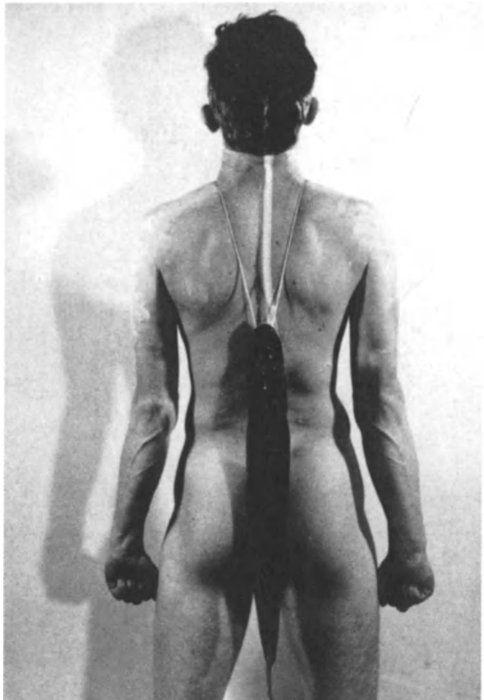
Otto Muehl, *Food Test*, 1965
Photo: L. Hoffenreich
Film: O. Wiener, © VBK, Vienna, 2005

Rudolf Schwarzkogler

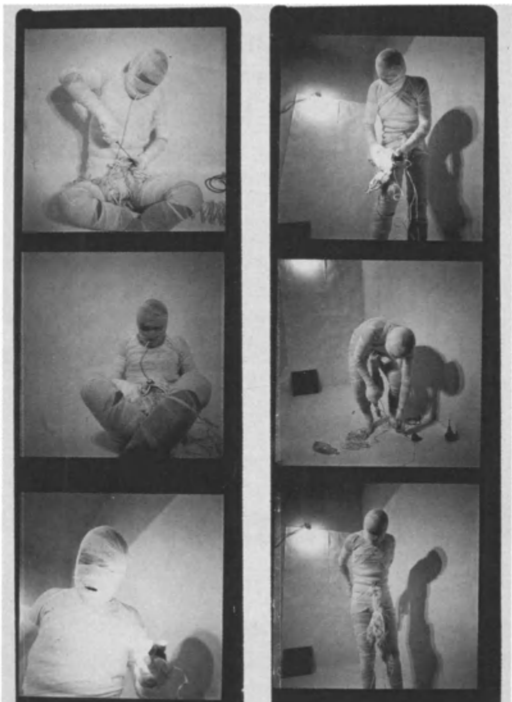


Rudolf Schwarzkogler, *2nd Action*, 1965

Rudolf Schwarzkogler, *3rd Action*, 1965
Photo: L. Hoffenreich, 23.2 × 17.8 cm



Rudolf Schwarzkogler, *3rd Action*, 1965
Photo: L. Hoffenreich, 38.9 × 29.3 cm



Rudolf Schwarzkogler, *6th Action*, 1966
Photo: L. Hoffenreich, 31 × 24 cm

Rudolf Schwarzkogler
born 1940 in Vienna. 1957-1961 he studied at Graphische Lehr- und Versuchsanstalt, Vienna. In 1960 he met with Hermann Nitsch and in 1965 with Günter Brus. Graphic designer. Since 1965 active participations in actions. 1965-1966 seven solo actions. Died in 1969 in Vienna.

1992/93 Museum des 20. Jahrhunderts, Vienna
1993 National Gallery, Prague
1993 Centre Georges Pompidou, Paris
1994 Frankfurter Kunstverein
1993 Kunsthalle Ritter, Klagenfurt
2000 Galerie Johannes Faber, Vienna
2002 *Hommage an Rudolf Schwarzkogler*, Galerie Krinzinger, Vienna

Group shows
1988/89 *Aktionsmalerei – Aktionismus 1960-65*, Fridericianum, Kassel; Kunstmuseum Winterthur; Museum für Angewandte Kunst, Vienna
2001 *La peinture comme crime*, Musée du Louvre, Paris
2002 *Aufbruch in der Kunst der 60er Jahre*, MUMOK, Vienna
2003 *Phantom of Desire*, Neue Galerie, Graz

Actions
1965 *1. Action – Wedding*, apartment of Cibulka, Vienna
1966 *6. Action*, apartment of Schwarzkogler, Vienna *Actions Concert für Al Hansen* (with Muehl, Nitsch, Kren, Steiger, Weibel, Haupt, Priessnitz), Galerie nächst St. Stephan, Vienna
1967 *With Oomph into the New Year* (with Brus, Muehl), apartment of Brus, Vienna
1968 *Satisfaction* (with Brus, Muehl), apartment of Brus, Vienna

References:
Eva Badura-Triska, Hubert Klocker (eds.), *Rudolf Schwarzkogler. Leben und Werk* (Klagenfurt-Vienna: Museum moderner Kunst, 1992).

8 Valie Export

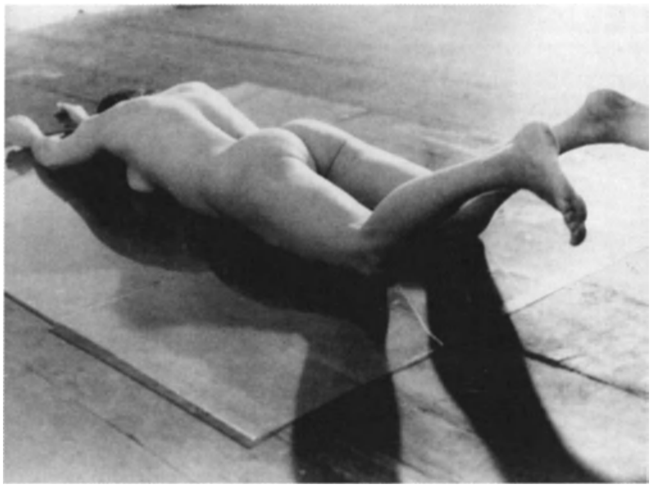
Valie Export
born 1940 in Linz. Attended the Arts and Crafts School in Linz (textile) and in Vienna (design). From 1983 lecturing at American universities. Professor at the Academy of Arts in Berlin, 1992/95. Since 1996 professor at the Art Academy for Media in Cologne. Lives in Cologne and Vienna.

1971 Galerie Klewan, Vienna
1977 Galerie nächst St. Stephan, Vienna
1980 Austrian Pavilion, Venice Biennial
1986 Blake Museum, Baltimore, USA
1996 EA-Generali Foundation, Vienna
2000 *Valie Export – Metanoia*, Galerie im Taxispalais, Innsbruck
2004 *Valie Export: Serien*, Atelier Augarten, Österreichische Galerie Belvedere, Vienna

Group shows
1973 *Trigon 73*, Neue Galerie, Graz
1975 *MAGNA. Feminismus: Kunst und Kreativität*, Galerie nächst St. Stephan, Vienna
1976 *Körpersprache*, Frankfurter Kunstverein
1977 documenta VI, Kassel
1986 *Eva und die Zukunft*, Kunsthalle, Hamburg
1988 *Television Art*, Stedelijk Museum, Amsterdam; Tate Gallery, London
1990 *Künstlerinnen des 20. Jahrhunderts*, Museum Wiesbaden
1996 *masculin/feminin*, Centre Georges Pompidou, Paris
2001 *doublelife*, Generali Foundation, Vienna
2004 *Woman – Metamorphosis of Modernity*, Fundación Miró, Barcelona
Phonorama, ZKM, Karlsruhe

References:
Roswitha Mueller, *Valie Export, Fragments of the Imagination*, (Bloomington-Indianapolis, 1994).
Valie Export, Werkschau III (Vienna: Fotogalerie, 1998).
Valie Export. Summary (Montreuil: éditions de l'œil, 2003).

Eros/Ion
Body-material-interaction, 1971
Material: glass plate, glass splitters, paper canvas



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The action *Eros/Ion* analyzes the relationship between social signs and the body, culture and the body, material and the body. I roll around naked: first in broken glass placed on canvas, my body cutting through the canvas, and then on a glass plate, and again on the canvas The traces that the glass splinters left on my skin-canvas leave spontaneous traces of paint on the paper-canvas. The glass splinters turn into signs by being reduced to mere traces of an aesthetic process on the body.

Asemy. The Incapacity to Express Oneself with One's Facial Expressions
1973, b/w, sound, 7:05 min

© VBK, Vienna, 2005

A bird is affixed with thin strings to a platform. I kneel in front of the bird on the platform and pour hot liquid wax over it, then pour the wax over my feet and my left hand; I then pour the wax on my right hand when I knock over the container with my head. I lift a knife from the platform with my mouth and free myself by cutting with the knife using my mouth. Around the platform a circle of nails has been hammered. On the platform, as the plateau of high civilization, the drama of the human being as sculptor is evolving.

Valie Export (exhibition catalogue) (Linz: OÖ. Landesgalerie, 1992) p. 206, p. 226.

Tibor Hajas

Transformed perception meets its object as raw material; while the "outer" is turned to the "inner" (that is, learned), the "inner" is turned to the "outer" (that is, realized).

He who never sees his own face forgets about it; he who sees it many times wears it as if it were his own product.

He who rarely sees his own face is often shocked by the encounter; he who looks in the mirror regularly worries about the success.

A successful picture is a successful face, a successful movement. In a photograph we do not document but create our look. This new perception is the settling of our identity crisis: the transformation of the personality, its modification, exchange, or materialization.

Photography makes us realize that we can undertake less responsibility for our own face than for our clothing, and that we are able to change this.

Photography encourages us to transform a man to a woman, a young man to an old man, a son to his mother, a foreigner to another foreigner with whom he has nothing but his appearance in common.

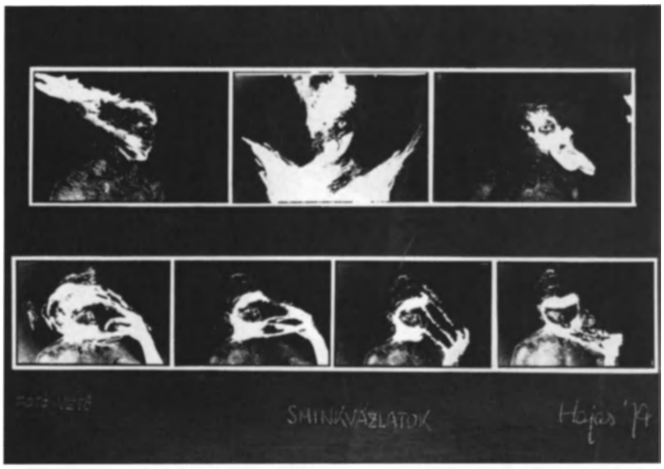
The crossing of the boundaries of the personality forces us to cross its restrictions.

Szógettó, 1976
in: *Jelenlét*, no. 1–2 (14–15): 1989.

Tibor Hajas
born 1946 in Budapest. Studied at the University of Budapest; trained as a bookbinder. His poems appeared in various journals as of 1967. In 1969 he began to create conceptual works and to carry out actions. Worked together with János Vető from 1974 and worked with film and video in the Belá Balász Studios. From 1978 to 1980 performance artist. Died in 1980.

1978 Bercsényi Kollégium, Budapest
1980 Bercsényi Kollégium, Budapest
Galeria Permafo, Wroclaw
1987 Szent István Király Múzeum, Székesfehérvár
1990 Anderson Gallery, Virginia Commonwealth University
1997 Ernst Múzeum, Budapest

Group shows
1979 Sydney Biennial
Works and Words, De Appel, Amsterdam
1981 *Erweiterte Photographie*, Secession, Vienna
1987 *Bilder. Zeitgenössische Ungarische Photographie*, Fotogalerie, Vienna
1989 *Más-kép*, Ernst Múzeum, Budapest
Az avantgárd vége, Csók István Képtár, Székesfehérvár
1999 *Aspekte – Positionen*, Museum moderner Kunst, Vienna

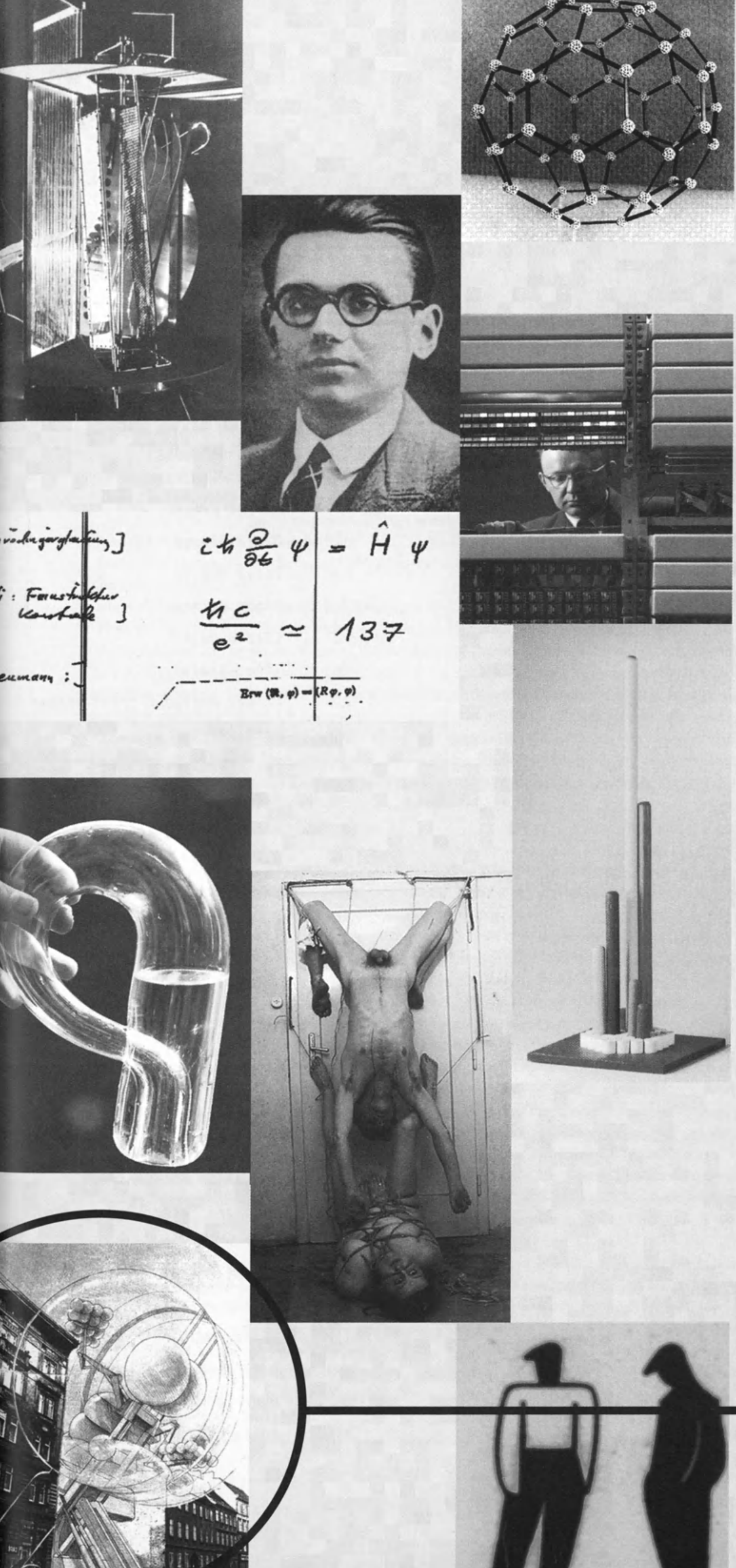


Tibor Hajas
Make-Up Sketches, 1979
Action stills

Tibor Hajas
The Watch, May 19, 1980
Action still

vision deconstruction

Hungarian Constructivism was primarily initiated and inspired by the Russian version, but considerable influence also came from De Stijl and Bauhaus. However, many Hungarians worked on Bauhaus and helped it achieve its profile and program. This is also true to a certain extent for De Stijl. Representative of the many Hungarian Bauhaus artists at the beginning of this section is a manifesto written in 1924 by Sándor Bortnyik, Marcel Breuer, Farkas Molnár, and Andor Weininger. Bortnyik also founded the Mühely (Budapester Bauhaus) upon his return to Hungary in 1928, where Molnár taught and Victor Vasarely studied; it lasted until 1938. The great four of Hungarian Constructivism — László Moholy-Nagy, György Kepes, Victor Vasarely, and Nicolas Schöffer — all world-class artists, came from this tradition. Austrian artists also worked at the Bauhaus; they moved, on the appeal of Johannes Itten, together with him in 1919 to Weimar: namely, Friedl Dicker, Franz Singer, and later also Herbert Bayer (among others).
Constructivist two-dimensional picture language was transformed early on by the Bauhaus into the three-dimensional language of stage and architecture. In that language, geometric bodies such as cubes, circles, spheres, and ellipses were preferred. In addition to sketches for buildings, drawings for theaters played a special role — it was with these that Austrian architect Friedrich Kiesler aroused interest. In the years following, the rational Constructivist picture language developed into a universal formal language in which the borders between picture, sculpture, design, and architecture became fluid. Hungarian as well as Austrian artists were, and still are, engaged with considerable success in all of these areas (such as Marcel Breuer, Joseph Urban, Paul Theodore Frankl, Karl Steiner, Friedrich Kiesler, and Hans Hollein). It is also important to bear in mind the amazingly early but repressed phase of geometric abstraction ("the abstract ornament") in Vienna around 1900, the primate of square and cube, as shown by Koloman Moser, Josef Hoffmann, and later Adolf Loos (see chapter 1). Not only the surface was made geometrical by the square, but the vocabulary of abstract forms was carried over to a universal form-language from pictures to fabrics, vases, dishes, consumer goods, furniture, furnishings, and finally, the house itself. The ideas of Bauhaus were preformulated.
The Constructivist sculpture and picture language reached a complexity with increasing abstraction, which led, in the end, to the dissolution of the square and the cube. In place of the cube, either a biomorphic understanding of space, which oriented itself on the oval or the sphere (Friedrich Kiesler), or the fragmentary splitting of the cube in its continuation in hexagons, and other complex geometric spatial forms (Alfred Forbáth, Wenzel Hablik, David Georges Emmerich, Victor Papanek). From the pictorial Constructivism of the 1920s and the accompanying utopian architectural designs in the 1960s, especially in Austria (as the essay from G. Feuerstein shows), a radically visionary architecture arose. This architecture first took on organic, and then later Deconstructivist, tendencies (Walter Pichler, Hans Hollein, Raimund Abraham, Friedrich St. Florian, Max Peintner, Günther Domenig, Coop Himmelb[l]au, and Haus-Rucker-Co). In an analogous way in Hungary (as L. Beke demonstrates), the Constructivist formal language, starting with Alfréd Forbáth, turned into a Deconstructivist one in the 1970s and 1980s (Dóra Maurer, György Jovánovics, János Megyik, László Rajk, Tibor Szalai, Gábor Bachmann).
Deconstructive sculpture, freed space, and utopian design is still be found in Austria (Walter Pichler). The dissolution of space and classical materials tended to lead to an architecture of absence, which additionally profited from the possibilities of a systematic method and digital programming (Otto Beckmann, Manfred Wolff-Plottegg). Agnes Denes, an Hungarian artist living abroad, shows new ways for using public space both conceptually and ecologically.


$i\hbar \frac{\partial}{\partial t}\psi = \hat{H}\psi$
$\frac{\hbar c}{e^2} \simeq 137$
Erw (R, φ) = (Rφ, φ)

9

9 *vision* *deconstruktion*

9

Sándor Bortnyik, Marcel Breuer
Farkas Molnár, Andor Weininger

*The Demands of the Age**

The artists of the Staatliches Bauhaus Weimar are architects, painters, sculptors, and designers working to unite the various disciplines of art.

I.

We have progressed so far with our knowledge that we can now measure the demands the era makes on us and the demands we make on the era.

The rational spirit of our times rejects social utopias and the scientific, artistic, and political utopias they contain — confronting us instead with practical problems. The individual areas of life, the abstract and concrete sciences, technology, chemistry, etc. profit from rationality. In addition to old materials, new materials are born to fulfil the new tasks of future life and to enhance existing life. The newborn age is characterized by strict rational thought, whose symbols are geometric form, the metric system, knowledge of all manifestations of life, as well as knowledge of the power of mankind.

Instead of utopias — practice!

Instead of arbitrariness — reason and expediency!

Instead of emotions — objectivity!

Instead of games — mathematics and geometry, for these are the factors of intellectual structures, the forms of the twentieth century.

How does art stand in relation to these facts, and what is the status of architecture, sculpture and painting in it? How do they take on the new tasks of the current age?

As mentioned above, we are aware of the demands of the age. The era demands that art reduce all manifestations of life to a common denominator. The artist must seek a rational, balanced unity of form and spirit through productive, creative will. Instead of an artificially connecting the useful to the beautiful, a common creative principle is called for, in which economy of material and intellectual expectations are one and the same.

The artist must arrive at the meaning, the principle, and the function of objects — at that inner activity that is expressed in an adequate form. But the artist must also find personal meaning and purpose. The artist's purpose should be to unite and realize the function of the elements explored in a synthetic unit, as the artist is creative, and creation is simply the interplay of various functions.

II.

In the field of painting, as it is understood in the narrower sense, we demand clearly objective work instead of the arbitrary and subjective expression we have seen so far. Naturalism and all other conventional "isms" can only partially express the relation among various manifestations and man.

The painter attempted to join together the real or visual experience of nature, objects, or emotions, forming a consistent image on his canvas. He made a connection between the individual objects and his aesthetic understanding and believed that, by so doing, he could connect these things to other people.

We do not deny the panel painting's right to exist. To us, however, the two-dimensional painting can only fulfil a purpose if it becomes a demand to create harmony among all things. The painting's challenge, in our opinion, is to shape objects into new manifestations of life. The demand is that all natural and artificial objects be combined in it, as in a center, to form a new modern order. New creative painting does not identify existing objects; it requires a constructive order through self-created, autonomous means.

The final purpose of this constructive order is not actually the picture itself, but reality. In its strictest sense, the configuration of reality with paint is the true task of the painter. The modern painter attempts to establish the mutual relations among the elements and to arrange them in a consistent order within reality.[1]

The modern painter does not bring to surface to life, but rather, space. The problems of the surface multiply and become problems of space. The order of the creation and spatial design imbues the room, exits the house, and crosses roads and paths — a signal of modern man's sense of color and form will travel via the bodies of trains, ships, or airplanes throughout the entire civilized world.

The primary element of painting is color; that of sculpture is form. The sculptor has disbanded the spatial manifestations of form and so has reached the essential: the geometrical bodies. He has discovered the possibility of employing his creative power in both utilitarian and aesthetic works, in areas far removed from the realm of art for art's sake. The present-day sculptor realizes sculptural values in the form of practical, functional items: in the bodies of furniture and the shapes of buildings.

Architecture is the true parent of painting and sculpture. Architecture is the center. All vital functions flow out from it and are reunited in it. The principle of order underpinning the consistent use of certain building materials ensures equal harmony and stability of matter and mind, function and beauty. Color is the dynamic force, it unites the interior of a building with its exterior, and, what is more, it connects both with nature and the entire macrocosm

* This essay was first published without a title in the September 1924 issue of a Hungarian magazine, *Magyar Iras*, on pages 84-85. The current title was added at a later date. See *Andor Weininger. Vom Bauhaus zur konzeptionellen Kunst* (Düsseldorf: Kunstverein für die Rheinlande und Westfalen, 1990, pp. 52-54). The current text, with its manifesto-like character, is an important document concerning the history of the Bauhaus around 1924. It is early evidence of the beginning of the third phase in the development of the school, in which the functional aspects of creative work and their usefulness in industrial production came to the fore. In linking an organic architectural view with a technoid belief in progress, the text is as close to the philosophy of Raoul H. Francé as it is to the architectural theory of Hannes Meyer, who was the second director of the Bauhaus, after Gropius, from 1928 to 1930. At the same time, as far as Weininger's own work is concerned, it is the result of his analysis of De Stijl, whose exemplariness is emphasized in many places. Particularly the demands made on painting reflect Weininger's development from two-dimensional compositions to three-dimensional representation. The Hungarian text creates the impression of a clumsy translation of what was originally a German manuscript. Géza Perneczky of Cologne did the sensitive translation from the Hungarian.

1. If objects, walls, and light in a room are balanced in terms of form and color, we do not need pictures; for the room itself, thus designed, is the picture.

in relation to people, painting, and sculpture.

Building up to now has not been a realization of regularity; rather, it was a compromise with necessities. It satisfied neither material nor intellectual demands. The artistic thing about it was nothing more than a disharmony of matter and mind, that is, an element independent of it, a lying type of ornamentation that had nothing to do with the real function of the house.

The architect of yesteryear stuck the most modern, the baroque, and renaissance ornaments on the finished house. If we omit this decoration, we still have the same house in which living is just as good or bad, but with less dishonest aesthetic pleasure.

The new architect gives the house new beauty by underscoring the function of the building and using this function to determine the organic order of the old and new materials.

In our view, the beauty of a building cannot be detached from the building itself. If we were to destroy the beauty of a house, we would destroy the whole house. For the beauty of a house consists simply of the order of its functions and the rationality of proper building construction.[2]

Modern architecture does not exclude human beings from the outside world, but keeps them in permanent contact with it. Yet it does protect them better from the discomforts of weather with the aid of advanced technology. It reckons with the properties of the surroundings, the climate, and the whole environment. A modern architect does not build from the inside to the outside, not from the outside to the inside. The inner life of the house, all of the inside rooms or niches, as well as the exterior of the house, i.e., the façade and terraces, are the cells of one and the same organism that exists in its germinal form, with its necessities and functions, from the very beginning.

Modern insulation materials, reinforced concrete, or modern window and door systems allow us to open up houses from all sides and equip them with free, airy balconies. Instead of a system of closed, isolated cells, the modern family prefers spacious, easily accessible places that nevertheless avoid any waste of space. Changed living conditions require partition walls that can be moved as needed and adapted to meet constant or ever-changing demands. With technical innovations, modern building elements, and lightweight elastic materials, it is possible to create the mechanical house instead of building it statically. The house becomes a machine that can change its rooms and external situation as required. This is a new task facing engineers and architects.

The problem of the house is part of the problem of the road. Emphasizing and joining individual components, the quality and sensible order of connections, lines, and traffic, produces the material and intellectual quality of the road. Moreover, combining the construction of several roads, selecting them correctly, without prejudice, tradition, or emotion, leads to the design of new cities. Radical implementation of constructive thought creates the modern synthetic order in the new city.

III.

Our age demands a style. However, the style should not be expressed in the application of one or more forms everywhere, which would only turn objects into the elements of a merely ostensible connection. New tasks demand new solutions, and all new features demand new forms. The style cannot be uni-form. The new style must consist of an economic and aesthetic unity of functions derived from necessities. In terms of content, our demands vary, whereas their implementation — the forms in which style is manifested — is new and different from everything done before.[3]

The task of modern man is to recreate conventional phrases of language in the name of a utilitarian, rational, and aesthetic spirit. Productive activity, rather than the old reproductive artificiality and emotional passivity. Its implementation will depend on our individual — and probably also our collective — will. The current financial weakness of Central European states can only pose a temporary obstacle to us; it cannot destroy the actuality of constructive ideas. Implementation and dissemination of our thoughts, incidentally, runs parallel to the same efforts in the West. American skyscrapers, industrial buildings in Germany, the work of Dutch urban designers, French airplanes, the lenses and prisms of Zeiss, the fine mechanism of radio telegraphy, and (as overall results of all these) the examples of German and Dutch constructivist art — they are all links in a chain, creations in the series of inventions of the human intellect.

Our will is to put all this into the totality of culture, into the structure of the new world view according to a constructivist, artistic balance and to proclaim them a manifestation of the new world spirit: mathematics and geometrical order.

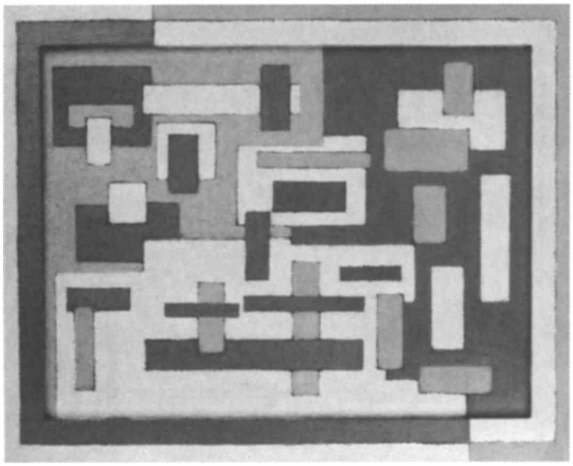
For the new spirit and the new form, mathematics and geometry — i.e., human awareness — demand this reshaping of current life for the very reason that they do not wish to subside in the one-sidedness of social and artistic utopias.

Weimar, 1924; reprinted in Andor Weininger. *Vom Bauhaus zur konzeptuellen Kunst* (Düsseldorf: Kunstverein für die Rheinlande und Westfalen, 1990, pp. 52-54).

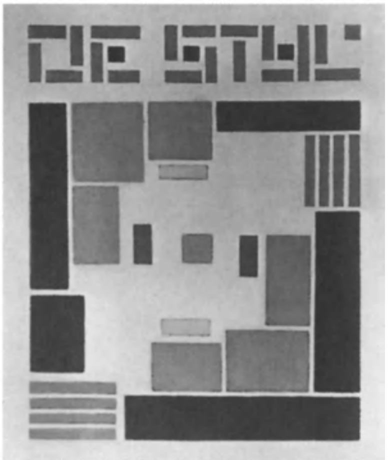
2. This not only applies to the overall mass of the building but also to its details. Formerly, for example, the chimney was a necessity and the weathervane on top was the art. Now, we give it a kind of beauty by underscoring its function.

3. We are aware that use of the term style could give rise to misunderstandings. Therefore we would like to stress that we do not regard style as the outward unit as it is expressed, for example, in the Gothic, Renaissance, or Biedermeier style. The form of a Gothic church was also reproduced in the design of its furniture and its items of practical use, etc. However, this form was only employed as an ornamental element, not as the only possible solution derived from the function of the objects. To us, the term style implies the intellectual and formal unit that evolves from the structure of the given object — and only this object. That means it is an organic design stemming from the inner essence. One example might be the human body, which, despite its numerous functions and the formal appearance of its individual components, is an organic network made up of its individual components.

Vilmos Huszár



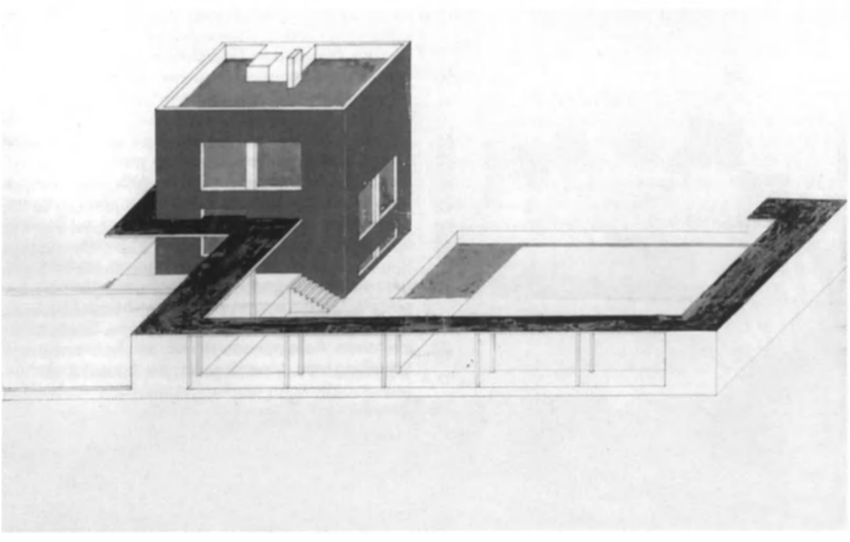
Vilmos Huszár, *Hammer and Saw*, 1919
Oil on wood, 34.9 × 46 cm
© VBK, Vienna, 2005



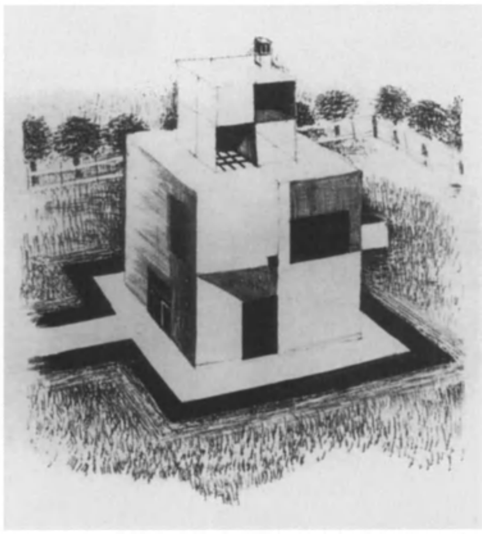
Vilmos Huszár
Composition *De Stijl*, 1916
© VBK, Vienna, 2005

Vilmos Huszár, born 1884 in Budapest. Studied at the College of Applied Arts, Budapest. He then studied painting under Simon Hollósy at the art school in Nagybány. Huszár followed Hollósy to Munich, where he completed his studies in 1904. In 1906 he joined the Bremmer artists' group in The Hague. Spent two years in Paris, finally settling in the Netherlands in 1909. First solo show in Rotterdam, 1912. Founding member of De Stijl in 1917 (with van Doesburg, Mondrian, van der Leck). Designed the logo for the *DeStijl* magazine. Between 1920 and 22, he published his works in *MA* magazine as well. In 1922 he attended the Constructivist International Congress in Düsseldorf and the Dadaist Congress in Weimar. In 1923 he and G. Rietveld did the interior design for the Berliner Kunstausstellung. Left De Stijl in 1923, was briefly a member of the November Group in Berlin. Between 1927 and 1932 Huszár concentrated on functional graphic design, but in the 1930s he returned to a figurative, naturalist style. Died in 1960 in Hierden, the Netherlands.

Farkas Molnár



Farkas Molnár, design for *Red Cube*, 1923
Ink, tempera, pencil on paper, 59 × 91.5 cm



Farkas Molnár, *Red Cube*, 1923

Alfréd Forbáth

Alfréd Forbáth, born 1897 in Pécs. Began studying architecture in 1914 at the Technical University of Budapest. In 1917 became a member of the bourgeois radical political party, Budapest. Joined the Galilei Circle in 1918. Moved to Munich, where he continued his studies under Theordor Fischer, graduating in 1920. Worked at the Gropius Studio at the Bauhaus. Participated in the Am Horn housing estate project. Forbáth and Bortnyik started an advertising company, "Neue Reklame Gestaltung", in 1923. Free-lance architect. Chief architect from 1925 to 1928 at the Sommerfeld concern, Berlin. Exhibition at the Bauhaus in Weimar, 1926. Forbáth opened his own architectural office in Berlin in 1928. Became a German citizen. Refused a professorship at the Bauhaus in Dessau, 1929. Taught housing and urban planning from 1929 to 1932 at the Itten School, Berlin. Member of CIAM. He and Ernst May worked as city planners in Moscow from 1932 to 1933. Returned to Pécs, worked as an architect there between 1933 and 1938. Immigrated to Sweden in 1938, where he became city architect in Lund, serving from 1938 to 1942. In 1942 he took on a job doing urban planning in Stockholm. Worked for the Institute for Space Exploration in Bonn in 1950. Professor at the Technical University in Stockholm, 1959-60. Died in 1972 in Stockholm.

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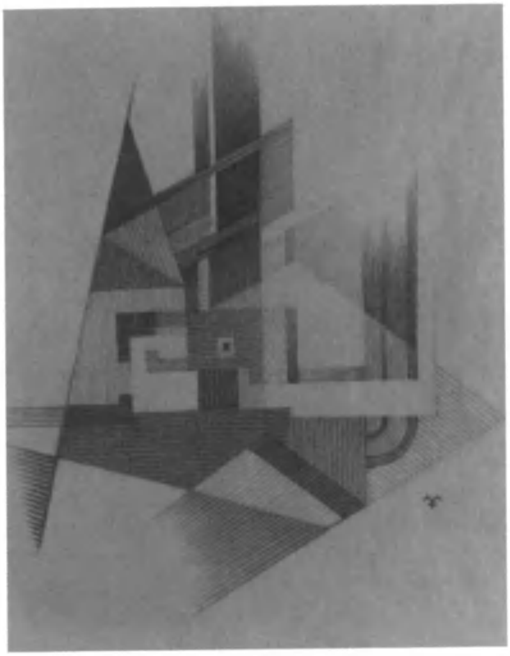
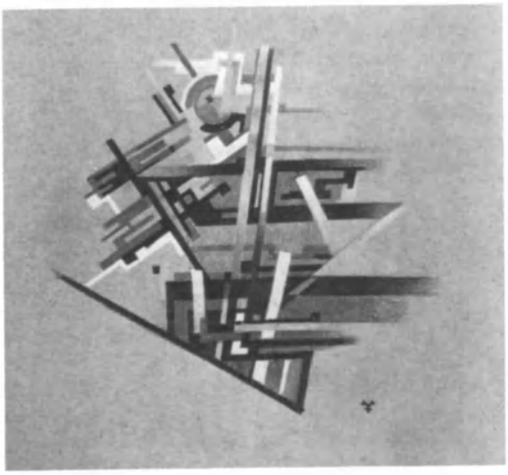
Fred Forbáth. Architekt und Stadtplaner (Darmstadt: Bauhaus Archiv, 1969).
Norbert A. Wiener, *Fred Forbát: Bauten 1919-31* (Göttingen: phil.diss, 1978).

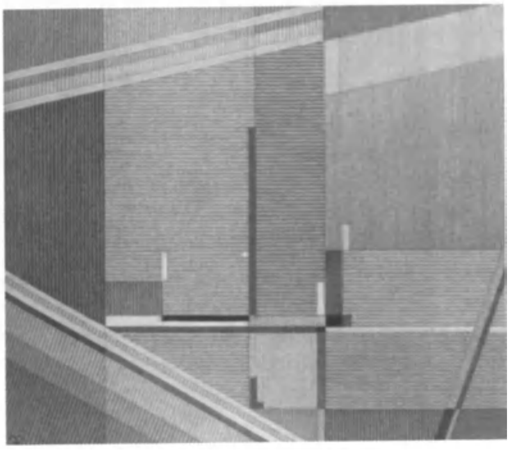
Alfréd Forbáth



Alfréd Forbáth, *Opus I,* 1920
Pencil, 22 × 18 cm



Alfréd Forbáth, *Abstract Composition,* 1921/23

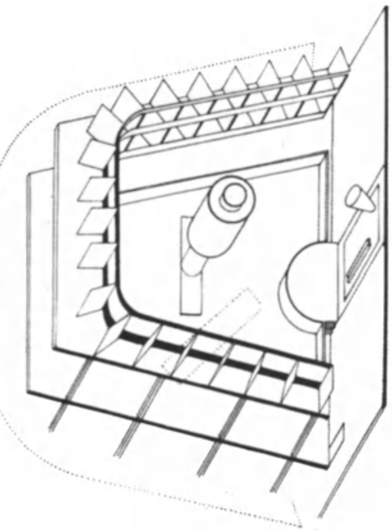


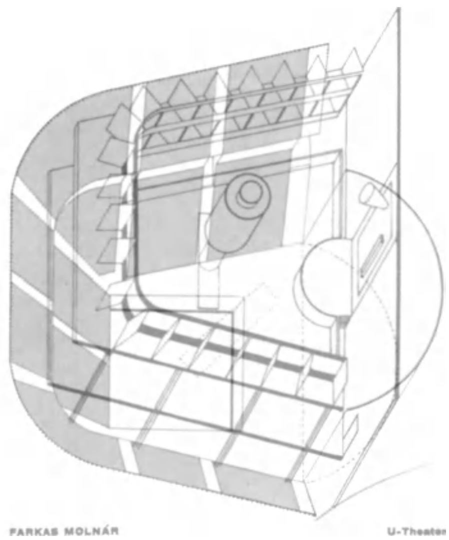
Alfréd Forbáth, *Untitled,* c. 1922
Color pencil, 23.5 × 26.7 cm

Their depth is indeterminate, but the criss-crossing elements dissect the surface into several intersecting layers. In these multilayered surfaces, whose tectonics are already complicated, opposing diagonals form a very taut, vividly dynamic scaffolding. Forbáth isn't an architect for nothing: the tectonic fantasy of his drawings has an outstanding effect...
— Erno Kállai, 1925

reprinted in Patrcia Rochard, ed., *Csárdás im Quadrat. Ungarische Avantgarde (1919-1930) und traditionelle Bauernkultur* (Mainz: Internationale Tage Ingelheim, Hermann Schmidt, 1995) p. 102

Farkas Molnár





U-Theater: The auditorium

I. and II.
Two U-shaped rings, built as an amphitheater. Adjustable, rotating chairs to ensure the best view of the stage. Numerous entrances and connecting paths to the stage. A gap between the first and second ring; the second ring is higher than the first. Together, rings I and II seat 1200.

III.
A circle with two rows of chairs adjoining the suspended stage to seat approximately 150.

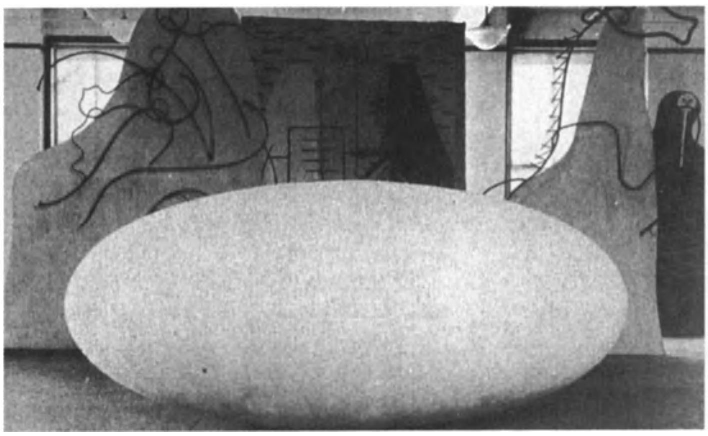
IV. and V.
Two rows of boxes above each other, each seating six persons, with a total of 240 seats. The partition walls can be moved and adjusted.

Oskar Schlemmer, László Moholy-Nagy, Farkas Molnár, *Die Bühne am Bauhaus*
Neue Bauhausbücher (Mainz:, Florian Kupferberg, 1965) p. 60.

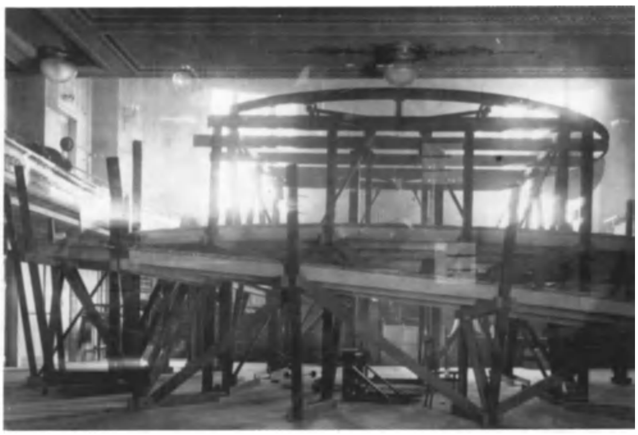
Farkas Molnár, born 1898 in Pécs. Emigrated after the fall of the Hungarian Soviet Republic in 1920. Began studying at the Bauhaus in Weimar under J. Itten in 1921, later worked for Walter Gropius. Molnár, Georg Muche, Marcel Breuer, and others were members of the "Architecture Department." He and H. Stefán published an album of lithographs together. Organized the Kuri Group and manifesto. In 1923 designed the Red Cube for the Am Horn housing estate. Returned to Budapest in 1925. Exhibited his architectural blueprints at the Mentor bookstore in Budapest. Taught until 1938 at the Műhely, the Budapest Bauhaus. In 1929 Gropius invited him to the CIAM Congress in Frankfurt. Molnár showed his work at the CIRPAC exhibitions of 1931 and 1932. Killed at home during the bombardment of Budapest in 1944.

References:
Molnár Farkas munkái 1922-23 (Új épités 1, 1933).
Éva Forgács, *Bauhaus* (Pécs: Jelenkor, 1991).
Molnár Farkas: Festmények, grafikák, épületek (Budapest: Kassák Múzeum, 1997).

Friedrich Kiesler



Friedrich Kiesler, *Endless Theater*, model, 1926



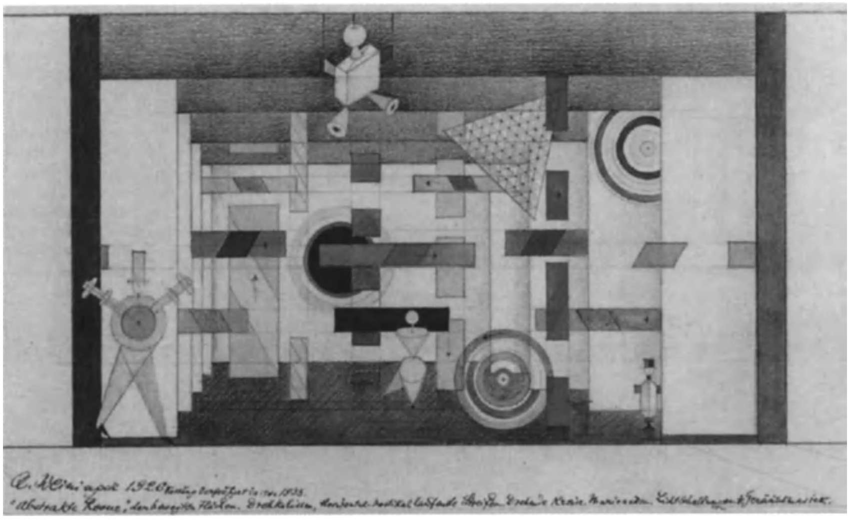
Friedrich Kiesler, *Space Stage at the Vienna Concert Hall*, Mozartsaal, Vienna, 1924

Andor Weininger

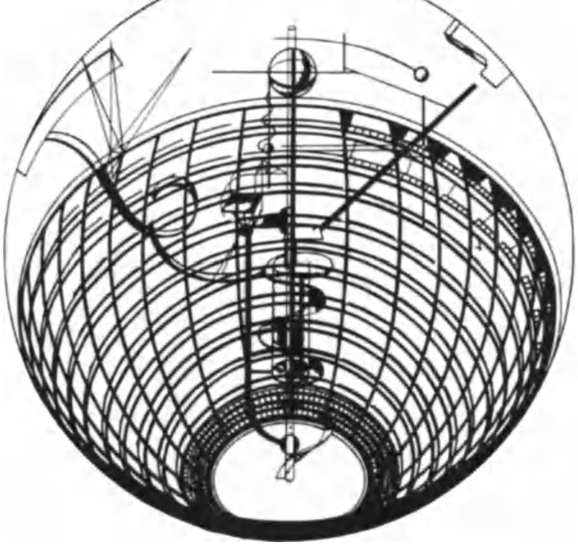
Andor Weininger, born 1899 in Karancs. Studied law and architecture in Budapest. Pupil at the Bauhaus under J. Itten between 1921 and 1923. Actor, dancer, and musician at the Theater Workshop. Returned to Hungary, settling in Pécs. Attended van Doesburg's De Stijl course in 1922. Member of the Kuri Group. Mechanical Revue, 1923. Walter Gropius brought him back to the Bauhaus in 1925. Presented his experimental "Bühnenelemente" in Jena in 1926. "Kugeltheater" and "Mechanical Revue," 1927. In 1928 Weininger went to Berlin to work as an interior designer. In 1938 he immigrated to Holland, where he worked as a painter. Joined the Creatic Group in 1945. Spent 1951 in Canada, painting. In 1958 he moved to New York. Member of ANONIMA. Worked for the Art Research Center. Died in New York in 1986.

References:

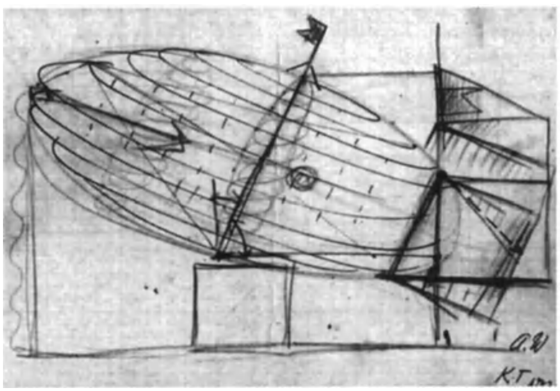
Jiri Svestka (ed.), *Andor Weininger. Vom Bauhaus zur konzeptuellen Kunst* (Düsseldorf: Kunstverein für die Rheinlande und Westfalen, 1990).



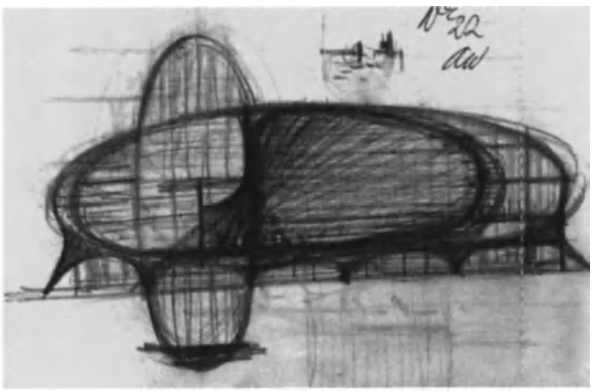
Andor Weininger, *Mechanical Stage-Revue*, 1926
Pencil, watercolor on drawing paper, 30.4 x 40.9 cm
© VBK, Vienna, 2005



Andor Weininger
Sphere Theater, section, 1927
Ink on drawing paper, 56 × 46.3 cm
© VBK, Vienna, 2005



Andor Weininger, Sketch for *SphereTheater*, 1927
Ink on paper, 12.7 × 19.4 cm
© VBK, Vienna, 2005



Andor Weininger, Sketch for *SphereTheater*, 1927
Pencil on paper, 10.8 × 17.5 cm
© VBK, Vienna, 2005

Marcel Breuer

Genesis of Design

The most decisive factor in the design of a building is probably its visible structure, the interplay of supported and supporting parts — a material manifestation of stresses working in dead matter. Construction is indeed a very old human activity, fueled and driven not only by practical requirements, but by instincts. We may justly call these instincts atavistic. To have a roof over our heads is not merely to have protection from sun and rain, but an instinctive need: small children like to play under a chair, a table, under a roof of their own, though they are already protected by the roof of the house. The child, nearly every child, starts to construct without need or purpose. To defeat gravity, to lift, move, and support weight, to rise higher and then higher, may be regarded as instinctive and atavistic too. The history of construction outlines our struggle with material, with its weight, with gravity — from the prehistoric pile of rock and the tree house, to the span of the Golden Gate Bridge and the swaying frame of the Eiffel Tower. We may possibly rationalize the urge to work against gravity: the Tower of Babel might establish communication with God, the rocket might serve to help us explore the moon, the satellite might provide an observation point, and the skyscraper might exploit or create land values. Whatever our excuse, the desire to dominate height, to get away from gravity, and to lift and float heavy matter remains part of human history.

Marcel Breuer
St. John's Abbey and University
Collegeville, Minnesota, 1953-61

The way we conceive enclosures for our daily needs, for living and working, for the intricate complex of requirements, determines to a certain degree the size and shape of our buildings and to a greater degree the interior spaces defined by the building. At the beginning of the design process, everything is a bodiless assemblage in the abstract — weights are without support, walls without thickness — a mere diagram of the needs. As we develop the design, we inevitably arrive at the point where the problem of ìwhat to buildî turns into the problem of "how to build." The theoretical, lineal enclosure of space is then given a wall, a slab, a column — a thickness of components made of material having mass, weight, and shape. The abstract process of planning transforms into the tangible science of construction. The necessity for a certain kind of space now becomes intrinsically connected with the art of building. The blueprint, the plan and the purpose of our diagram, grows, taking on weight, mass, and form. The aspect of material enters the design process, with its rules and niceties and details: architecture.

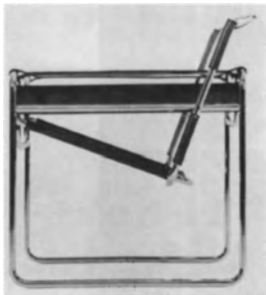
The analytical approach — first investigating the purpose, then developing the basic needs in an abstract, lineal diagram, nursing this composition of sequences and dimensions into a physical structure, using the conflicts between demands and the experiential nature of materials as inspiration for architectural, three-dimensional buildings, spaces, masses, and voids — this approach is the achievement of the twentieth century. This so necessary working diagram in the abstract was perhaps a major fascination of our new architecture, and the desire to come as close to it as possible resulted in the utmost transparency of the building, in the lineal façade, weightless, a mere reflection with little relation to material, to mass. With little relation also to the human material, to our need for things to touch, to lean against, to cover.

The vocabulary of architecture expands: solids, three-dimensional masses, and plasticity appear next to transparent elements; form appears next to pure proportions; the depths of the façade — sun and shadow. The abstract space does not claim universality. In its variations and adaptations, it claims to be truer to our varied needs, to differentiations of visible structural solutions, to our three-dimensional human instincts.

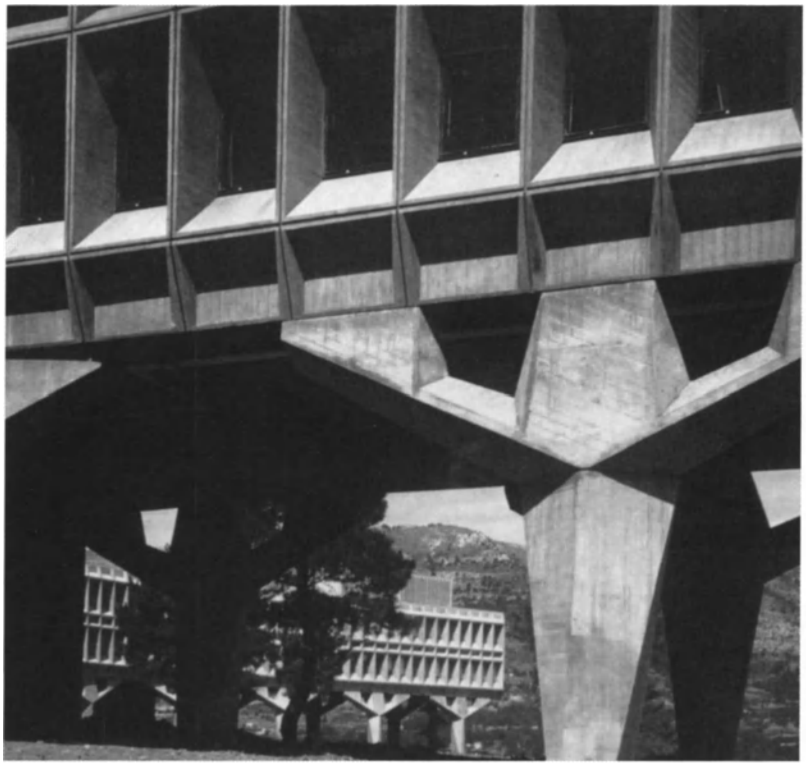
György Kepes, ed., *vision and value* (New York: George Braziller, 1966).

Marcel (Lajos) Breuer, born 1902 in Pécs. Graduated in autumn 1920 from the Academy of Arts in Vienna. Studied at the Bauhaus from 1920 to 1925. Designed furniture for the Am Horn housing project, 1922-23. Head of the furniture department at the Bauhaus in Dessau, 1925-28. Developed the first steel tube chair. Designed furniture for Piscator's apartment in Berlin. Various architectural projects. Worked on his own as an architect and interior designer between 1928 and 1931; left Berlin in 1931. Immigrated to England in 1935, where he worked for F.R. S. Yorke as an architect in London. Moved to the U.S. A. in 1937. Breuer and Walter Gropius's opened an architectural office in Cambridge, Massachusetts. Professor for architecture at Harvard between 1937 and 1946. Designed the Geller House in New York, 1945, with a fresco by Jackson Pollock. He and Gropius moved their office to New York in 1946. In 1956 Breuer founded Marcel Breuer and Associates Architects with H. Beckland, R.F. Gatje and H.P.Smith, with a branch in Paris. Died in New York, 1981.

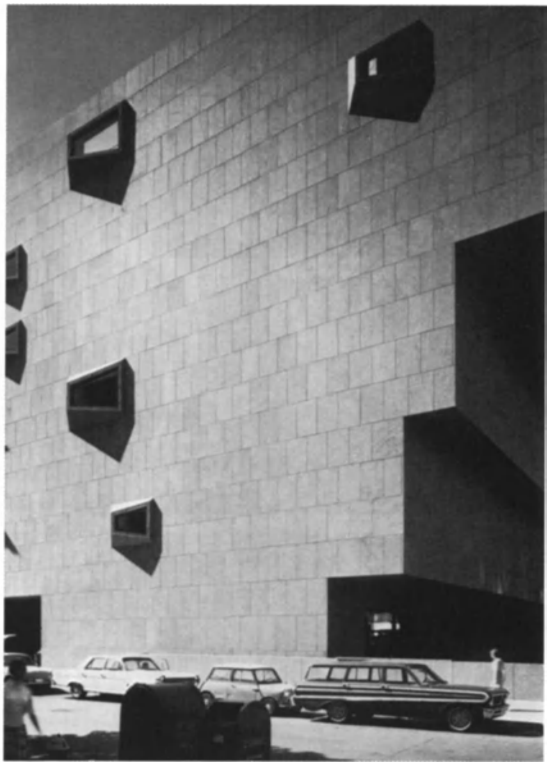
References:
Marcel Breuer, *Furnitures and Interiors* (New York: Museum of Modern Art, 1981).
Tician Papachristou, *Marcel Breuer. New Buildings and Projects* (New York: Praeger Publ., 1970).



Marcel Breuer
Curved steel armchair, 1925



Marcel Breuer
IBM Research Center, 1960-61
La Gaude, Var, France, new wing 1968-69



Marcel Breuer, Hamilton Smith
The Whitney Museum of American Art
New York, 1963-66

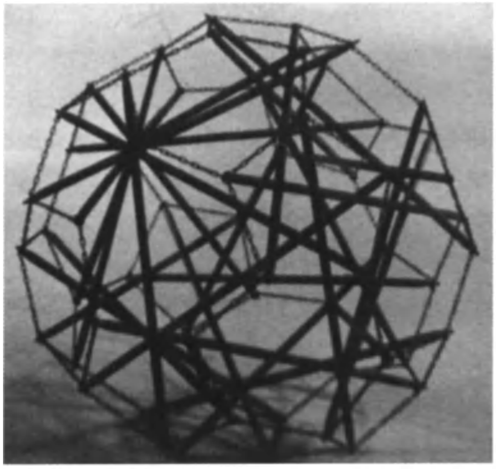
Marcel Breuer, Herbert Beckard, Nolen-Swinburne and Associates
Headquarters for the Department of Housing and Urban Development (HUD), Washington D.C., 1963-65

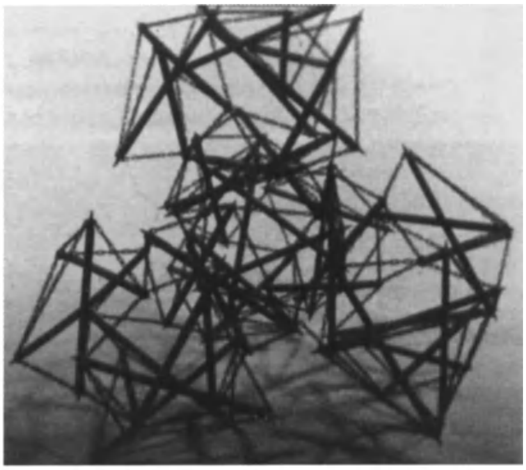
Marcel Breuer, Robert F. Gatje
Armstrong Rubber Company
West Haven, Connecticut, 1965-69

David Georges Emmerich
Self-Building Constructions

In 1957, the architect Yona Friedmann founded the Groupe d'Etude d'Architecture mobile (G.E.A.M.). It initially comprised Jean Pecquet, Jerzy Soltan, Jan Trapman, and David Georges Emmerich, and later included Frei Otto and various other architects. In 1958 *Bauwelt* [Building world] magazine devoted one of its issues almost completely to G.E.A.M. The group dissolved in 1962, but their ideas continued to be of relevance.

David Georges Emmerich, born in 1925 in Debrecen, Hungary. Died in 1996 in Paris.





David Georges Emmerich
Structures Autotendantes,
1969

In November 1964, for example, René Sarger published a long article on the significance of structural formations in André Bloc's magazine *l'architecture d'aujourd'hui* [architecture today], which included Emmerich's analysis of the understanding and order of space. G.E.A.M. declared that social changes in cities necessitated a drastic revision of urban development and housing. The accelerated growth of the world's population as well as technological change (traffic, communication, production) required a completely new rhythm of construction and posed completely new demands — a theory that is still of topical interest but which needs to be reformulated today in view of innovations in the fields of telecommunications and simulation technology.

With an intent that was optical, not technology-crazed, G.E.A.M. suggested targeted use of housing technology, which was meant to make cities "elastic" and facilitate life in them. David Georges Emmerich writes in *l'architecture d'aujourd'hui*:

> *Industry needs the number and the series. The only solution, therefore, is industrialization, but in changing technology, it is also necessary to change form, for whatever is claimed, it is technology, not function, that creates form.*

Emmerich generates his canon of forms using the basic form of the cube, with its six surfaces, and other polyhedrons (with up to one hundred faces). This canon aims to guarantee maximum add-on possibilities, diversity, and convenient flexibility. On a first polyhedron, which acts as the basic framework, another far more complex polyhedron can be built, which in turn acts as a framework for the next. With the aid of this patented method, it was supposed to be possible to create increasingly complex configurations in successive stages of development (in quasi-infinite variability).

Emmerich on the advantages of his concept:

> *Self-supporting, non-deformable, light, easy to take apart and put together — what evolves is a thoroughly economical, stereometric dome. On the other hand, of equal importance from an economic and social point of view is the fact that, owing to their simplicity, these compositional techniques permit great freedom to develop self-building construction in a structural and personalized way. Creative activity is the best recreation. After all, this housing is designed without any kind of plan. With an economical construction that can be adapted to new conditions or, if required, removed, there is no point in saving space and certainly not in setting up any pathetic functionalist standards. For the inhabitant, it is the possibility of free arrangement that makes sense.*

Die Schrift des Raumes (Vienna: Kunsthalle Vienna, 1996) pp. 36-37.

9

János Megyik

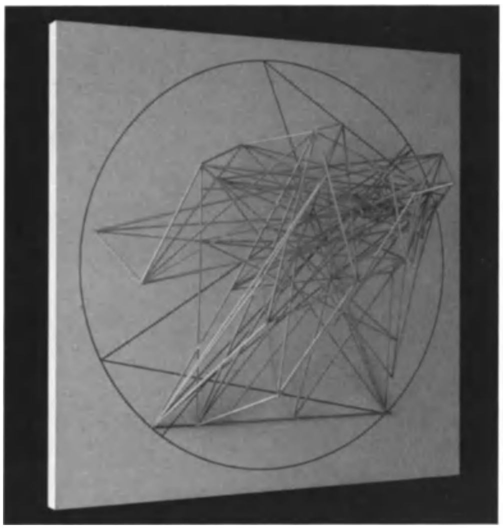
The Forms of Emptiness

János Meyik
born 1936 in Szolnok. Studied at the Academy of Fine Arts in Budapest under Andersen and Dobrowsky. Lives in Budapest and Vienna.

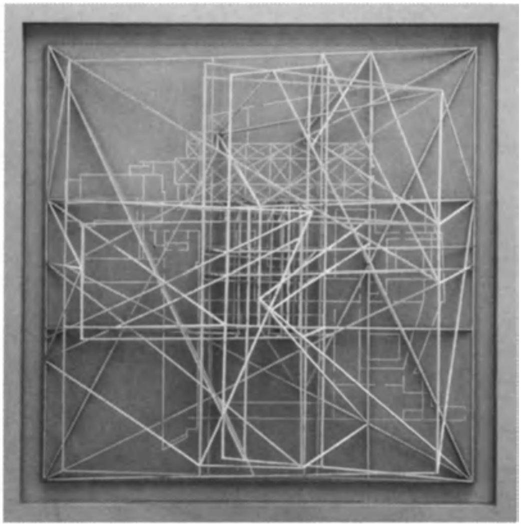
1988/89 Museum moderner Kunst, Vienna; Műcsarnok, Budapest
1990 Fekvő Corpus, Kunsthalle, Hamburg
1993 Szent István Király Múzeum, Székesfehérvár
Galerie Station U3, Vienna
2001 st. Art Galéria, Budapest (with A. Wolsky)
2004 Ateliers Pro Arts, Budapest

Group shows
1977 *Geometrica 77*, Tulln
1982 *Exakte Tendenzen*, Modern Art Galerie, Vienna
Tisztelet a szülőföldnek, Műcsarnok, Budapest
1984 *1984 – Orwell und die Gegenwart*, Museum des 20. Jahrhunderts, Vienna
1990 *Architektonikus gondolkodás ma*, Műcsarnok, Budapest
1991 *Kunst Europa – Ungarn*, Gesellschaft für aktuelle Kunst, Bremen
1996 Collegium Hungaricum, Vienna
Sacralità – Modernità: Nove Artisti Ungheresi, Accademia d'Ungheria, Rome
A Vonal, Ernst Múzeum, Budapest
1998 Zacheta, Warsaw; Galeria Miedzynarodowego
1999 *Perspectiva*, Műcsarnok, Budapest
2000 ARCO, Madrid
2003 Gutmann Galéria, Budapest

References:
Bujdosó Alpár, János Megyik, *A semmi konstrukciója* (Budapest: Magyar Műhely, 43/44, 1974).
János Megyik: Holzkonstruktionen, Fotogramme, Zeichnungen (Budapest-Vienna: 1988).
Werner Hofmann, *Liegender Corpus* (Hamburg: Kunsthalle, 1990).



János Megyik, *Hommage à Pascal*, 1980-1981
Wood, acrylic, 130 × 130 × 40 cm



János Megyik, *Santa Maria Novella*, 1981
Wood, acrylic, 110 × 110 × 30 cm

In my work I am interested in the structure of the panel painting, which I regard as a reflection upon vision. I interpret it as a three-dimensional structure, as an element of space, a pre-defined surface, and not, like Alberti, as a window. The classical theory of perspective (with the focal point, vanishing point, and horizon) works only with partial elements, meaning the elements end at the horizon. This — geometrical — error was made by Renaissance artists because the view was to them a value; they strove to create a real image that could be manipulated any way they liked.

Perspective creates a constructed image that reconstructs the nature of the eye, and strangely enough, this construction destroys its own carrier, which allowed it to emerge in the first place: the plane. A paradoxical phenomenon, then, which may also be seen as deconstruction.

Frescoes, wall decorations, break up the surface of walls. In Baroque art, all this challenges the boundaries of architecture. Here, painting becomes deconstruction from the architectural viewpoint; it breaks up the static structure, as if it were trying to create the immaterial idea. Painting and other related arts do not appear to supplement architecture, but rather, they are equal to it.

In my work I redefine the elements eliminated by classical perspective with their own means. To me, perspective is part of projective geometry, which lends infinite expanse to the basic elements of geometry (the point, line, and surface). With geometrical consistency, I draw the construction of perspective beyond the horizon, thus creating two three-dimensional structures: one in front of and one behind the horizontal line. They create a double image (reverse mirror image with reverse perspective), thus achieving dynamic symmetry in the fictitious or actual three-dimensional space. The alternative spatial form can be constructed with the aid of the principles of geometry: in the symmetry thus created, the image is at the same time the empty space of the other; seen geometrically, it is a form of emptiness. In my works from the 1970s and 1980s, I tried to realize the principle of projective geometry in three-dimensional, model-like objects. Here, the work not only consists of the projected image — as in the perspective — but it is also extended by using the mathematical theorem that it refers to or, respectively, by the equally important use of projection beams.

In *Hommage à Pascal*, I was not only working with Blaise Pascal's philosophy, but also with the geometrical law regarding the principle of duality (Pascal-Brianchon theorem), which appears in several places in the work in both two and three dimensions. The important thing is that this accumulation obscures the structures and allows us to handle their seemingly chaotic mass as new matter.

In this work a law of geometry is drawn on the surface, whereas in *Santa Maria Novella*, the ground plan of the Florentine building determines the surface. In the third dimension, two random (subsequently cut off) points and the application of Desargue's theorem form the possible approach. A procedure similar to the one described above — that is, the representational handling of the principle and its dissection into layers — allows me the scope required for my creative work.

László Beke

Deconstruction in Hungary

If we accept the working hypothesis that deconstruction comprises the breaking down of one entity into its elements, with the aim of establishing a new entity, and furthermore, that in order to express this definition, it is no longer compulsory for us to work our way through Derrida and his successors, then two possibilities remain: we may approach the concept with the aid of metaphors, or else we can use a chain of associations and go back in history (and at least get to constructivism, or even further back).

This metaphor is the game of pick-up-sticks, which goes like this: one player holds a bunch of light wooden sticks in his hand and lets go of them. They fall on the table so that we begin with a more-or-less chaotic situation. We must then pick up each stick, one at a time, without moving another stick, even by accident. The instructive thing in all this is the chaotic yet at the same time intentionally established situation (see chaos theory, chance and game theory), as well as the observation that the state of the sticks looks like a model of a building after an earthquake. Based on this last metaphor, we may posit that deconstruction is nothing other than the architectural modeling of a post-catastrophe condition. In this sense, Domenico Gargiulo's (1612-1697) plan for the mural for San Martino in Naples, the *Collapse of the Carthuse* (Baroque Museum, Salzburg) is a deconstructive building model. It is not by chance that the theme of the Sixth International Architectural Exposition, organized in 1996 as part of the Venice Biennial, was "The Architect as Seismograph," and that for the occasion, Isozaki and his colleagues presented an architectural investigation of the Kobe earthquake in the Japanese Pavilion.

In the Hungarian Pavilion, on the other hand, Gábor Bachman's work was presented. His program, *Architecture of Nothing*, moved from an ideology consisting of constructivist, ironic, "new wave socialist realism to attain pure deconstruction. It was *Architecture of Nothing*, because it was provisional and would be torn down after a couple of months at the most (although, according to Peter Weibel, Bachman could have chosen the more appropriate title, *Architecture of Absence*). It is comprised of a building constructed (deconstructed?) of red and white slanted planes and blocks, as well as beams, crossbeams, and cables converging at acute angles, whose supreme theoretical contribution is the method by which it is erected. To clarify, Bachman first prepares a paper model, and only subsequently, on the basis of the model, a drafted plan (the building is realized according to the plan; finally, he makes paintings as documentation, which are of the quality of works of art). On the other hand, you cannot distinguish the plan (drawn at first by hand, and later with a computer) from a design pattern. The central category of Bachman's architecture is "cut," which, in the various professional jargons of the Hungarian language, means both design pattern and motion picture editing. (Not yet touching upon the fact that the architectural "section" is also connected with exactly the same concept. Architecture is therefore not built of elements, but rather the reconstruction of a deconstructed section!) In Bachman's works, the relationship between function and the formation of pure deconstructivist space is similar to that in works by his Austrian counterpart, Coop Himmelb(l)au, with their Groningen Museum and their reconstruction of the Venice Pavilion.

During the 1960s, as Bachman was on the path leading to deconstruction, his colleagues included a few other "film architects:" the creator of postmodern iron sculptures reminiscent of industrial architecture, Attila Kovács; Tibor Szalai, the body photographer and later designer of white paper installations; and László Rajk, who, in those days, was a member of the political opposition prior to the fall of the Communist system and is today a member of the Hungarian parliament. One of Bachman's role models was the prematurely deceased film director, Gábor Bódy. Bachman's connection with film is probably due to him; Bachman did his first provisory (video) installation in his memory. Another source of more recent date is the work by sculptor János Megyik. The plan for *Architecture of Nothing* even originated with him. Megyik has been developing his constructivist art since the end of the 1960s. It is founded partially on his study of perspective and partially on his reflections upon projective geometry. On the basis of his constructions assembled from thin wooden sticks, Megyik also worked up architectural plans (Santa Maria Novella), orthographic projections of geometric bodies — see the correlation between the projection (*vetítés* in Hungarian) and the (orthographic) projection (*vetület* in Hungarian) in both geometry and in the Hungarian language. Megyik also created anthropomorphic photograms (while a good many of Megyik's constructions are anthropomorphic, the others relate construction to photograms of human bodies — hence the inversion of the conditions of projection, light, and shadow). The map can also bear a relation to the broader understanding of the architectural plan if we consider that certain archaic maps (or their modern equivalents produced as a network of lines using the principles of graph theory) exclusively denote particular lengths of road.

Megyik exhibited one of his most monumental installations, whimsically and restlessly constructed of manifold oblique lines and acute angles, in the Hamburg Kunsthalle, as a reference to the Caspar David Friedrich painting titled *Die gescheiterte Hoffnung* [literally, "wrecked hope," but known as *The Polar Sea* in English] in the permanent collection there. Perhaps it is not even necessary to mention that in the picture, the

Gábor Bachman
born 1952 in Pécs. 1971-1972 studies of architecture at the Technical University, Budapest, and 1972-1977 interior architecture at the Academy of Applied Arts, Budapest. 1977-1991 stage designer for *Mafilm*. Lives in Budapest.

Architectural works, installations
1983 Studio of the Károlyi Foundation, St. Paul-de-Vence
1986 Hadházy-Studio, New York
1990 NA-NE gallery, Budapest
1998 Nahual Huapi, National Park Hotel, Buenos Aires

Exhibitions
1985 Messepalast, Vienna
1987 *Hommage à Gábor Bódy*, Ernst Múzeum, Budapest; Stedelijk Museum, Amsterdam; Musée d'Art Contemporain, Lyon
1988 Aperto '88, Venice
1990 Stuart Levy Gallery, New York
1992 Malakoff Gallery, Paris; Art Gallery of Windsor, Windsor; Oklahoma City Art Museum, Oklahoma; Art Gallery of Ontario, Toronto
1993 Academy Castle Solitude, Stuttgart
1994 Ludwig Múzeum Budapest
1996 VI. Architecture Biennial, Venice
2000 *L'autre moitié de l'Europe*, Jeu de Paume, Paris; Magazine Sztuki, Warsaw

References:
Gábor Bachman, *The Architecture of Nothing*, VI. Architecture Biennial, Venice, 1996.

Gábor Bachman, *Academy Castle Solitude I*, 1993, Steel

László Rajk
born 1949 in Budapest. Studied architecture at the Technical University, Budapest; McGill University, Montreal. Since 1990 member of parliament. 1990-1996 professor, designer and architect at the Academy of Film in Budapest. Lives in Budapest.

1980 Bercsényi Klub, Budapest
1982 Óbuda Galéria, Budapest
1986 Dorottya utcai Galéria, Budapest
1987 Elac Galerie, Lyon
Institut Français, Budapest
1989 Hungarian National Gallery, Budapest
1996 Művészetek Háza, Pécs
2000 Goethe-Institut, Budapest
L'autre moitié de l'Europe, Jeu de Paume, Paris

Stage and film sets
1983 *Kutya éji dala* (dir.: G. Bachmann)
1988 *Red Heat* (dir. Walter Hill)
1989 Nagy Imre és mártírtarsai disztemetésének díszletei, Place of the Heroes, Budapest (dir.: G. Bachmann)

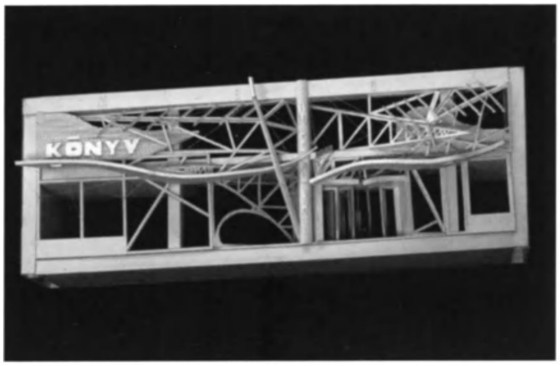
Most important buildings
1994 Reconstruction of the Corvin cinema, Budapest
1995 Reconstruction of Fókusz bookshop, Budapest (not realized)
1996-1998 Collegium Hungaricum, Vienna (renovation)

Gábor Bachman
The Architecture of Nothing, 1996

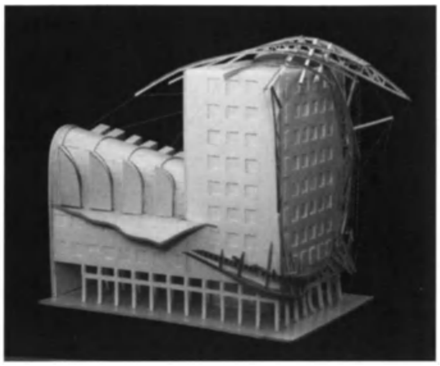
enormous glaciers piled up at angles, one upon the other, and the collapsed ship jammed between them, offer a similar prototype of a deconstructive situation.
Megyik's kindred spirits can be found in the space constructions composed of right and oblique angles and the irregular polygonals that either project or cast shadows (occasionally also suggesting "n"-dimensional spaces) space forms by Goran Petercol (Croatia), Antoni Mikolajczyk (Poland), Vera Székely (Hungary/France), Frantisek Kyncl (Czech Republic), Martin Puryear (U.S.A.), and Béla Kondor (who, toward the end of his life, built model airplanes and chaotic constructions and photographed them). More can be found among today's Hungarian artists: the spiritual Tamás Trombitás, who builds skewed blocks, or Dóra Maurer, who works with geometric, anamorphic space. György Jovánovics, a cultivator of subjective geometry similar to Megyik's, can also be included here, especially because the forms of his ethereal plaster reliefs are created by shadows, while his painted and "crumpled" reliefs have more to do with László Moholy-Nagy's work. (A completely different idea led Miklós Erdély to a similar result when he created what was almost literally a *Tortured Drawing*, drawing so intensely with a pencil that he brought the paper to the point of almost tearing.)
The topology of the creased, folded, broken surfaces also connects deconstruction with constructivism. Moholy-Nagy's crumpled photogram, the *Power Diagram*, done in the 1930s, is simultaneously a demonstrative example of the behavior of mechanical power, shadows, and the quantity of light (luminous output as well as the "quantity of shadows"). Moreover, if we connect it with the problematic sphere involving the treatment of airbrushed surfaces, it is also exemplary for its "quantity of pigment" (paint) for sculptural modeling. In the 1970s, Hungarian artist Gyula Pauer built his "pseudo" theory and practice based on the illusionary effects of light and shadow in photographs and the treatment of airbrushed surfaces.

The reference to Moholy-Nagy, who stood at the center point of the Bauhaus, raises the question of deconstruction and its origins in constructivism. In their constructivist plane compositions, Russian artists generally accounted for the appearance of what were at first 45° oblique angles in the prevailing vertical/horizontal system with the explanation that the absolutism of above/below had ceased to exist in painting, and that the new compositions were the same from every perspective, meaning they should be viewed from above! However, every sign points toward the fact that El Lissitzky and Moholy-Nagy (who kept getting mixed up in polemics with each other), as well as Vladimir Tatlin or Gustav Klucis (a Lithuanian suprematist who made symbolic wood constructions) also wanted to build the origins of projective geometry into their artwork — "at least the whimsically placed oblique lines allow us to conclude that they were aiming for the differentiated sole point of origin." From this perspective, it is worth studying the other Hungarian constructivists alongside Moholy-Nagy, as well as the work of the Bauhaus teachers and students: Sándor Bortnyik, Marcel Breuer, Alfred Forbát, Farkas Molnár, Andor Weiniger (whose "sphere theater" plan allowed abstract structures of two-dimensional surfaces to move in space). Also worth exploring would be the similarly constructivist "icon analyses" of these artists, although these analyses are not connected to the Bauhaus. Not to mention that the spiritual master of every Hungarian constructivist and activist, Lajos Kassák, coined this motto: "Destroy, so that you may build and build, so that you may triumph!" With its surfaces broken into tiny bits and crystals, deconstruction not only maintains a connection to constructivism, but also to cubism. Not really to classical (analytical) French cubism, but rather to those tendencies that approached the motif from other starting points, for which the

Gábor Bachman
Architecture of Nothing, 1996, model of the entrance of the Hungarian pavilion at the Venice Biennial



László Rajk, *Fókusz Bookshop*, Budapest 1995
Paper model, 106 × 35 × 38 cm, © VBK, Vienna, 2005



László Rajk, *Collegium Hungaricum*, Vienna 1996
Paper model, 40 × 60 × 52 cm, © VBK, Vienna, 2005

essential issue was not the reconciliation of various viewpoints, but rather the disruption of the planar point of view. Such was Czech cubism. Just as János Megyik did later, Bohumil Kubiöta also did geometric analyses of numerous classical paintings (Poussin, El Greco, etc.), and with the aid of a similar type of linear construction, composed his own paintings. Likewise, it is worthwhile to note the fact that Czech cubist architecture counts among its antecedents the late-Gothic crystal vaults of the southern Czech Republic. A similar interest in the construction of crystals was in turn manifested by another architectural group at the turn of the century, the Gläserne Kette (Glass chain), whose membership included Bruno Taut, Hans Scharoun, and other colleagues. Likewise, it is also no coincidence that Milan Knisak, an ironic socialist/realist, or new wave Czech artist, whose interests were similar to Gábor Bachman's, selected the cubist building details and furniture of Pavel Janák as a model for his own early designs.

It is likely that nowadays very few will remember that Paul Virilio, creator of an important postmodern theory known as dromology, was represented in his younger days at the French Pavilion at the 1970 Venice Biennial with an *Impossible Space* built of oblique planes (co-designer: Claude Parent).

Another generally valid connective point for the anthropomorphic structures already mentioned in relation to Megyik is the correlation of the skeletal structure of more highly developed living creatures to the airplanes, ships, or roof constructions (so-called organic architecture) built by Hungarian architect Imre Makovecz. The latter can in turn be related to the wood constructions, such as the *Devil's Lock*, by Romanian sculptor Mihai Olos, whose work is also nourished by his national roots.

From the standpoint of form, the innumerable pointed, sharp, spiky motifs that became fashionable in the 1990s in architecture, installation, design, painting, and graphics can all equally be ascribed to deconstruction. From the perspective of content, however, we must take note that deconstruction converges with another, still more significant cultural tendency: digitalization. Everything that is broken down into its elements to become a grid network of any given density, "regardless of whether it is composed of regular pixels or of chaotic, capricious atoms that can only be statically managed," can be interpreted as part of the same universe. The interpretation will continue to be made by scientists, technicians, and artists.

Tibor Szalai, *Composition*, 1994
Cardboard model, 300 × 300 × 300 cm

Tibor Szalai, *BSCH Architecture*, 1994
Cardboard model

Tibor Szalai
born 1958 in Tét. Studied at the Technical University in Budapest between 1977 and 1982. Worked at the Institute for City Planning in Budapest from 1982 to 1986; from 1985-86, the School of the Hungarian Architecture Society, Budapest. Employed from 1986 to 1990 at the MAKOWA architectural office in Budapest, and then from 1990 to 1994 at the WA-NE architectural studio. Died in 1998 in Budapest.

1981 Toldi Galéria, Budapest (with L. Vincze)
1982 Bercsényi Klub, Budapest
1991 Szént István Király Múzeum, Székesfehérvár
1996 Studio R, Budapest

Group shows
1982 Photo Biennial, Esztergom
Álomi szép képek, Lájos Galéria, Budapest
Fiatal építészek 84, Történeti Múzeum, Budapest
1987 *De-Construction*, Fodor Museum, Amsterdam
1989 *Más-Kép*, Ernst Múzeum, Budapest
Trigon 89, Neue Galerie, Graz
1992 Sydney Biennial
1994 *A nyolcvanas évek*, Ernst Museum, Budapest
1996 Művészetek Háza, Pécs

László Beke, born 1944 in Szombathely. Studies in art history at ELTE University, Budapest, 1963-1968. 1987/88 guest professor of art history at the University of Lyon. 1989-1996 research fellow at the Hungarian Academy of Applied Arts in Budapest. From 1990 professor of interdisciplinary studies at the Academy of Fine Arts, Budapest. From 1995 director of Műcsarnok, Budapest. Numerous publications and lectures in the field of contemporary art and exhibition curator. Lives in Budapest.

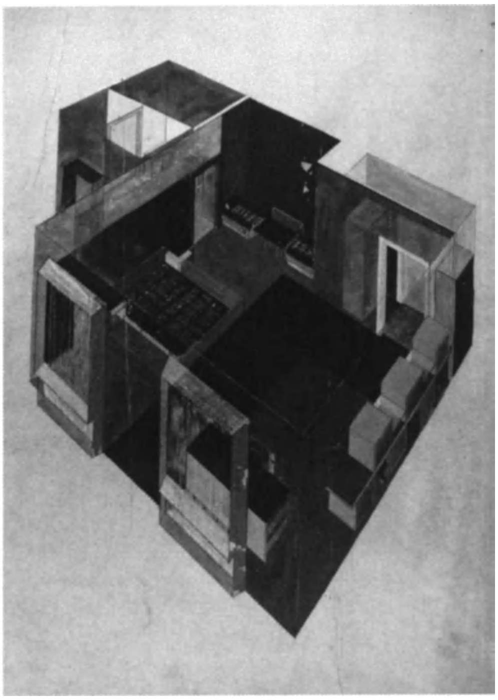
References:
László Beke, Zsusza Varga, *Kozma Lajos* (Budapest: Akadémiai Kiadó, 1968).
László Beke, *Művészet/ elmélet*, (Budapest: Intermédia, 1994).
László Beke, *Médium/elmélet*, Budapest: Intermédia, 1997.

Friedl Dicker and Franz Singer

Friedl Dicker (née Brandeis), born 1898 in Vienna. Studied photography and reproduction at the Graphische Lehr- und Versuchsanstalt in Vienna. In 1915-1916 textile class at the Arts and Crafts School, Vienna. In 1916 Itten School. In 1919 at the Bauhaus in Weimar. 1923-1926 "Workshops of Fine Art" with Franz Singer. In 1934 arrest because of her engagement for the political left, emigration to Prague, worked as interior designer. In 1942 deportation to the KZ Theresienstadt, where she organized illegal drawing classes for children. Died in 1944 in Auschwitz.

Exhibitions (with Franz Singer)
1927 *Kunstschau*, Vienna
1929 *Ausstellung moderner Innenarchitektur*, Austrian Museum, Vienna
1940 Royal Arcade Gallery, London

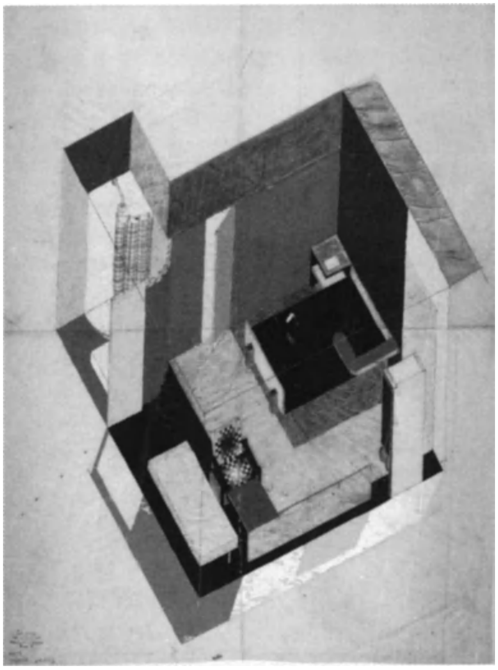
References:
Jarmila Skochova, *The Literary Legacy of Friedl Dicker-Brandejsova*, quoted after Al Hurwitz, in: *Friedl Dicker-Brandeis. The Art Educator as Hero*, in: *Seeing through Paradise. Artists and the Terezin Concentration Camp*, Massachussets College of Art, Boston 1991.



Friedl Dicker and Franz Singer, *Design for Hans Heller's Apartment*, Vienna 4, Kardinengasse, c. 1927
Living room and dining room for a bachelor, axonometric view, tempera, pencil on drawing paper, 58.7 × 41.8 cm

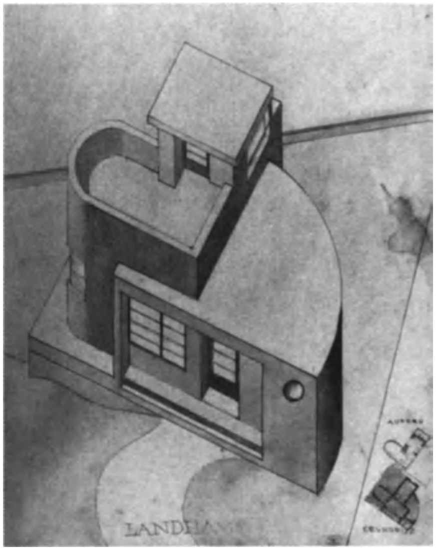
Franz Singer, born 1896 in Vienna. In 1914-1915 student of F. A. Harta in Vienna. In 1916 member of the Vienna Secession and participation at the Austrian exhibition in Zurich. In 1916-1919 studies of philosophy. In 1917-1919 studies with J. Itten. In 1919-1923 at the Bauhaus in Weimar. 1923-1926 "Workshops of Fine Art" with Friedl Dicker. Worked as architect and interior designer. Since 1934 freelance architect in London. Designs for standardized children's furniture. Died in 1954 in Berlin.

References:
Friedl Dicker, Franz Singer, *2 × Bauhaus in Wien*, Academy for Applied Art, Vienna 1988.

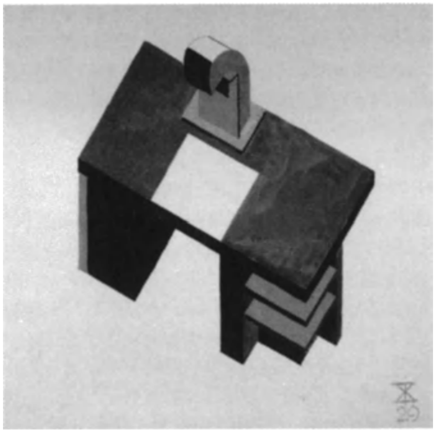


Friedl Dicker und Franz Singer, *Design for Viktor Kraus's Apartment*, Reichenberg, 1929, Bedroom with shower, axonometric view, tempera, colored pencil, pencil on tracing paper, 57 × 43.5 cm

Karl Steiner



Karl Steiner, *Country house*, 1924
Watercolor, 29 × 20 cm



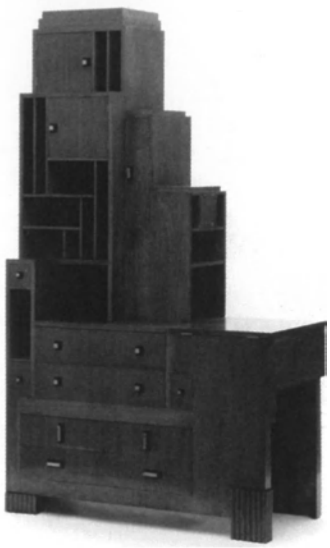
Karl Steiner
Design of a Desk with Lamp, 1929
Tempera on paper, 30 × 40 cm

Karl Steiner, born 1902 in Neunkirchen. In 1924-1927 he studied at the School for Arts and Crafts in Vienna (E. Steinhof). Exhibitions: in 1925 International Arts and Craft exhibition in Paris; in 1929 exhibition to celebrate the sixty-years anniversary of the School for Arts and Crafts, Vienna; in 1940 International Traffic exhibition, Cologne. Frescoes and interior design of many public and private buildings. In 1929 advertising agency in Neunkirchen. In 1945-1978 sgraffiti, frescoes, ceramics, and gobelins for public buildings. In 1979 he moved to the Bretagne. Died in 1981 in Burg Blanc near Brest.

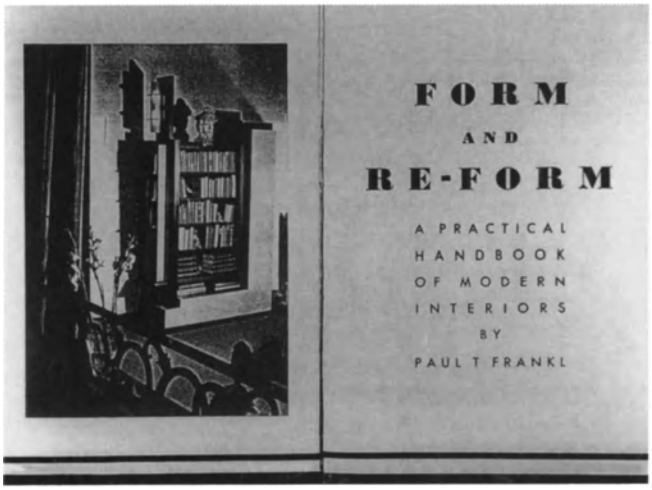
Paul Theodore Frankl

Paul Theodore Frankl
Pictures from *New Dimensions. Looking down on Comfort. Designed by P.T. Frankl,* New York 1928.

Paul Theodore Frankl
Two "Skyscraper" Bookshelves, c. 1930



Paul Theodore Frankl, *"Skyscraper" Bookshelf with Desk,* c. 1930, nut wood



FORM
AND
RE-FORM

A PRACTICAL HANDBOOK OF MODERN INTERIORS BY PAUL T. FRANKL

Paul Theodore Frankl
Form and Re-Form, New York 1930

Paul Theodore Frankl, born 1886 in Vienna. He was, besides Joseph Urban, one of the Austrian pioneers of modern design in the U.S.A. His interior and shop designs were an essential contribution to the glamorous art déco background for the dawn of a new era after World War I. He wanted to study painting, but his father demanded that he should study architecture, which he began in 1904 at the Technical University in Vienna; in 1905 he moved to Berlin. In 1911 he graduated, worked for a short time at a Swiss architectural office, and in Copenhagen. Several trips to Italy. In 1914 travels to U.S.A. When the war began he stayed in New York and worked as a graphic designer at the International Art Service. In 1915 renovation and interior design of a beauty salon for Helena Rubinstein. More followed (Elizabeth Arden, the so-called Arden-Penthouse; interior design of the Voisin of Otto and Alphonse Baumgarten). In 1916-1917 designer of receptions in the Austrian embassy in Washington, also stage settings for theater productions (Isadora Duncan). In 1922 opening of a gallery: he imported self-designed furniture (*skyscraper-furnitures*), wallpaper and textiles from Japan. He participated in many exhibition on modern design. In 1928 founding member of AUDAC, an organization for the improvement of the copyright situation of designers. Around 1930 publication of many books on modern design. In 1929 interior design of the mansion of Glendon Allvine, Long Island. In 1934 he moved to Los Angeles; founding of the Frankl Galleries in Beverly Hills. In 1946 he opened a new studio in Los Angeles. He produced his furniture designs under the name Paul T. Frankl Associates. Died in 1958.

9

Joseph Urban

Joseph Urban, born 1872 in Vienna. According to the wishes of his father he began to study law at the university, but soon he started to study architecture at the Academy of Fine Arts, Vienna (Carl von Hasenauer). In 1893 diploma and work at the architectural office of Ludwig von Baumann. Book and calendar illustrations with Heinrich Lefler (whose sister he married in 1896). In 1900 he was founding member of the Hagenbund, which he dominated till 1909 as director and designer of most of the exhibitions. Realized several architectural works in Vienna and surroundings. Stage settings with Lefler for more than 25 theater productions. In 1911 stage setting director of the Bostoner Opera; concept and direction of operas. In 1914 first Broadway production, New York. Artistic consultant of Florenz Ziegfeld (Ziegfeld Follies). Moved to New York. In 1917 American citizenship. From 1917 to his death in 1933 he made nearly all stage settings at the Metropolitan Opera. In 1920 art director of the film company Cosmopolitan Productions of William R. Hearst. Urban became one of the most important founders of film architecture. Urban-Blue is still a terminus technicus of the film industry. Urban always was a "place-to-go" for Austrian emigrants: 1920-1922 Wiener Werkstätte of America. With Mar-a-Lago, 1925, the renovation of a mansion for Mrs. E.F. Hutton in Palm Beach, Florida, his career as an architect in America began. Several buildings in Florida; and the New School for Social Research, New York. Died in 1933 in New York.

Joseph Urban, *Exhibition Hall of the Künstlerbund Hagen ("Zedlitzhalle") in Vienna*, 1901

Joseph Urban, *Wiener Werkstätte of America*, New York, 1921

Joseph Urban, Auditorium of the *New School for Social Research*, New York, 1929-1931

Joseph Urban, Library of the *New School for Social Research*, New York, 1929-1931

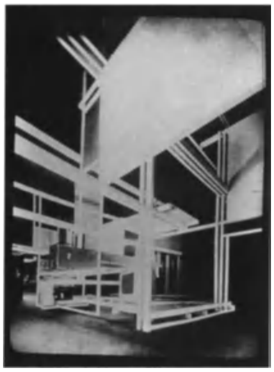
The participants in the exhibition *The Architect and the Industrial Art*, Metropolitan Museum of Art, New York, 1929: standing (from left): Raymond M. Hood, Eugene Schoen, Ely Jacques Kahn. sitting: Ralph T. Walker, Armistead Fitzhugh, Eliel Saarinen, Leon V. Solon, and Joseph Urban

Joseph Urban, *New School for Social Research*, New York, 1929-1931

Dieter Bogner

Friedrich Kiesler

During the forty years of his artistic activity — from the 1920s in Vienna to his death in New York in 1965 — Friedrich Kiesler worked continually to evolve a multidisciplinary concept of artistic design focused on the human being. He regarded *City in Space* — a support structure he built for theater models in the Grand Palais in Paris in 1925 for an Austrian exhibition of theater art — as a functional construction, a constructivist synthesis of the arts, and a visionary urban model planned to create radically new living conditions. The effect this monumental spatial composition must have had on the Dutch artist's group can be deduced from Theo van Doesburg's comment. "You have realized what we dreamt of doing someday," he said to Kiesler, "This is the amalgamation of the arts and not Le Corbusier's Pavilion de l'Esprit Nouveau."[1]



Friedrich Kiesler
City in Space, 1925

Friedrich Kiesler, temporary set with parts of the environment, *us-you-me* in the studio, 1964-65

Between this constructivist model of a utopian metropolis lifted off the ground and his last major three-dimensional work, a large installation titled *us-you-me*, there lay a process of summarizing artistic, architectural, sociological, psychological, and magical experiences, which led to the great complexity of Kiesler's later œuvre. *us-you-me* is a total environment comprised of many different large bronze sculptures and elements of architecture. Kiesler saw this work as a holistic symbol of the human being woven into the fabric of city culture, but characterized at the same time by the superior strength of myths — contents that he aims to convey with the aid of various media, including light, sound, and smell. To this day, no one has interpreted this extensive installation, which can be regarded as the sum of Kiesler's experiences in life.

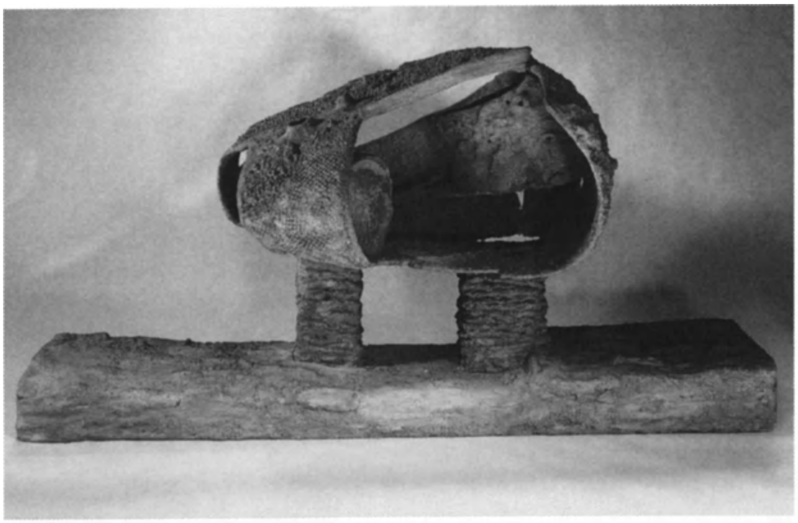
The conceptual background to Kiesler's projects is his holistic way of thinking — the fact that he was convinced of the interplay among all material and immaterial phenomena. He compiled his theoretical thoughts, rooted in the intellectual climate of Vienna in the 1930s, in his theory of correalism. In this concept he adds physical and psychological phenomena to his exploration of formal interactions (*City in Space*, 1925), referring to discoveries in elementary particle physics and combining them with insights in the world of biology. Kiesler's demand was that this biotechnical theory use scientific means to investigate the chances human beings have to influence life by shaping their environment in a certain direction. In this sense, this deals with the "interrelation of a body with its spiritual, physical, social, and mechanical environment."[2] Kiesler contrasts this biological, evolutionary approach with the functionalist view of architecture in the 1920s. On the basis of these reflections, he designed the interior of the famous *Art of this Century Gallery* for Peggy Guggenheim in 1942. However, among the most important concepts of this period was the *Vision Machine*, which Kiesler probably developed between 1938 and 1942. It is a demonstration object designed to show "that neither light, nor the eye, nor the brain can see alone or together. Rather, we see as a result of the total coordination of human experiences; and even then it is the view we ourselves create and not the actual object that we perceive. Thus, we must recognize that seeing is founded upon our creative capacity and is not created by mechanical reproduction."[3] The *Vision Machine*, animated by light and sound (language) is intended to show how perception of an object affects both the mind and the body, triggering an interrelation that creates an inner image that overlies the image we "see" in the outside world. By installing a perception apparatus in the middle of an exhibition whose scope ranged from exemplary prehistoric works to contemporary works of art, Kiesler wanted to display the various physiological and psychological sources that are the foundations of visual art. In this way he aimed to demonstrate that "the capacity of every human being to see and imagine something is, in certain individuals, intensified to such an extent that they can express the ever-changing images of the imagination in the form of pictures, sculptures, and other media generally described as 'art of applied art.'"[4] Kiesler combined a large number of preliminary studies for the *Vision Machine* in a large plan, in which he aimed to depict the connection between the various artistic forms and human perception.

Friedrich Kiesler
born 1890 in Vienna. Studied architecture at the Academy of Fine Arts and the Technical University in Vienna. In 1923 he conceived of the first theatrical stage created with film projectors. In 1924 he published a catalog for the International Theater Exhibition in the Würthle gallery. Moved to New York in 1926; designed many galleries and theaters, as well as his first cinema in 1928. Head of the set design department at the Julliard School from 1934 to 1947. Also designed for the Metropolitan Opera. Director of the Design Laboratory at the Columbia University School of Architecture, 1936 to 1942. In 1942 he designed Peggy Guggenheim's gallery; designed his famous *Endless House*, 1949 to 1961. Worked on projects with Armand Bartons from 1957 until his death in 1965 in New York.

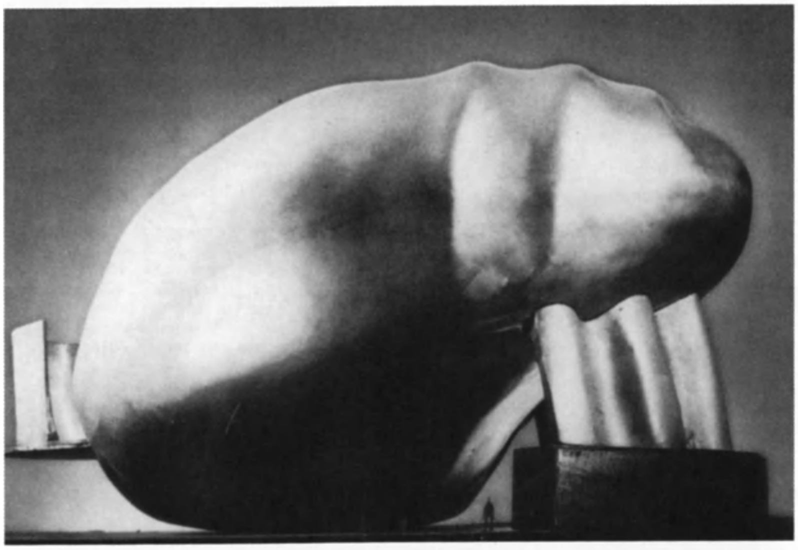
Group shows
1936 *Cubism and Abstract Art*, Museum of Modern Art, New York
1960 *Visionary Architecture*, New York

Exhibition designs
1947 *Exposition International du Surrealisme*, Maeght Gallery, Paris
1951 *De Stijl*, Stedelijk Museum, Amsterdam
1952/53 *De Stijl 1917-28*, Museum of Modern Art, New York

References:
Oswald Oberhuber, ed., *Frederick Kiesler, Architekt 1890-1965* (Vienna: Hochschule für angewandte Kunst, 1975); Dieter Bogner, ed., *Friedrich Kiesler, Architekt. Maler. Bildhauer. 1890-1965* (Vienna, Museum des 20. Jahrhunderts, 1988).



Friedrich Kiesler
Endless House, 1959
Concrete model



Friedrich Kiesler
Universal Theater,
1959-1961
Aluminium model

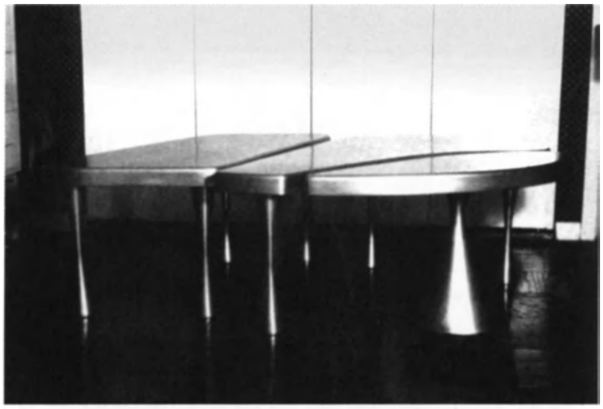
Friedrich Kiesler,
Armand Bartons
Shrine of the Book, 1957-1965
Jerusalem

Under the influence of his Surrealist friends, Kiesler added magical-religious phenomena to his conception in the course of the 1940s. To him, artistic and architectural design is a synthesis of the arts rooted in the totality of human existence. The complexity of dimensions of form and content achieved is one of the key phenomena of his later œuvre.

Just how strongly Kiesler's way of thinking in reference systems shaped his work can be deduced from two quotes. One is from the program text of the Paris *City in Space*, the other is taken from a preface to a catalogue for the exhibition of his four-part image constructions called *Galaxies*. Kiesler regards the elementarist construction of the *City in Space* as a "system of tensions in free space."[5] Almost thirty years later, he wrote about the *Galaxies*:

> *My pictures consist of many images, that is, smaller and larger units separated from each other by variously dimensioned intervals, although they belong together like a group, a nova or a galaxy...This correlation, no matter whether it concerns a smaller or greater distance, does not necessarily depend on physical connections. As in the case of wireless electricity, it is a correlation without connection. These 'endless' images and sculptures lead a life of inner connection. Between these physical units there are extremely different empty fields of tension that hold together the parts likes planets in empty space.*[6]

1. Friedrich Kiesler, "Die Vereinigung der Künste," Transparent (3/4: 1984) 57.
2. F. Kiesler, "Notes on Architecture. The Space House," Hound and Horn (March 1934) 292.
3. F. Kiesler, "Brief Description of Vision Machine," typed manuscript, Kiesler Archives, New York.
4. F. Kiesler, "A Paraphrase of the Memorandum," typed manuscript, Kiesler Archives, New York.
5. F. Kiesler, "Die Stadt in der Luft," G (5: 1926) 10.
6. F. Kiesler, "Notes on Correalism," *15 Americans* (New York: Museum of Modern Art, 1952) p. 8.
7. F. Kiesler, ibid.



Friedrich Kiesler
Aluminium Table, 1935/36

Friedrich Kiesler
View of the surrealist gallery in Peggy Guggenheim's exhibition *Art of this Century*, New York, 1942

Kiesler with Duchamp, Ernst, Breton, Mondrian, Léger and others, New York, 1941

The human being is integrated into this field of relations, be it a house or a sculpture. Speaking about the Rockefeller Galaxy created in the late 1940s, a wooden structure that evolved from a theater production by Kiesler, he says, "My sculpture is a usable sculpture. It is designed to be lived in and lived with."[7] The human being as a center of power in permanent interaction with the surrounding forces is the background for this attitude, which developed from the theory of correalism.

9

Wenzel Hablik

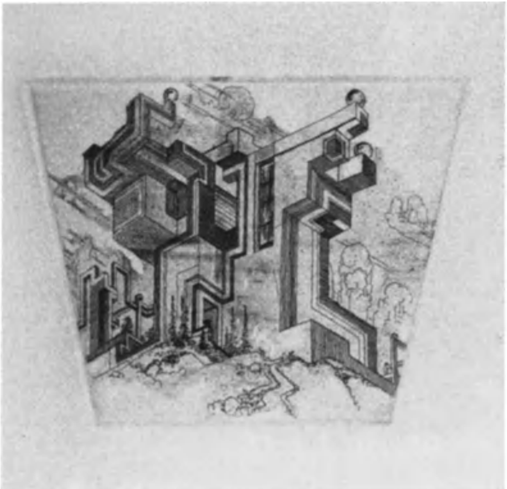
Architecture Between Utopia and Reality

Wenzel Hablik
born 1881 in Most, formerly Czechoslovakia. Became a master carpenter in 1895. Began a four-year program at the College for Clay Industry and Related Crafts in Teplice, 1898. Began studying at the Vienna School of Applied Arts in 1902 under F. von Myrbach, R. Larisch, H. Heller, A. von Starck, and O. Czeschka. Hablik designed furniture, textiles, and interiors. He painted and made etchings on the side. In 1917 he started Hablik-Lindemann Weavers with Elisabeth Lindemann. The fabric they made was shown in the leading art and crafts exhibitions. Hablik published his texts in various magazines and other publications. In 1926 he designed a series of clothing models, which he produced in his weaving mill. The *Lebens-Varieté* series was created between 1929 and 1933. Died in 1934 in Iztehoe, Germany.

1910 Galerie Commeter, Hamburg
1911 Ernst Richter Kunstsalon, Dresden
1915 Kunstverein, Magdeburg
1917 Gewerbemuseum, Bremen
Kunst- und Kunstgewerbehaus Bock, Hamburg
1918 Kestner-Museum, Hannover
Kunsthalle, Kiel
1925 Kunstverein, Prague

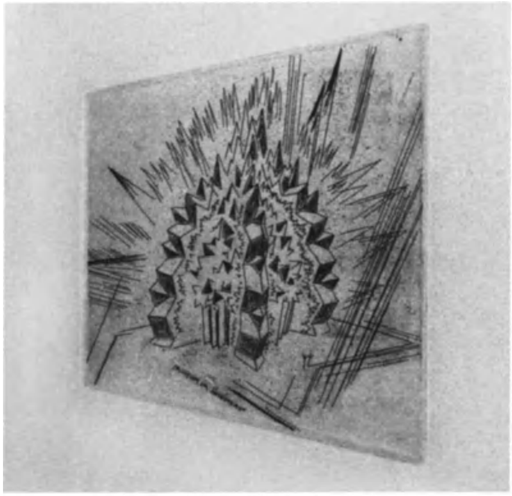
Group shows
1909 XVIII. Exhibition of Berlin Secession
1912 *Der Sturm*, Berlin
Kunstverein, Münster
1914 Deutscher Werkbund, Cologne
International Exhibition for Book and Graphic Design, Leipzig
1925 Second International Exhibition for Arts and Crafts, Monza

References:
Wenzel Hablik, *Orientreise 1910. Istanbul, Bosporus, Bursa, Ulu Dag*, Schriften der Wenzel-Hablik-Stiftung, vol. 1 (Itzehoe, 1988)

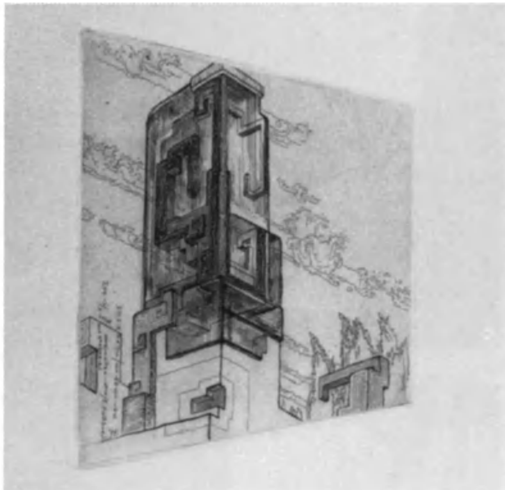


Wenzel Hablik, *Architecture*, 1925
No. 1
Etching, 39.3 × 34.8 cm

Wenzel Hablik, *Architecture*, 1925
No. 20 *(Floating Metal Sphere)*
Etching, 33 × 32 cm



Wenzel Hablik, *Architecture*, 1925
No. 15 *(Museum in the High Mountains)*
Etching, 33 × 32 cm



Wenzel Hablik, *Architecture*, 1925
No. 8 *(House and Studio)*
Etching, 39 × 31.8 cm

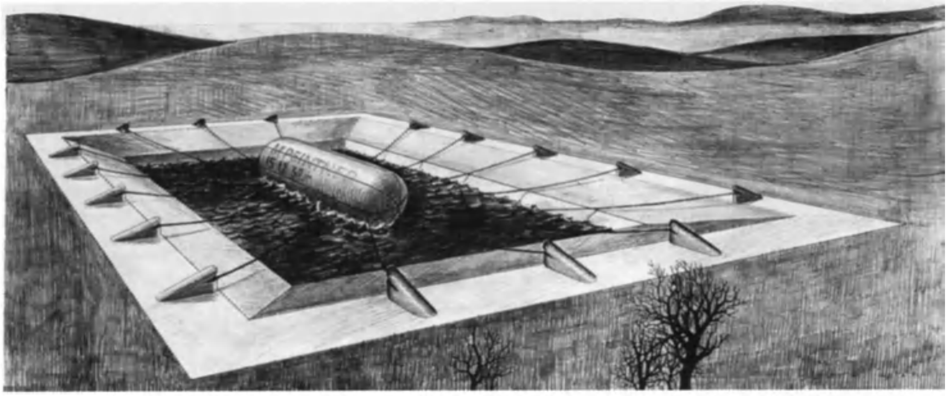
In Hablik's œuvre of designs, it is possible to identify one group of works, which despite its imaginary/visionary content, introduces what are to a great extent clearly formulated architectural systems. They have the potential to be realized and are thus utopias that can be implemented.

What they display is Hablik's fine instinct for the graphic division of surfaces, which implies that he had Viennese models — though of course it is not possible to clearly prove the reference. What is more, in view of details such as the window frames and the pieces connecting the portico pilasters, as well as in his general preference for angular forms, it cannot be denied that Hablik used the crystal as a model for the theme of a large number of his architectural fantasies. It is in this way — on the basis of recurring angular and pyramidal forms, diversified in abundance — that Hablik managed to anticipate several elements of an architectural language that was to re-emerge later in Bohemian cubism.

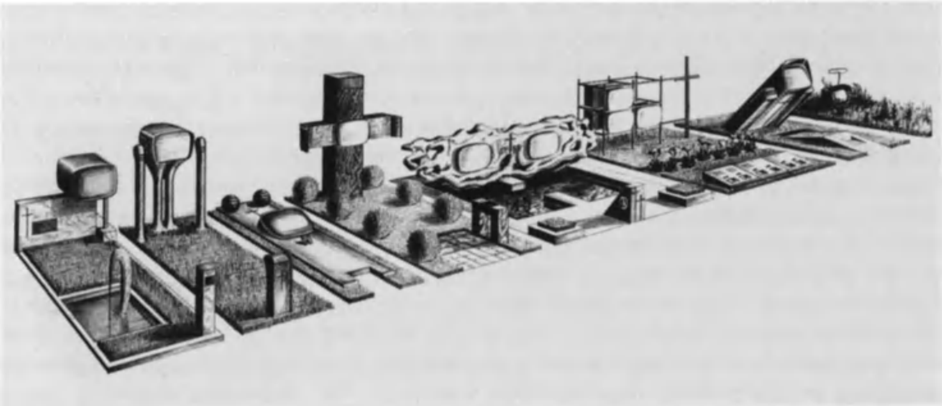
Hablik's "journey to the Orient," which took him to Constantinople in summer 1910, was a fundamental experience for his artistic work — an experience that was also reflected in his architectural designs. He described his encounter with the world of the Orient in his correspondence with his patron, Richard Biel, to whom he relayed the most impressive moments of his adventurous journey.

Franco Bevilacqua
Wenzel Hablik. Attraverso l'espressionismo (Florence: Museo Mediceo, 1989)

Max Peintner



Max Peintner
My Own Captive Grave Between Königsbrunn and Flandorf, Lower Austria,
1969
Pencil on paper, 37 × 61 cm



Max Peintner
Cemetary with Audio Visual Gravestones,
1969
Pencil, 62.5 × 88 cm

On the screens so-called "survival films": the dead in their favorite roles during lifetime. Put into operation through a coin slot, a key, or the adjusting of a code number. The console usually on the front part of the grave.
Sound: Headphones in the console or stereo loudspeakers (the 2nd, 3rd, and 4th grave from the left, the second to the last).
In the last third of the row a family grave according to the modular-design principle.
Possibility of extension: three-dimensional survival through color holography.

Max Peintner
The Continuous Power of the Attraction of Nature
1970/71
Pencil, 44 × 62.5 cm

9

Günther Feuerstein

Visions and Realities
The Austrian Scene in the 1960s and 1970s

Günther Feuerstein, born 1925 in Vienna. Studied architecture at the Technical University, Vienna. From 1961 assistant at the Institute for Building and Planning and from 1966 lecturer for contemporary architecture at the Technical University, Vienna. In 1966 doctoral thesis *Archetypes of building*. In 1967 exhibition *Urban Fiction*. 1970-1989 magazine *Transparent*. 1973-1996 professor for environment design at the University of Design, Linz. Also lecturer at the Academy of Fine Arts and the Technical University of Vienna (theory and history of architecture). In 1987 he was awarded with the Prize of the City of Vienna for Architecture. In 1996 Architecture Biennial, Venice; exhibition *Inhabitated Bridges*, London. Lives in Vienna.

References:
Günther Feuerstein, *Biomorphic Architecture: Menschen und Tiergestalten in der Architektur* (Edition Axel Menges, 2001).

Walter Pichler
born 1936 in Deutschnofen, South Tyrol. In 1959 diploma at the Academy for Applied Arts, Vienna. In 1963 longer stay in New York. In 1972 completion of the first buildings in St. Martin/Raab, Burgenland.

1963 Galerie nächst St. Stephan, Vienna (with H. Hollein)
1967 Museum of Modern Art, New York (with R. Abraham, H. Hollein)
1975 Museum of Modern Art, New York
1997 Stedelijk Museum, Amsterdam
1998 *Prototypen*, Generali Foundation, Vienna
2001 *Drawings, Sculpture, Architecture*, Barbara Gladstone Gallery, New York
2004 Galerie Thomann, Innsbruck

Group exhibitions
1968 documenta IV, Kassel
1982 Venice Biennial
1996 Architecture Biennial, Venice

References:
Walter Pichler: Drawings, Sculpture, Architecture, Jung & Jung, 2001.

Is architecture, understood as a virtual environment, in need of theory? It notoriously requires literary assistance — the word — as didactic and explicatory reinforcement, a polemic and demagogic weapon in defense of innovative processes within the complex medium of architecture. Since Vitruv at the latest, the written word has been also the site of theoretical discussion, although formulations like those standard in scientific explanations within the humanities or natural sciences are not to be expected.

The late nineteenth and the twentieth century hold a wealth of grand declarations about architecture, whose efficacy reaches into constructed architecture. William Morris, Henry van de Velde, Otto Wagner, Adolf Loos, Le Corbusier, to name the most prominent, are among those eloquent architects who supported their most significant works of construction with literary arguments, although often enough the difficulty in relating theories and works cannot be overseen. "Polemic theories" do not hold true for all ages. They are better described as working hypotheses or propaganda for a short period of time.

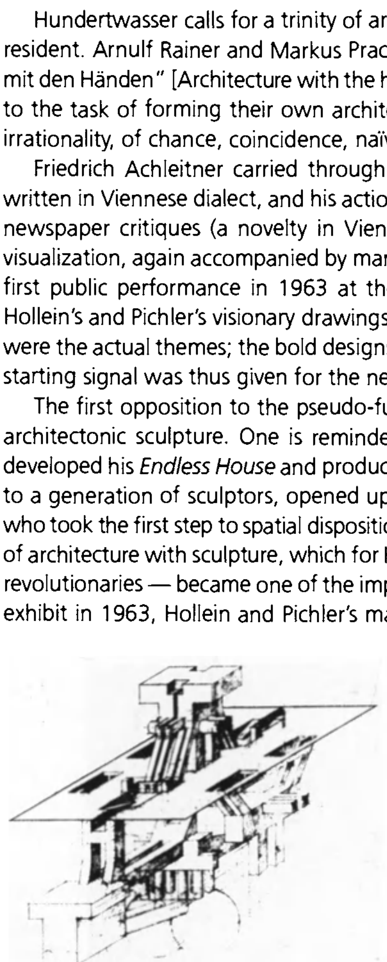
After the architectural drought between 1933 (or 1938) and 1945, there was a long breather until new concepts and ideas could again be formulated, insofar as one does not blindly assume a continuum after the 1930s. A sense of helplessness was perceptible in Austria, especially Vienna, formed by the emptiness of the housing developments built on the outskirts, the provinciality of school buildings, the façade demolition of the Gründerzeit houses, and the naiveté of postwar reconstruction. In light of the dreary architectural climate after the war, it is hardly surprising that new impulses again emerged from the literary field.

As early as 1958, three architectural manifestos formulated the discontent with (a misunderstood) functionalist architecture. Fritz Stowasser, later Friedensreich Hundertwasser, entered the fight against the rationality of the straight line and, in his "Verschimmelungsmanifest" [Mold manifesto], opposed rationalism in architecture. "The straight line is godless and immoral.... When a wall begins to mold, when the moss grows in the corner of a room ... this new life should be welcomed into the house."

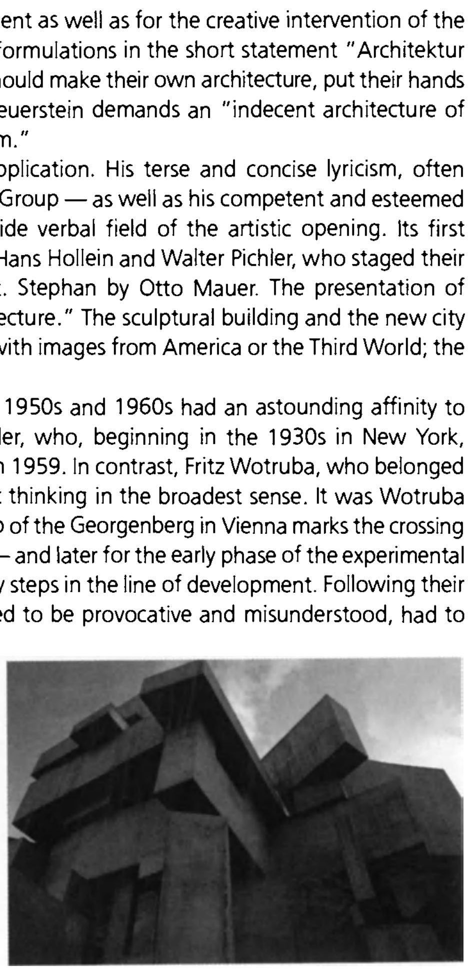
Hundertwasser calls for a trinity of architect-mason-resident as well as for the creative intervention of the resident. Arnulf Rainer and Markus Prachensky use similar formulations in the short statement "Architektur mit den Händen" [Architecture with the hands]: "Everyone should make their own architecture, put their hands to the task of forming their own architecture." Günther Feuerstein demands an "indecent architecture of irrationality, of chance, coincidence, naïveté and amateurism."

Friedrich Achleitner carried through the first literary application. His terse and concise lyricism, often written in Viennese dialect, and his actions with the Vienna Group — as well as his competent and esteemed newspaper critiques (a novelty in Vienna) — span the wide verbal field of the artistic opening. Its first visualization, again accompanied by manifestos, comes via Hans Hollein and Walter Pichler, who staged their first public performance in 1963 at the Galerie nächst St. Stephan by Otto Mauer. The presentation of Hollein's and Pichler's visionary drawings was called "Architecture." The sculptural building and the new city were the actual themes; the bold designs were confronted with images from America or the Third World; the starting signal was thus given for the new scene in Vienna.

The first opposition to the pseudo-functionalism of the 1950s and 1960s had an astounding affinity to architectonic sculpture. One is reminded of Friedrich Kiesler, who, beginning in the 1930s in New York, developed his *Endless House* and produced a grand model in 1959. In contrast, Fritz Wotruba, who belonged to a generation of sculptors, opened up Vienna to tectonic thinking in the broadest sense. It was Wotruba who took the first step to spatial disposition; his church on top of the Georgenberg in Vienna marks the crossing of architecture with sculpture, which for Hollein and Pichler — and later for the early phase of the experimental revolutionaries — became one of the important intermediary steps in the line of development. Following their exhibit in 1963, Hollein and Pichler's manifestos, formulated to be provocative and misunderstood, had to



Walter Pichler
Core of a Subterranean City, 1963



Fritz Wotruba, Fritz G. Mayr
Church of the Holy Trinity on the Georgenberg, 1965-76

withstand critique. Hollein claimed that "architecture is an elitist affair ... elementary, sensual, primitive, terrible, violent, dominant ... architecture is useless." No less harsh, Walter Pichler writes: "architecture is the embodiment of the power and desire of a few people. It is a brutal thing that has long departed from art.... The city for the elite is carried by the dwellings of the masses."

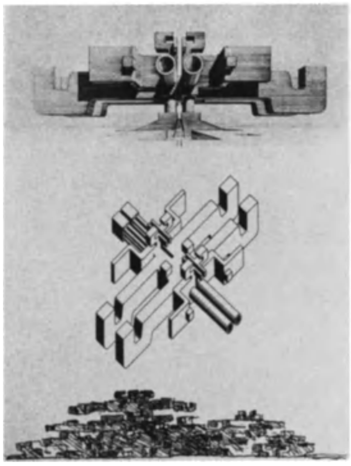
The nonsensical accusation of a fascist attitude can be drawn from such citations, but does not follow from the persons themselves. Another key sentence of Hollein is an indicator for the further, gradually diverging work of Hollein and Pichler: "All construction is cult-like.... Architecture is a mental ordering, realized through buildings." The cult-like claims of construction find their clear resonance in the ritualization of construction concepts and in an architecture of scenic events. In this, significant fields of reference are cited: theater on the one hand, Catholic liturgy on the other, and, summarizing both, Vienna Actionism, which can be seen as a temporal phenomenon of the 1960s but which extends up to the present with Hermann Nitsch and his O.M. Theater.

Since the 1960s the works of Arnulf Rainer can be counted as ritual art in a broader context, and his overpaintings sometimes relate to architecture, for example when a photo of Vienna's Burgtheater disappears before our eyes, covered over by thick paint, allowing merely the tower of St. Stephen's Cathedral to jut forth from the bouquet of brush strokes. Rainer celebrates an ambivalent proceeding: covering and extinguishing relate in their Freudian senses in the same way as love and aggression.

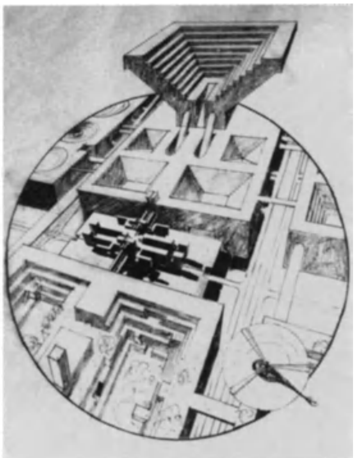
The process becomes even clearer when Wolfgang Ernst covers the city with soil, or young architects want to submerge the city of Graz in water so that only the watchtower is visible after flooding. A ritual character can already be seen in some of the early works of Hollein and Pichler, and it is in Vienna above all where the themes of injury, sickness, and death are unavoidably carried over into the artistic spectrum.

With his blood, Walter Pichler drew a map of South America onto white linen cloth. In a two-man procession he carried a mysterious tabernacle-like shrine through the streets of Vienna. Hans Hollein spread out the spectrum of childhood, sickness, and death as a spatial event at the Biennial in Venice in 1972 through readable metaphors in and around the Hoffmann Pavilion. With Hollein, the theme of the wound, the injury, again becomes a delicately presented, so-called neo-manneristic attitude, in the sense of the "injuries" by Giulio Romano or Romanticism: staged convincingly with the jeweler's shop of Schullin am Graben (1972/74). The further paths of Hollein and Pichler are characterized by an astounding continuity. Walter Pichler built wondrous houses for his sculptures; Hans Hollein rose to the summit of architectural renown. Above all, his museum buildings, as sovereign stagings of path, space, light and artwork, display a magical, ritualistic character. The Actionist or scenic approach, however, becomes most important along with another phenomenon: the experimental groups, which precipitated out of the seminar works under Günther Feuerstein at the Technical University in Vienna after 1963. The tendencies towards liberation from the conservative environment of the TU found their forum in three pools of ideas and information: in the "Klubseminar der Architekturstudenten" [Architecture student's club seminar], "Experimentelles Entwerfen" [Experimental design], and "Gegenwartsarchitektur" [Contemporary architecture].

Among the active students, the first to make a mark was Laurids Ortner, who dreamt of wonderful, animalistic bone forms and, vaguely reminiscent of Kafka, rapturously tells of strange beasts. "Embedded inside



Hans Hollein, *Sacred Building*, 1961; *Urban Interchange*, 1962



Hans Hollein, *Compact City*, 1964

Hans Hollein, born 1934 in Vienna. In 1956 architectural diploma at the Academy of Fine Arts (with C. Holzmeister). 1958-1960 studies at ITT, Chicago, and at University of California (Institute of Design). 1965-1970 with Pichler, Feuerstein, Peichl, and Dimitrion publication of the magazine *Bau (Building)*. 1967-1976 professor at the State Academy of Arts, Düsseldorf. 1976-1979 professor for industrial design at the University of Applied Arts, Vienna. From 1979 professor for architecture at the University of Applied Arts, Vienna. In 1978-1990 curator of the Austrian pavilion at the Biennial of Venice. Lives in Vienna.

1963 Galerie nächst St. Stephan, Vienna (with W. Pichler)
1987 Museum des 20. Jahrhunderts, Vienna
1990 Peggy-Guggenheim-Museum, Venice
1995 Historisches Museum der Stadt Wien, Vienna
1996 Architecture Biennial, Venice
2000 Historisches Museum der Stadt Wien, Vienna

Realized buildings
1965 Retti candle shop, Vienna
1969 Richard L. Feigen Gallery, New York
1974 Schullin I, jeweler shop, Vienna
1982 Städtisches Museum Abteiberg, Mönchengladbach
1978 Glass- and Ceramics Museum, Teheran
1990 Museum für Moderne Kunst, Frankfurt
1989 Haas House, Stephansplatz, Vienna
1988 Concert Hall, Los Angeles
1992 Michaelerplatz, Vienna
1996 Kunsthalle St. Pölten Lichtforum Zumtobel, Vienna
2001 Medienturm (Generali Tower), Vienna
2001 Interbank Tower, Lima
2002 Vulcania Museum, Auvergne

Haus-Rucker-Co, founded in 1967 by Laurids Ortner, Günter Kelp (Zamp), Klaus Pinter. In 1971 Manfred Ortner became a member. In 1972 Pinter left; Studio Haus-Rucker-Inc. in New York until 1977. Haus-Rucker-Co had its office in Düsseldorf, lasted until 1992. Projects and realizations in the fields of architecture, urban planning, exhibitions, free artistic works.
Laurids Ortner, born 1941 in Linz. In 1965 architectural diploma at the Technical University, Vienna. 1976-1986 professor at the University of Design, Linz. In 1987 professor for architecture at the State Academy of Arts, Düsseldorf.
Günter Kelp (Zamp), born 1941in Bistritz, Romania. In 1944 he went to Austria. In 1965 architectural diploma at the Technical University, Vienna. In 1967-1969 assistant at the Institute for Building Topology and Design at the Technical University, Vienna. From 1988 professor for architecture at the University of Arts, Berlin.

me is the thought that it must be wonderful to live inside an insect, to use its organs as stairs and ramps and then I finally saw that among all these powerful archways, there was not a single right angle." In 1966, Laurids Ortner built his *47th City*: an assemblage of materials that, in ironic alienation, compiled everyday objects into a monumental airborne urban sculpture.

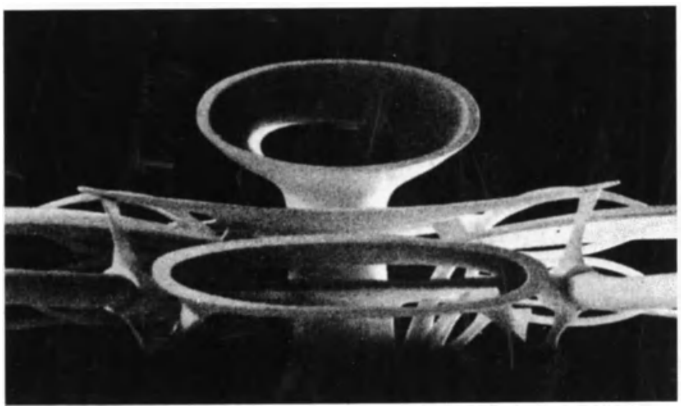
Laurids Ortner became friends with Günter Kelp (pseudonym "Zamp"), who placed his school of architecture, a monumental cloister, onto a mountain. And one year later, Laurids and Zamp, inspired by the painter Klaus Pinter, found new things to do as the group Haus-Rucker-Co: the pneumatic objects were the adequate medium for easy and provisionary, transitory, and flexible architecture. And again the action was sizably significant: already in the founding year 1967, the *Balloon for Two* was hung out of the window of a Viennese apartment house, and once again the Viennese police were called to the scene. In a later stage of development, the balloon could again be encountered as an oasis at the documenta V in Kassel in 1972.

Together with André Heller in 1969, *Vanilla-Future* was celebrated, the *Yellow Heart* beat in a construction ditch on the Viennese Ring, and the *Giant Billiard* at the Museum of the 20th Century anticipated the fair's attraction of air mattresses for children.

Among the active students at the Technical University, Wolf-Dieter Prix, with his flexible apartment house, and Helmut Swiczinsky and Michael Holzer, with their unconventional designs, also won attention. In 1968 the group Coop Himmelb(l)au grew out of this affinity in their works and there too, the first opportunity for articulation lay in the pneumatic ambient. The drawing alone became insufficient — the *Villa Rosa* became a prototype for a new antirationalist architecture at the Technical University and was presented at the Museum of Arts and Crafts in Vienna. "No longer do pillars and beams, nor construction, stand in the foreground of architecture. Since the erection of the first totem pole, the goal has been dematerialization, the suspension of gravity, the dream." In this early attestation, it becomes clear that the conflict with the earth's mass and the decline of the horizontal and vertical would lead down the long road to "Deconstructivism." The intermediary stations are noteworthy enough. Soon after their distancing from the pneumatic objects, the structure became solidified. A 1982 room installation in Stuttgart covered all criteria for "Deconstructivist architecture," which manifests itself in the attic construction, Falkestraße, in the Funder factory, and finally in the Museum Groningen in astoundingly adequate forms in comparison to the expressive, automatic sketches.

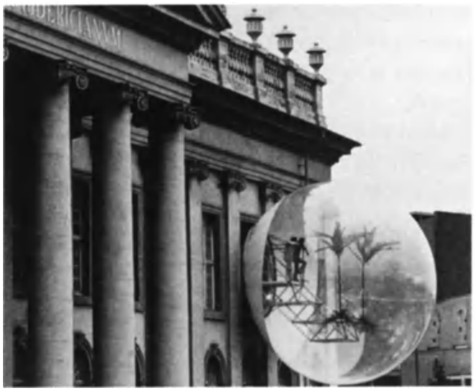
Himmelb(l)au were not thrifty with polemics and provocative verbal declarations; their brevity and terseness certainly have the character of a manifesto:

> *Architecture is not the means to an end; architecture does not function. Architecture is not beautification, but rather the bones in the meat of the city. It gains its importance through the degree of decline caused by taking possession. And power from the wretchedness surrounding it.*
>
> *And this architecture has the message:*
>
> *That which pleases is bad.*
> *That which functions is bad.*
> *That which must be accepted is good.*

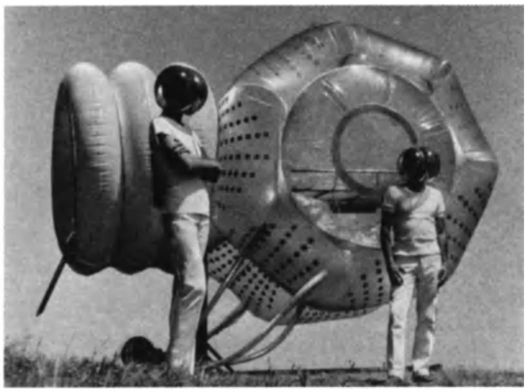


Laurids Ortner
Airport, model, 1964/65

Haus-Rucker-Co, *Balloon for Two*, Apollogasse, Vienna, 1967



Haus-Rucker-Co
Oasis # 7, documenta V, Kassel, 1972



Haus-Rucker-Co
Yellow Heart, 1968

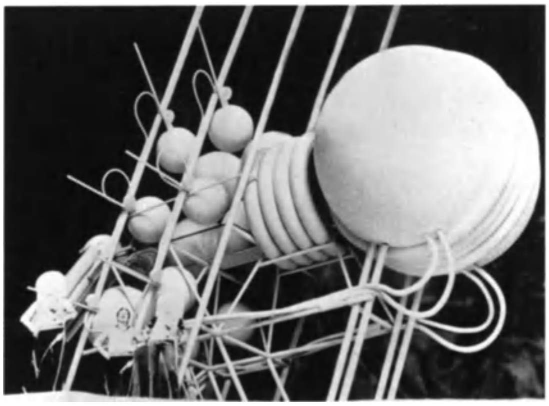
If there is a poetry of wretchedness, then it is the aesthetic of architecture of death in white shrouds. Of death in tiled hospital rooms. The architecture of the sudden death on concrete.
The architecture of the ribcage pierced by the steering column, of the direction of the bullet entry in the head of the dealer on 42nd street.
The aesthetic of the architecture of the razor-sharp scalpel of the surgical intervention and the sex of the peep-show in washable plastic cells, of broken tongues and withered eyes.
And so the buildings must stand. Unpleasant, raw, penetrating. Burning.
Like constructed death angels.

And the demand "architecture must burn" is motivated by the following:

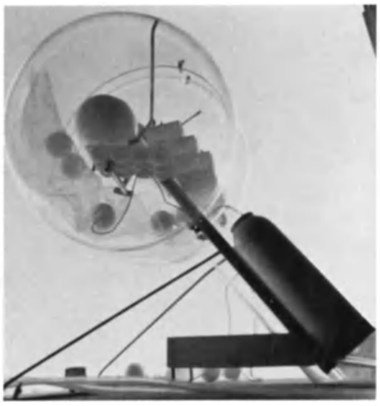
We want architecture that has more. Architecture that bleeds, tires, turns, and breaks, for all I care. Architecture that glows, stings, tears, and splits when stretched. Architecture must be gorging, fiery, smooth, hard, geometric, brutal, round, tender, colorful, obscene, horny, dreamy, approachable, alienating, wet, dry, and heart beating. Alive or dead. If cold, then cold as a block of ice. If hot, then hot as wings of fire.
Architecture must burn.

The idea of the flame — an eternal cult metaphor — is ignited twice: once as an actual flame, in the *Flaming Wing* that blazes up to the heavens from the courtyard of Graz's Technical University and a second time with *Hot Flat*, a project for the Neue Markt in Vienna: an "open" residential house out of which bundles of flames shoot out. *The Hard Space* — explosions in the landscape — and *The Soft Space* — the foam flooding of a street — are also cited as further actions from Himmelb(l)au.

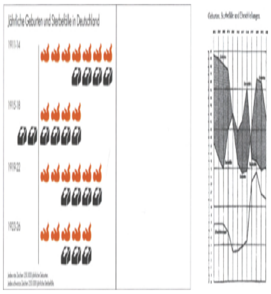
The 1968 Student's Congress in Vienna brought forth a huge social confrontation: the work was wrongly criticized by the German participants as not being political enough, as aestheticizing and playful. The



Coop Himmelb(l)au, *Villa Rosa*, model, 1968
Photomontage



Coop Himmelb(l)au
Cloud II, 1968-1972



Zünd up
Great Auto Expander
Karlsplatz, Vienna, 1969

"Viennesque" — understood as meaning an almost-baroque assemblage — nonetheless experienced a quite committed enrichment: the Karlsplatz, at the time still an undeveloped area, became a construction site: lattice constructions, plastic skins, pneumatic wrappings, manipulated cars, emergency quarters for the Third World creating an "Instant City," so to speak, in the sense of Archigram.

The accusation of not being political can be dismissed with a look at the group Zünd Up, founded in 1969. Timo Huber, Walter Michael Pühringer, Bertram Mayer, and Hermann Simböck formed the "radical" wing of the Viennese experimental scene. Their fetishisitc involvement with the motorcycle as machine also clearly bore social-critical characteristics, covered in their "creed":

We believe in the destruction of the existing relationship between architecture and social patterns of behavior. Destruction is positive action. Architects always remain responsible for their actions. Architecture is aggressive, it burns, it stinks, it changes, it is dirty and beautiful. Our favorite color is black.

And this black, simultaneously death and aggression, is confronted by the other "color":

your environment is gray,
your environment is gray,
your environment is gray,
it is gray, your environment.
or architecture is seen, heard, felt, and smelt. it ages, rots, and disappears.
or to bring a blower to the pissed-in corners.
or the naïveté of our fellow citizens who still believe themselves to be free, mainly in their free time, must still be destroyed. (momo, kohoutek, brunbauer)
revealed to the observer is the immeasurably rich property of western culture as a
living legacy which is necessary to acquire in order to own (concert guide),
or the rumble of our century thunders through the historical,
or war memorials and the like would run dry,
or readiness for arrangement with the existing order is your not yet recognized
suicide,
or do you feel responsible for the present situation?
as "visuality" as a medium of conscious experience is over-rated, ZÜND UP "visually" boxes against historical taboos.
or to hit the clerics under their sacral belt
or to pound on deeply frozen uncritical environmental brain convolutions,
or are you aware that you're again only building walls,
you can still participate in the fascinating ZÜND UP "change or destroy play" that already provides immense pleasure!
ZÜND UP blasts, blasts, blasts discontent away!
ZÜND UP also wants to design a modern vienna and keep it nice!
we ask: what should our cities become?
how do you imagine their future situation, mr. construction minister?
what will become of our johann strausses?
we demonstrate: the roar of our century thunders through the historical!

The group Salz der Erde [Salt of the earth], which included Wolfgang Brunbauer, Günter Matschiner, and Johann Jascha, had a brief existence in 1970. Together with Zünd Up they worked on action art and films that had a very distinct social-critical character.

The Missing Link group, on the other hand, had a ten-year existence, from 1970 to 1980. Adolf Krischanitz, Otto Kapfinger, and Angela Hareiter challenged with a broad spectrum of activities: drawing, exhibition, film, urban planning concepts, and action-art were all media they employed equally.

To sketch out the scene of the 1960s it is necessary to flash back once again: until 1966, before the experimental groups were founded, the activities and ideas were concentrated in such a way that a public presentation appeared justified. Günther Feuerstein showed the revolt of the young, progressive students and architects in an exhibition with the title "Urban Fiction." Here the first intensive encounter was made with those from Graz, whose works demonstrated affinities to the Viennese.

The most important person in the Grazer scene was Raimund Abraham, although the main emphasis of

Raimund Abraham, born 1933 in Lienz, East Tyrol. Graduated in 1958 from the Technical University, Graz. 1960-1964 he had his own office for architecture and design in Vienna. In 1963 he published his book *Elementary Architecture*. In 1964 first travels to the U.S.A., where he met Friedrich Kiesler in New York. 1964-1971 he taught at the Rhode Island School of Design in Providence. In 1968 he founded with S. Thomasson the Studio of Environmental Technology. In 1971 he moved to New York, where he had his own studio. From 1971 professor for architecture at the Cooper Union and lecturer at the Pratt Institute in New York. Guest professor at several universities in Europe, the U.S.A. and Mexico. In 1985 he became Davenport Professor for architecture at Yale University and was awarded with the Stone Lion of the Architecture Biennial in Venice. 1998/2002 he built the Austrian Cultural Forum in New York. Many exhibitions, a. o. Museum of Modern Art, New York; Musée National d' Art Modern Centre Georges Pompidou, Paris; Nationalgalerie, Berlin; Architektur-Museum, Frankfurt/ Main. Lives in New York.

his work quite quickly shifted to the USA. Once more the literary affinity is apparent: his initial drawings (from ca. 1960) are accompanied by poetic montages: in *Vision of the City* (1962), magic and irrationality, ritual, and cult become a dense metaphor for the suffering and the pleasure of the city:

cities
altars
rendered intestines
wide opened
radiating
piled up ganglia
earthenware receptacles
chasms
men on rolls
spherical receptacles
mobile volumes
moved sideways
without direction
very dark parts
plants
gigantic piled up halls
machines
incessant movement
of the lower parts

glassy
pencilled rays
domes
chasms
passages
mortuaries
slaughterhouses
coffins in freight elevators
topping-out ceremonies in the interior
wonderful chaos of
endless
clear arranged
concrete volumes
holes
plugs
sewers
churches
shafts
windowless solar craters

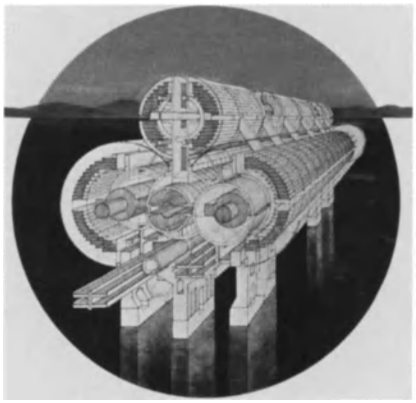
buildings at the crossroads
round
rising
immense massive buildings
festive buildings
brothels under the earth
endless
cylindrical
crossing buildings
towers to the light
cluster of spheres
ashlars
deserted
useless sun places
streets
gallows
circular
in the enormous stomach
of the inner cities

Raimund Abraham post-delivers the designs for the city as virtuoso drawings: *Metropolitan Core* as a compact condensed creation, a protest against the dispersed sprawling of the cities, and *Mega Bridges*, the colossal bridge city which spans the ocean. In his later works, Raimund Abraham unfolds a broad dialectical area of conflict: on the one side are wonderful drawings of the houses which dissolve into paths, walls, particles, curtains, aisles. On the other side are the steles and totems of a semantical monumentality: in Berlin, Vienna, and New York we find the realizations which only in the 1980s turned from a vision into the world of real buildings.

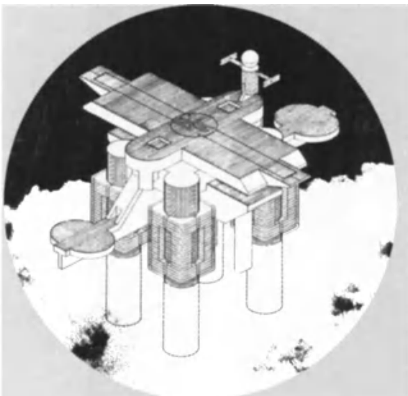
Friedrich St.Florian worked on the same line as Abraham for a short period. His *Vertical City* picks up the motif of the tubes; they are attached to a traffic light that converts the horizontal to the vertical. Also in St. Florian's art there is an amazing breadth of architectural conception: the compact urban creation opposes the imaginary rooms of light, laser, and idea. The theme of the changers also occupied Bernhard Hafner, who also accompanied his work with expressive appeals:

Space, Time, and Architecture?????
Space-Time and Architecture?!?
Raumzeit – Architektur!!!!!

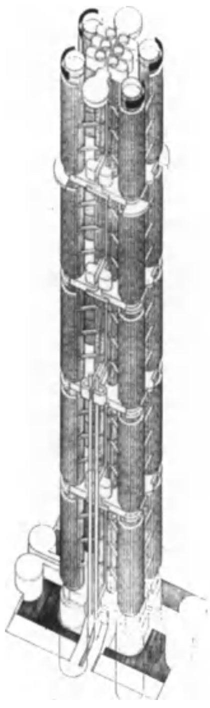
Friedrich St.Florian, born 1932 in Graz. 1952-1958 he studied architecture in Graz, Brussels, and Zurich. In 1962 Master of Architecture at Columbia University, New York. From 1963 professor for architecture at the Rhode Island School of Design, Providence, Rhode Island. In 1966/67 director of the Europe Program of the Rhode Island School of Design in Rome. From 1971 at the MIT, Center for Advanced Visual Studies. 1978-1988 dean of the Department of Architecture, Rhode Island School of Design. In 2004 his "National World War II Memorial" was inaugurated in Washington. Lives in Cambridge, Massachusetts.



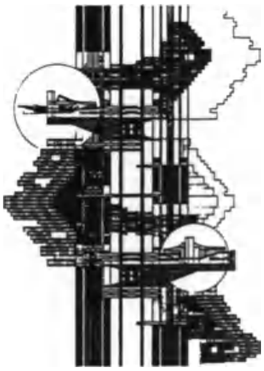
Raimund Abraham
Mega Bridges, Bridge City, 1965



Friedrich St.Florian
Elements of the Vertical City, Interchange 2, 1966



Friedrich St.Florian
Vertical City 2, 1966



Bernhard Hafner
Cover of *architekturalternativen I, Towerblock-Changer,* 1966

Space and time seen as elements of architecture, of art; polarities and alternatives?
A comma and no comma, that is the question.
Space and time as unit, space-time as essence of the architectural, of the artistic itself. Life-evolution. The spiritual process of becoming and passing away.
The change: the continuity of the dynamic.

Construction is:
Experiment, fantasy, and imagination of the futuristic for the present, idea, unfolding, and development. Conception, expression of a mental and conscious state, art, life, and technology with greater value than architectural confidants want to grant it.

Hafner oriented his urbanist concept of architecture on the system of the city. In the framework of a theory of "structural architecture," which he published in 1966 with the title *architekturalternativen I* [Architectural alternatives], he wrote, "Thus every socially organized volume builds a total energetic system because it is filled with diversity."

The "Grazer School" — which never really articulated itself as a school — found its uncrowned leader in the complex personality of Günther Domenig. The early works, after 1963, together with Eilfried Huth, attempt to bring the idea of the grid city, possibly inspired by Yona Friedman, into reality. To no avail, however: the dream of mobility, flexibility, availability, and freedom failed due to economics. Domenig calculated the feasibility through a concrete example and arrived at one of the answers as to why so little had been realized from these bold ideas: the costs for the support and supply structure alone exceeded the economic limits.

Nonetheless, Domenig's isolated artistic drafts of the 1970s and 1980s were transferred to reality: the zoomorphic multipurpose hall in Graz, the Z-bank in Favoriten, the university buildings in Graz, and his own *Stone House* as a manifesto to the sculptural-spatial complexity — staking out the borders of a "real irrationality" in architecture.

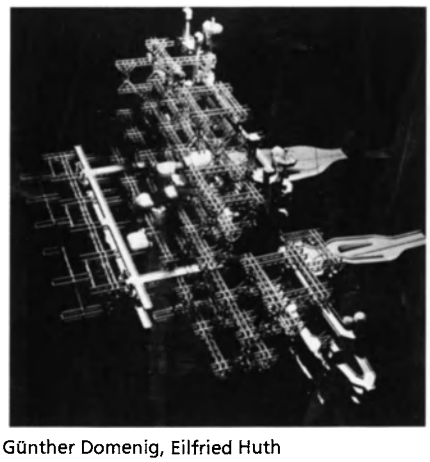
In addition to Günther Domenig, it was Michael Szyszkowitz and Karla Kowalski who determined the architectural scene in Graz — or more accurately, in Styria. As with Domenig, their architectural language also clearly mellowed in the 1990s without sacrificing the original concept. Working on the fringe of the scene, they are loners, but in no way with less quality or importance.

Also notable here is the substantial and virtuoso work of Carl Pruscha. His idea of a total urbanization of the Earth with a network of string-city structures has not lost any of its relevance in light of the continuing population explosion. For Pruscha, as with all other concepts in Austria, before the great idea comes the question of its visual articulation. Pruscha gives finalized answers: first in drawings, in projects, and then in a few (far too few) realizations: in Katmandu, in the Donau City, and in Liesing.

Gernot Nalbach, one of the most original and distinctive minds in the Viennese scene found his field of activity in Berlin and, like so many of his contemporaries, used teaching as the most important medium for his architectural message. Previously, however, he crossed through the manifold paths of experimental and fantastical architecture. If the date is correct, he had already developed his Low-Cost-House in 1962 as a pneumatic construction, elevated off the ground by four balloons in an archetypal disposition. In his *Pneumo-*

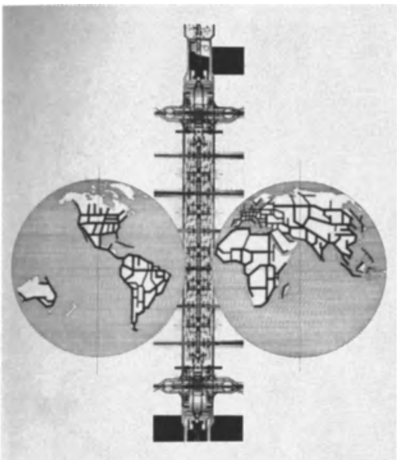
Günther Domenig, born 1934 in Klagenfurt, Carinthia. In 1959 architectural diploma at the Technical University, Graz. 1963-1973 co-operation with Eilfried Huth. 1971-84 guest professor at universities in Germany, Austria, Turkey, Italy, France, Great Britain. From 1980 professor for Building Topology and Design at the Technical University, Graz. In 1995 and 1998 stage setting and costumes for *Electra* resp. *Moses and Aaron*, Opera, Graz.

Realized buildings
1968 Pedagogical Academy, Graz
1969 Project Ragnitz, Graz
1972 Restaurant, Olympics, Munich
1973 Research Institute VOEST-Alpine, Leoben
1979 Z-bank Favoriten, Vienna
1992 Z-bank, Vienna
1998 Theater Klagenfurt
2000 Augarten Hotel, Graz
2001 Documentation Center, Reichsparteitag area, Nuremberg
Academy of Arts, Munster

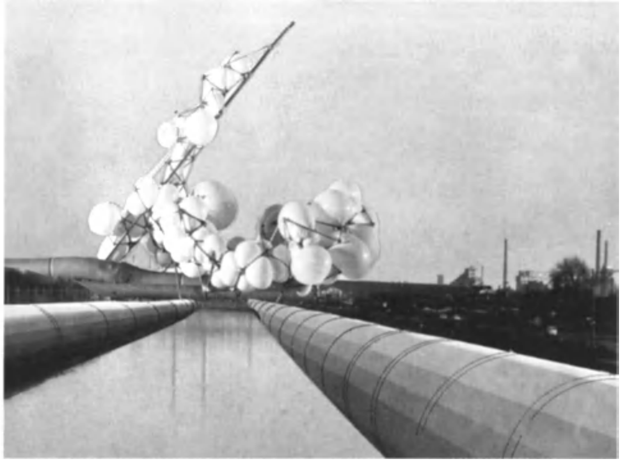


Günther Domenig, Eilfried Huth
Residential Homes Graz-Ragnitz, model, 1966-1969

Günther Domenig, *Stone House*, 1987-1989
Model of his own house in Steindorf



Carl Pruscha, *Concept for a Global Settlement: Infrastructure of a Global Net of Urban Landscapes*, 1962-64



Gernot Nalbach
Pneumo-City, Project for "Austriaca 70," 1965/66

City Nalbach conjures up the dynamics of the Russian constructivists penetrating into the room (the Haus-Rucker would realize them ten years later with the Nike in Linz), but the room-support-system is now filled in with pneumatic rooms and becomes an expressive organic structure, representing monumentality as well as transitoriness. The realization was achieved at least in "design:" the pneumatically controlled leather armchair from 1967 can also be seen as a prototype for a constantly changing ambience.

Naturally the Austrian works didn't arise as if from an island (and certainly not the one of "the blessed," according to a saying of the Pope), but rather were deeply bound up with parallel phenomena: the works of Archigram which commanded their respect, the French-made grid cities and architectural monuments, the Japanese plans to advance upon the ocean. But still that was not enough: an enormously dense realm of experiences pleased and threatened us daily: the "wonder" of space travel, the first step of a man on the moon. The development of computer technology, genetic engineering, new artificial materials. But the illusion of a total feasibility of our visible environment quickly met with its own borders: Vietnam and nuclear testing, Baader-Meinhof and Paris Students' Uprising, Prague Spring and the Six-Day War, the Berlin Wall and the Cuban Crisis demonstrated the far too narrow radius of our powers. Thus we held onto those positive events that left no visible traces behind in the architecture but were nonetheless influential: the Beatles and the Stones, Hendrix and Zappa, Warhol and Christo, Beuys and Lichtenstein — to name but a few.

Yet it would be a huge error to interpret the scene of the 1960s in that same isolation that one sometimes wants to assign — absolutely without justification — to the 1968 generation.

There are no breaches, no end that can be as clearly determined as the beginning in 1958. Indeed, it is correct that the heyday of the visionaries didn't last longer than two decades — relatively long compared with other progressive currents of our century — but in a fluid transition substantial currents lead directly to the present.

The Zünd Up may have dispersed, but the rudiments of their position are still traceable in their later works. Hollein and Pichler followed a grand path of continuity that never showed stagnation. And it is mainly the Coop Himmelb(l)au who, with an unbelievable consistency even through barren periods, have pursued a goal that they have also been able to achieve in its constructed realization. Their appropriation as "Deconstructivists" — a completely misleading term – was more useful than harmful and today they have moved into the elite, equivalent to the top ten, of the international architectural scene.

The members of Haus-Rucker-Co also quickly distanced themselves from pneumatic construction and, with urban symbols, mark out a new area to focus on. The most beautiful example is the Nike perched on a steel scaffold and based on El Lissitzky — providing an ironic response to Linz's baroque Trinity column. Following this significant semantical phase, Haus-Rucker dissolved and offered their work for thoroughly high-quality construction. The scene of a "visionary architecture" has transformed: we have consciously never spoken about "utopias." They were never dreams that could never be fulfilled; instead, they were views of the world to come.

Indeed, in the real world several of them have come true, thirty years later!

Günther Feuerstein, *Visionäre Architektur. Wien 1958/88* (Berlin: Ernst & Sohn, 1988).

Carl Pruscha, born 1936 in Innsbruck. In 1959 architectural diploma at the Academy of Fine Arts, Vienna (with R. Rainer). 1962-1964 studies and urban planning at the Harvard University and in New York. 1965-1973 urban planning in Nepal for UNO and UNESCO. In 1973 return to Vienna. In 1975 doctorate of technical sciences. Since 1976 professor at the Institute for Building Topology and Housing at the Academy of Fine Arts, Vienna. 1988-2001 headmaster of the Academy.

Realized buildings
1982 Development Biberhaufenweg (with Tesar, Häuselmayer)
1988/91 Development Traviatagasse, Vienna (with Abraham, Lautner, Scheifinger, Szedenik, Giencke)
Kunsthaus Horn
1994 Adaption of the Semper Depot, Vienna

Gernot Nalbach, born 1942 in Vienna. In 1962 *Low-Cost-House*, Technical University, Vienna. In 1965/1966 *Pneumo-City*, project for "Austriaca 70." In 1968 architectural diploma at the Technical University, Vienna. Together with K. Schwanzer *Relaxing Room*. In 1969 mobile living units. 1969-1971 assistant at the Technical University, Vienna (with R. Gieselmann). In 1971 professor at the University of Arts, Berlin (industrial design). In 1973 office with Johanne Nalbach in Berlin. In 1975 guest lecturer at the Technical University, Brasilia. Since 1970 professor at the Technical University, Dortmund (design and representation). In 1986 Fa. Nalbach Design GesmbH. Berlin. In 1988 guest lecturer at the Academy for Architecture, Amsterdam. Published the *Dortmunder Skizzenbücher*. 1998-2000 he built the "Haus der Bundespresse-Konferenz" in Berlin.

References:
Les Années Pop, Centre Pompidou, Paris 2000.

9

Dieter Bogner

Coop Himmelb(l)au

Coop Himmelb(l)au, was founded in 1968 by Wolf-D. Prix and Helmut Swiczinsky in Vienna. Works in architecture, art, and design. Buildings, projects, and designs in Austria, Holland, Germany, France, Switzerland, Finland, the USA, Japan, Korea, Denmark, Cuba etc.

Wolf-D. Prix, born 1942 in Vienna. Studied at the Technische Universität, Vienna; the Southern Institute of Architecture, Los Angeles, and the Architectural Association, London. Professor for architecture 3, Academy of Applied Arts, Vienna, and adjunct professor, Southern California Institute of Architecture, (SCI-Arc), Los Angeles.

Helmut Swiczinsky, born 1944 in Poznan, Poland. Studied at the Technical University, Vienna, and the Architectural Association, London. Studios in Vienna and Los Angeles.

References:
Coop Himmelb(l)au, Venice Biennial (Vienna/New York: Springer 1995).
Werner Frank, *Covering + Exposing: Die Architektur von Coop Himmelb(l)au* (Basel: Birkhäuser, 2000).

The architectural concept of Coop Himmelb(l)au is characterized by a break with key principles of classical European building culture. The readability of the tectonic links between individual building components is the most central of these principles. This not only applies from a technical point of view, but even more from a visual one. A building should be an integral whole in which comprehensible relations exist between the parts. The principles of supporting and loading are among the most fundamental parameters. In the classical Modernism of the twentieth century, these canonical principles were not merely continued but, in Functionalism, they also led to a maximally reduced, transparent, constructive solution.

Coop Himmelb(l)au breaks with this European tradition by bursting the coherence of the overall form, discarding rectangular structures, and replacing the principles of supporting and loading with an antistatic, apparently weightless distribution of elements in space. The continuous structural connection of standardized components is replaced by a free interplay of independent particles that, like monads, seem to be moving in a continuum across space and time. The museum pavilion in Gröningen, completed in 1995, embodies the uncompromising implementation of this architectural concept. Its roots date back to the early 1970s, when Coop Himmelb(l)au consistently began to formulate the concept, for example with two significant installations — in Stuttgart and Berlin — in the early 1980s.[1]

At the beginning of this dissolution of traditional architectural forms and the structural link between components, distinct cracks emerge in the building structure. As a significant architectural motif, the crack first appears in 1973, in drafts for a house with wings and in the house with a flying roof project,[2] carried out with students of the London Architectural Association.

A further crucial step in this development took place several years later. In Coop Himmelb(l)au's first building project, the Reiss Bar in the center of Vienna, a wide crack divides the interior into two different-sized room segments. Due to the fact that both segments are several centimeters apart, a new architectural element emerges — the interval that belongs to neither of the two parts and yet helps to constitute them. A frame, made of what appears to be precious metal, lends a special emphasis to the crack (the gap) that runs across the floors, walls, and ceilings with interruptions, thus making it the key architectural motif of this project.

The violent treatment of an existing building substance does not — and this is the whole point — aim at its total destruction: that is, the dissolution of the tectonic links between wall, floor, and ceiling. Rather, the crack runs through the architectural structure in such a way that the original structure is preserved in the two autonomous fragments without any loss of substance. By breaking up regular forms, Coop Himmelb(l)au later develop their future construction material — the irregularly formed autonomous particle and its correlate, the immaterial spatial interval.

The interval is defined as the distance between two isolated parts — an "in-between" that does not belong to either spatial segment and, in dividing the two, defines them. Jacques Derrida characterizes this quality of the "in-between," constituted as absence, in his analysis of différance by example of language:

> *We cannot hear the difference between two phonemes that alone enable their being and effect as such.*[3]

Translated to the status of the interval in the architectural concept of Coop Himmelb(l)au, we could suggest that the difference between the material particles that enable their being and effect is immaterial as such.

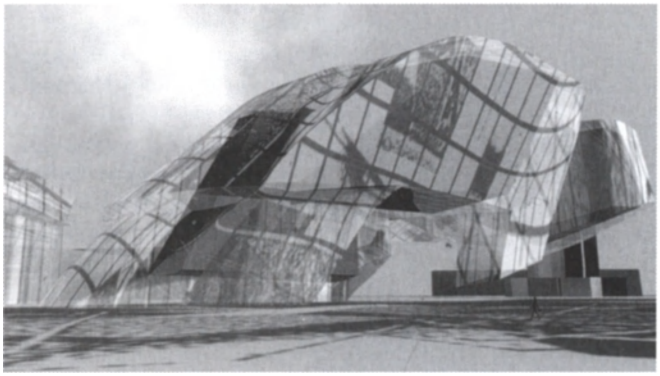
The vertical cut with which the American artist Gordon Matta-Clark cut apart a typical American log house in 1974, tilting both halves slightly apart *(Splitting, Four Corners)*, is typologically comparable with the crack in the Reiss Bar. A lingering echo of this cleaving of a building can be found in the museum pavilion in Gröningen. On one short side the building seems to break apart and the corner segments fall away. With the crack in the Reiss Bar, Coop Himmelb(l)au laid the conceptual foundations for the development of the Deconstructivist philosophy of the 1980s. This position is first radically formulated in the attic extension in the Falkestraße and culminates in the museum pavilion in Gröningen. The museum pavilion is made of irregularly shaped surfaces and cubes that have the appearance of flying fragments from an object torn apart by inner forces. Each particle has its own individuality founded on material, form, color, texture, and, above all, a position that follows no apparent system. The tectonic-static coordination of the parts cannot be grasped visually. Weightless, they appear to hover in an unlimited three-dimensional continuum. The seemingly chaotic architectural composition (both formally and in terms of material, but also the spatial position) of these extremely differentiated particles is not the result of an additive (structural) joining together of irregular geometric shapes. Quite the contrary, it is the result of a violent breaking apart and splitting up of the homogeneous "primeval form" that comprises the maximum volume above the set ground plan. This act of creation can be metaphorically described as a "big bang" — that is, an explosive transformation of an extremely condensed, undifferentiated mass into a field of highly individualized particles expanding in all directions.

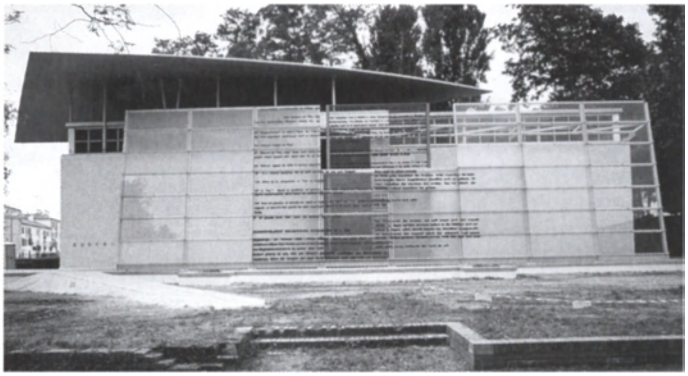
1. Coop Himmelb(l)au, *Architecture Is Now* (Stuttgart, 1983) p. 11.
2. Ibid. pp. 163, 212.
3. Jacques Derrida, "Die différance," *Postmoderne und Dekonstruktion*, Peter Engelmann ed. (Stuttgart, 1990) p. 79.

Dieter Bogner, born 1942 in Vienna. Studied art history, archaeology, and philosophy at the University of Vienna and the Sorbonne, Paris. Assistant and editor at the Kunsthistorisches Institut at the University of Vienna, 1974-84. Since then, has worked as a freelance curator in museums and other art institutions, specializing in contemporary art and architecture as well as research in the field of twentieth-century art. Organizes management seminars for administrators in museums and art institutions. Works in the field of museum and cultural concept planning. Lives in Vienna.


Coop Himmelb(l)au, *Museum Pavilion Gröningen*, 1993-94


Coop Himmelb(l)au, *Museum Pavilion Gröningen, interior*, 1993-94


Coop Himmelb(l)au, *Cloud Nr. 9, UNO Center*, Geneva, 1995


Coop Himmelb(l)au, *Media Pavilion*, Venice Biennial, 1995

This central aspect of the architectural conception of Coop Himmelb(l)au manifests a fundamental difference to the utopias of Constructivist architects. Their projects are the result of a traditional compositional process — an additive joining-together of irregularly shaped geometric elements. Coop Himmelb(l)au confronts these constructive principles with their conception of architecture as an unstable point within a temporal-spatial process of expansion that seems to lead to an entropic state. In this respect, their work is akin to the Suprematist compositions of Kasimir Malevich hovering in indeterminate, infinite space, and, above all, the Prouns of El Lissitzky. What both groups of works have in common is that the autonomous parts move in a relational structure not marked by any pre-existent grid or oriented to the principles of gravity (supporting and loading).

With this spatialization of time and temporalization of space that are characterized by a focus on process, Coop Himmelb(l)au opposes classical European architecture's claim to represent supra-temporality and permanence. They confront this claim with instability and transitoriness. The building is an expression of an expansive movement that, although being interrupted for an indefinite time, is nevertheless potentially possible in which presence is manifested as a point in space and time between the past and future. The break with the ideals of classical European building culture could hardly be greater than in this architectural conception of Coop Himmelb(l)au that is marked by a focus on process, instability, and expansion.

Architecture begins where space ends.
Coop Himmelb(l)au is not a color, but rather the idea of making architecture with imagination, as light and changeable as clouds.
(1968)

9

Otto Beckmann

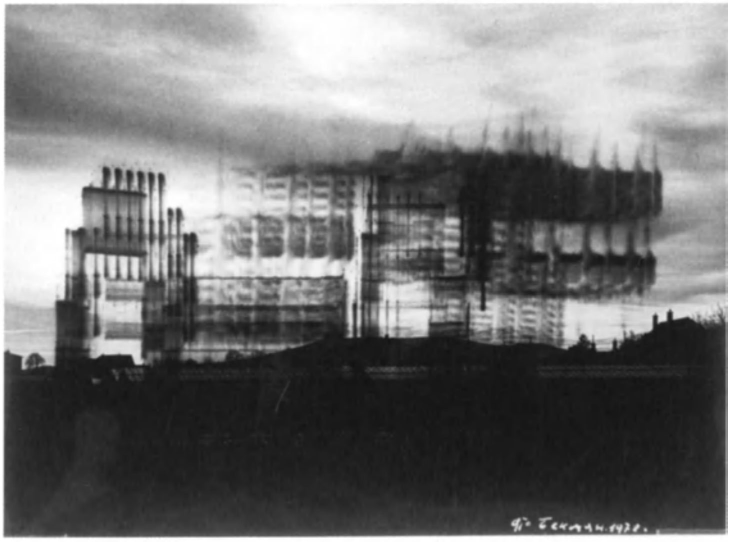
Otto Beckmann
born 1908 in Wladiwostok. Studied sculpturing in Vienna. In 1940 lecturing at the Academy of Arts in Kraków. In 1968 foundation and direction of the experimental workshop ars intermedia. Died in 1997 in Vienna.

1969 Secession, Vienna
1971 Modern Art Galerie, Vienna
1976 Audio Visual Center, Palais Attems, Graz
1979 NÖ Landesmuseum, Vienna
1983 Museum moderner Kunst, Vienna
Volkshaus, Mürzzuschlag
1986 Blau-Gelbe Galerie, Vienna
1994 Kunsthaus, Mürzzuschlag

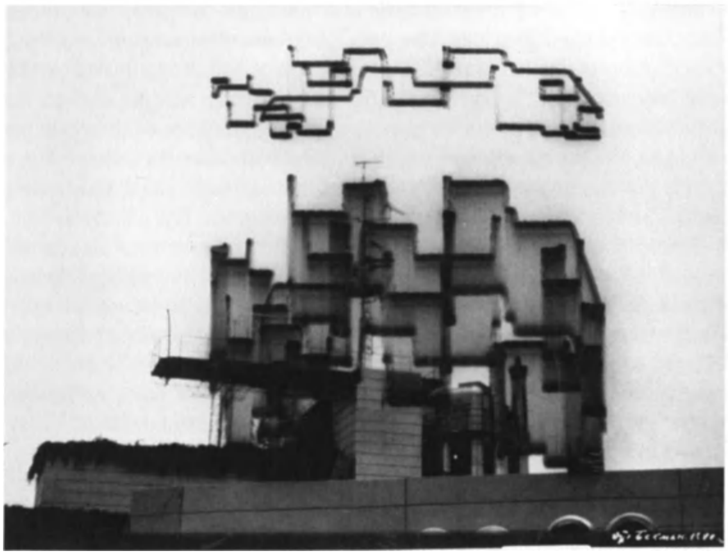
Group shows
1970 *Impulse Computerkunst*, Kunstverein, Hannover; Kunsthaus, Hamburg; Kunstverein, Munich
Art Systems, Centro de arte y communicacion, Buenos Aires
1971 Arteonica, Sao Paulo
1972 *Canadian Computershow*, Place Bonaventure, Montreal
1977 Geometrica 77, Tulln
1990 *Von Zuse bis Beckmann und ars electronica*, EVN-Center, St. Pölten
1993 *Vorurteil-Verletzung-Menschenrecht*, Messepalast, Vienna
1995 *Fisch & Fleisch. Photographie aus Österreich 1945-1995*, Kunsthalle, Krems

References:
Otto Beckmann, *Neumagische Objekte des Kultismus und textgenerierte Maschinen*, Melk 1986.
Otto Beckmann, *Text-Foto-Objekt*, Museum moderner Kunst, Vienna1983.
Otto Beckmann, *Photographien zu Texten von Walter Buchebner*, Kunsthaus Galerie, Mürzzuschlag 1994.

Otto Beckmann
Electronical Power Station, 1978
Computer graphic, color print
30.2 × 40.3 cm



Otto Beckmann
Imaginary Architecture Hotel Project, 1978
Computer graphic, color print
30.2 × 40.3 cm



Otto Beckmann
Imaginary Architecture ORF-Building, Linz with Ground Plan, 1980
Computer graphic, color print
30.2 × 40.3 cm

Manfred Wolff-Plottegg
Quick and Dirty

When computer-generated architecture developed, the previous anthropocentric approach was replaced by external, automated events. The computer allowed architecture to dispense with the intention to represent views of the world, allowing the formulation of an up-to-date and modern architecture. The architect's trademark as an individual signature, the purpose as fulfillment of an aim, predefined functions as metaphor for teleologies: none exist any longer. The long-lived predominance of form, body, and material has been overcome; architecture is no longer a signifier; unplugged from retrospection, relieved from habits, personal desire, and projections, it does not render service to the powerful anymore. Being no longer derivative, architecture will be autocatalytic.

Within the environment of the CPU, the linear, singular, and visual logic of orthogonal projection and perspective are obsolete. Binary lines are cracks void of any content, the namelessness of lines leaving them without any functional purpose; the CPU supplies the vocabulary of forms. The binary house is complete in the CPU, without location in an environment, without point of view, a site without standpoint. For the eye, the presentation is immediate, all images opened are equivalent; the CPU condenses duration of time into simultaneity. The binary house itself has no dimension; it is simultaneous and timeless, non-hereditary, abstract, dematerialized architecture. The plan has died, perspective has died. There's no more point of view. The flow in the net defines architecture as instantaneous and placeless.

By browsing the Internet, architecture is further accelerated: as the Internet is characterized by rapid access to an enormous amount of data stored without order or hierarchy, quasi-equivalent, architecture manifests itself by browsing or surfing. In conventional thought, each step of designing was a stage of development, an improvement of the former; browsing, because of the huge amount of equivalently coexisting data, now relativizes the illusion of "quality," the idea of truth, and thus also the fiction of improvement. The modern architect is no longer an idealistic do-gooder.

The aspect of rightness is abolished, and the architect's know-all dogmatism no longer has a basis. Subsequently, compatibility of materials or craftsmanship or construction no longer exists. As a criterion, compatibility is now replaced by speed, and as a result of speed, precision is replaced by superficiality. For this ever-faster speed and superficiality, the theory of fuzzy logic has been developed. This means that there should be more generosity. A good architect is a good surfer.

Static models of architectural production have run out. Instead, intelligent, interactive surfing in system processes has become important. The formulations of architecture algorithms in the net will not aim at a better world or any other content or ideology. This architecture without teleology will be autocatalytic, algorithmic, and emancipated: quick and dirty.

Manfred Wolff-Plottegg, born 1946 in Schöder bei Murau, Styria, Austria. Studied architecture from 1965 to 1972 at the Technische Universität, Graz, and from 1972 to 1973 at the École des Beaux Arts, Paris. Architect in Graz since 1983. Instructor in planning methods at the Technische Universität, Graz from 1986 to 1992. Instructor in computer conception at the Hochschule für Gestaltung, Linz, 1991 to 1993. Professor of CAD at the Technische Universität, Munich, 1994 to 1995. Guest instructor in experimental architecture and algorithmic design, University of Innsbruck. Head of the Institute for Architecture and Design at the Technical University in Vienna. Lives in Graz an Vienna.

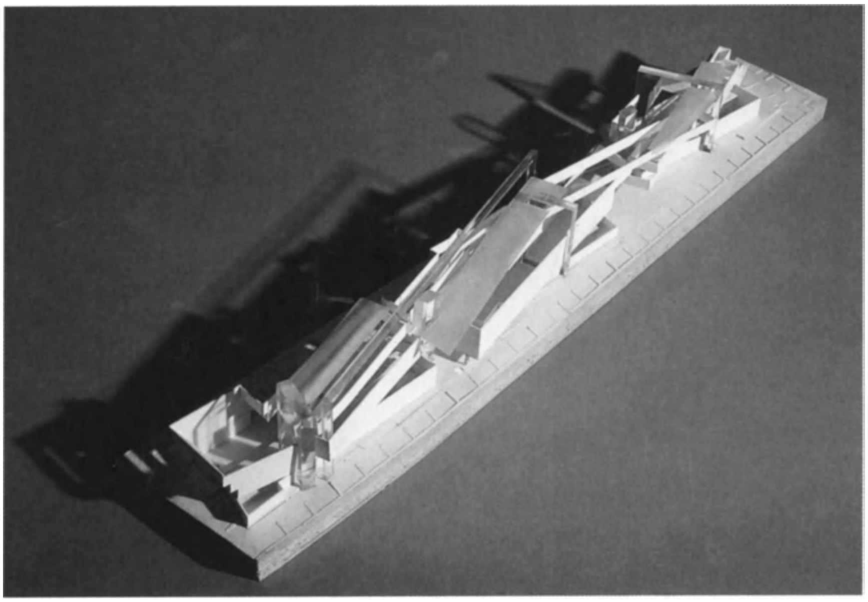
References:

M. Wolff-Plottegg, *Das binäre Haus. Die Computer-Architektur-Theorie* (Munich: Architekturgalerie, 1989).

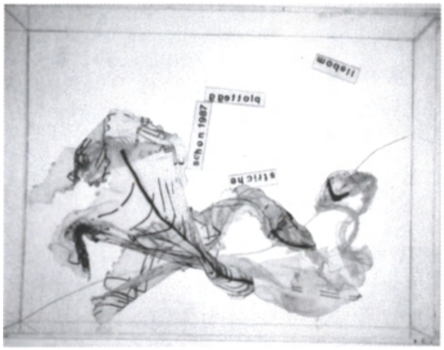
Die Plotteggs kommen, Bericht von F. Achleitner (Vienna: Sonderzahl, 1992).

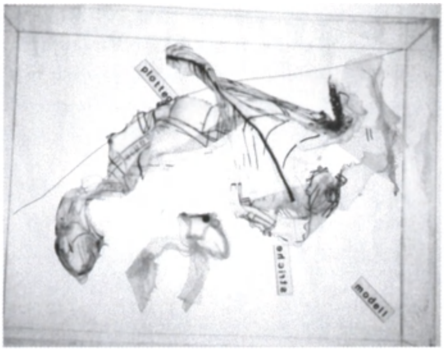
M. Wolff-Plottegg, *Architektur Algorithmen* (Vienna: Passagen, 1996).

M. Wolff-Plottegg, *Hybrid Architektur* (Vienna: Passagen, 2005).



Manfred Wolff-Plottegg
Digitally Generated Design,
university building, Graz, 1985,
model 1:500
20 × 80 × 40 cm





Manfred Wolff-Plottegg
Analog architecture generator, 1985
21 × 14 × 14 cm

Ingredients of the *Analog Architecture Generator:*
Plexiglas prism 14/21/14 cm, enclosing four spatial rasters (thermal-mechanically made overhead sheets), 1 polyline (thread), signature, date

Method of application:
Shake hard, put it down abruptly (standing or lying); each combination of elements is an architectural design; we recommend repeating this procedure several times.

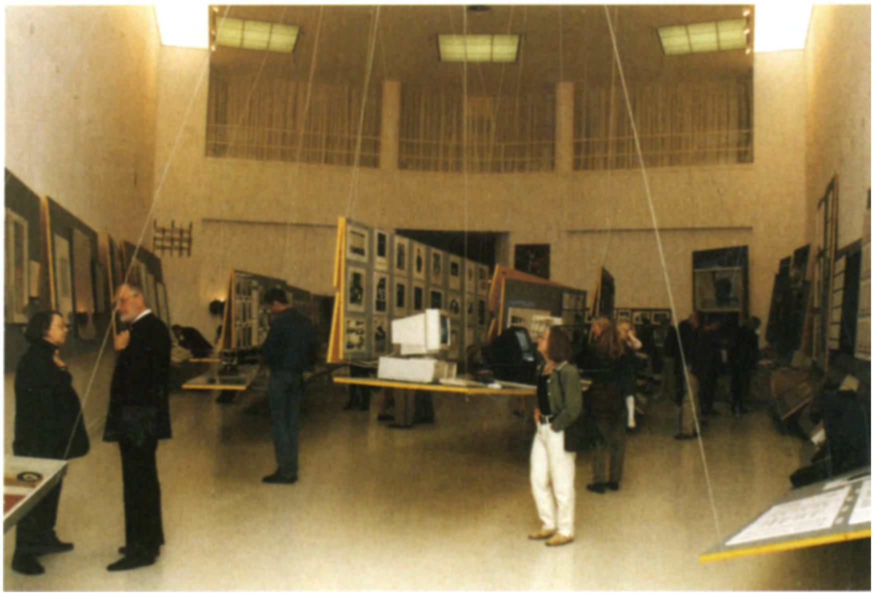
Fields of application:
Non-verbal approach to architecture, overcoming individualistic formation, shifting creativity to external processes.

Interplays:
The effects of habituation appear as soon as the image of the limits is recognized.

Side effects:
Regardless of who shakes up the elements, Plottegg has already signed the result and dated it 1987.

In case of uncertainty, we recommend consulting an expert.

Manfred Wolff-Plottegg
Hanging exhibition architecture with formwork panels and wire ropes for *Voorbij de kunst, MUHKA, Antwerp,* 1998



Victor Papanek

HOW TO DRAW A HEXAGON

By building huge tetracadecadronal cells thirty-eight feet in diameter, it is possible to construct a sub-oceanic shelter area for men and materials that might be used for sub-ocean mining or oil drilling. Each cell would have three floor levels; a cluster of between thirty and ninety of these cells would constitute a sub-oceanic station housing two to three hundred scientists and workers.

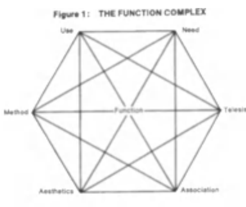
By reducing the diameter of the cells to one-eighth of an inch, it was possible to develop a new type of radiator for an automobile radiator, which exhibited more surface areas and contained more water. A folding, semi-permanent vacation house, sleeping twenty, could be taken down and transported in a standard VW camper or Dormobile.

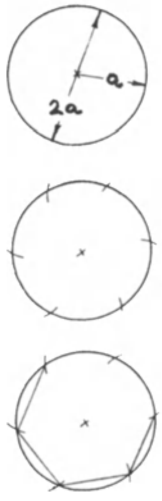
A tetracadecadron measuring thirteen meters in circumference could be used to make a central tower, 141 meters tall, with eleven units. Twenty-eight more units of the same size could then be attached in a spiral form, surrounding the central core. With each unit being trilevel, the result is a luxury apartment building. The central core tower would contain stairways, air-conditioning conduits, elevators, water, heat, and electricity. In addition, each central core unit (also trilevel) would house bathrooms, kitchens, and other service rooms; each level would contain rooms for the closest cantilevered spiral unit. The three floors of the exterior spiral unit would be given over to living, entertainment, and sleeping areas, with the hexagonal roof of each acting as a combination heliport and garden. Because of the ease with which more omnidirectional units can be 'plugged in' or, for that matter, 'unplugged,' each tetracadecadron that is part of the exterior spiral could easily be airlifted and plugged in other core units in different areas of the world. The same structure could also serve as a contractable or expandable grain silo. When the first visual model of this structure was removed from its base, I attached a line to it and dragged it through water. It has excellent motion characteristics in water. This suggests the possibility of constructing huge hollow tetracadecadra out of ice (reinforced with algae), pumping them full of crude oil, and towing a string of these spiral clusters across the Atlantic by submarine, thus eliminating the need for tankers.

The most elegant technological use, however, lies in the field of space travel. Assume that a basic cluster of tetracadecadra (each trilevel and thirteen meters in diameter), consisting of forty-eight single units, were to be put in a locked orbit two hundred miles above earth. This unit could house a labor force of three hundred people. If we now place further single cells in orbit, we will find that, thanks to the many angles of incidence and adherence mentioned above, three hundred workers can attach another fifty units in a twenty-four-hour work period. At this point, the station (which, incidentally, would provide enough centrifugal spin to give a semblance of earth's gravity) could house six hundred. After two days of work, it will house 1,200 workers, 9,600 at the end of five days, 307,200 at the end of ten days, and 9,830,400 at the end of fifteen days. In other words, it would be possible to absorb entire large populations in two weeks, with all of these people housed in trilevel structures. Now give the whole construct a push, and when it arrives at, say, Mars, Alpha Centauri II, or Wolf 359, it will be possible to decant people and their homes, establishing a city at the same speed as people can be landed. Much of the early research on the tetracadecadron was done between 1954 and 1959.

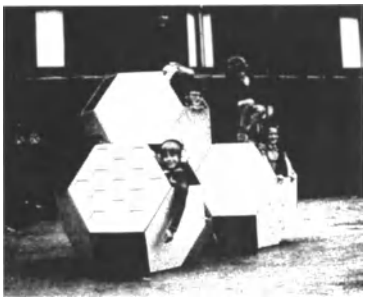
Victor Papanek, *Design for the Real World* (London: Thames Hudson, 1997)

The typeface used in the title is based on the font "Vic & Jim" by Victor Papanek which is used throughout his book *Nomadic Furniture*.





How to draw a Hexagon; Victor Papanek, James Hennesey, *Nomadic Furniture I* (London: Studio Vista, 1974).



Modular structure for a children's playground, *The Green Imperative*, London 1995.

The tetracadecadron, an exemplary multi-functional form made of six rectangles and eight hexagons, is derived from the shape of the human fat cell. Symptomatic for an understanding of "integrated" design, where basic shapes derived from constructive or biological principles function as transporters among pedagogy, utopia, and pragmatics.

Victor Papanek, born 1926 in Vienna. Studied anthropology and architecture with Frank Lloyd Wright and others. Besides his work as a teacher and author, Papanek was commissioned by various governments to work a designer and consultant for UNESCO/UNIDO (including development projects), as well as for Volvo, Sweden, and Dartington Industries in the UK. He has also been an instructor at Cal Arts, Charlton University in Ottawa, and the University of Kansas. Papanek has received numerous awards, including the "Distinguished" and "Outstanding" Designer Award from the IKEA Foundation, and was nominated in 1982 for the alternative Nobel Prize for his many years of work in the Third World. His well-known book, *Design for the Real World*, has been translated in to twenty-three languages and remains one of the most widely read books on design to this day. Characterizing this and other books by Papanek is a universal concept of design, which is continually illustrated with very specific design tasks. Besides utopian, architectural superstructures, one finds proposals for car-sharing, a general pedagogical method for teaching design, and designs for children's toys. Papnek's work is inseparably connected with terms such as "social" or "poor" design, and is significant for a very coherent image of social themes, which clearly opposes the discourse on "good form" and its accompanying ideas embedded in society. Died in 1999.

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Victor Papanek, *Design for Human Scale* (New York, 1983).
Victor Papanek, *The Green Imperative* (London, 1995).

9

Agnes Denes

Tree Mountain – a Living Time Capsule, 10,000 Trees, 10,000 People, 400 Years, 1992-1996, 420 x 270 x 28 meters, Ylöjärvi, Finnland

Agnes Denes, born in Budapest, grew up in Stockholm and New York. She ceased to paint in the mid-1960s and began to use new technologies such as X-rays. Co-founder of concept art, pioneer of ecological art since 1968. 1982's *Wheatfield. A Confrontation*, a field of wheat planted in downtown Manhattan, is one of her best-known works. 1995 saw the creation of *On the Edge* in Mitzpe Ramon, Israel: symbols of dead civilizations and poetry were engraved into a four-million-year-old abandoned rock. Denes has had almost three hundred solo and group shows around the world, including 1970's Information at the Museum of Modern Art, New York; the 1976 Sydney Biennial; documenta VI, 1977; the Venice Biennial in 1978, 1980, 2001; a 1992 retrospective at the Museum at Cornell University (monograph); 1996's The Visionary Art of Agnes Denes at the Roland Gibson Gallery; State University of New College at Potsdam. Her many fellowships and awards include those from Carnegie Mellon University, Massachusetts Institute of Technology, New York University, and the DAAD, Berlin. She has published several books, including *The Book of Dust. The Beginning and End of Time and Thereafter*, 1989. Has taught at many American universities and lived in New York since 1955.

TREE MOUNTAIN is a collaborative, environmental project that touches on global, ecological, social, and cultural issues. Ten thousand trees are planted by the same number of people according to an intricate pattern derived from a mathematical formula. The mathematical expansion changes with one's view and movement around and above the mountain, thus revealing hidden curves and spirals in the design. If seen from space, the human intellect at work shaping a natural formation becomes evident, yet they blend harmoniously.

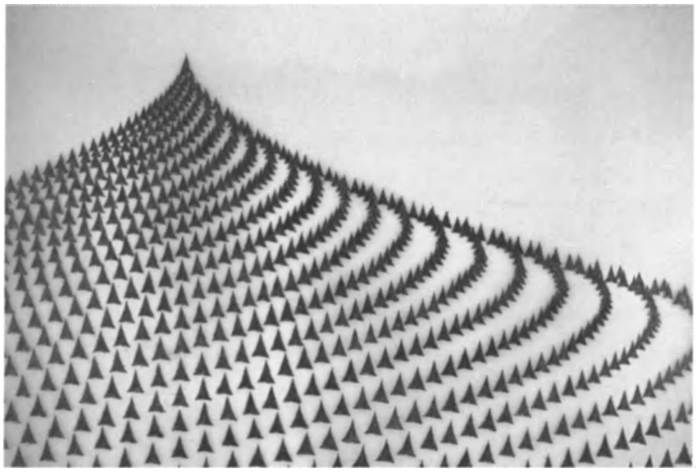
The size of TREE MOUNTAIN is site-specific. The mountain will be three hundred meters in length, one hundred meters in width and fifteen meters in height in Finland. It is oval in shape. Both shape and size can be adapted to areas of land reclamation and the preservation of forests. I chose pine trees for the Finnish TREE MOUNTAIN, because these trees are typical for this environment. The trees must outlive the present era and carry our concepts into an unknown time in the future. If our civilization as we know it ends, or as changes occur, there will be a reminder in the form of a strange shape for our descendants to ponder.

TREE MOUNTAIN is a collaborative work in all its aspects, from its intricate landscaping and forestry to funding and contractual agreements for its unfamiliar, unheard-of land use of three to four centuries. The collaboration expands as ten thousand people plant the trees that will bear their names and remain their property through succeeding generations. The trees can change ownership, e.g., by inheritance, but TREE MOUNTAIN itself can never be owned or sold, nor can the trees be moved from the forest. TREE MOUNTAIN represents the concept, the soul of the artwork while the trees are a manifestation of it.

Agnes Denes, 1995

Agnes Denes's Pyramids crystallize her conceptual art into a single structure, visually succinct and intellectually complex: they are the ultimate distillation of her scientific interests and philosophy of life. Denes's art is extraordinarily multifaceted, ranging from environmental projects to map projections, including conceptual statements that in effect range over the whole of human knowledge. Her work is both two- and three-dimensional, grand and intimate in scale, and inherently visionary. In my opinion she is a kind of a Blake in mathematical form.

Donald B. Kuspit, *Artforum* (February 1996) 82.



Tree Mountain is a mathematically spiraling forest made up of 10,000 trees planted by 10,000 people from around the world, to be maintained for four hundred years.

Bernard Rudofsky
architecture without architects

architecture without architects attempts to break down our narrow concepts of the art of building by introducing the unfamiliar world of non-pedigreed architecture. It is so little known that we don't even have a name for it. For want of a generic label, we shall call it vernacular, anonymous, spontaneous, indigenous, rural, as the case may be. Unfortunately, our view of the total picture of anonymous architecture is distorted by a shortage of documents, visual and otherwise. Whereas we are reasonably well informed about the artistic objectives and technical proficiency of painters who lived 30,000 years before our time, archeologists consider themselves lucky when they stumble over the vestiges of a town that goes back to the third millenium B.C. only. Since the question of the beginnings of architecture is not only legitimate but bears heavily on the theme of the exhibition, it is only proper to allude, even if cursorily, to possible sources.

The untutored builders in space and time – the protagonists of this show – demonstrate an admirable talent for fitting their buildings into the natural surroundings. Instead of trying to "conquer" nature, as we do, they welcome the vagaries of climate and the challenge of topography. Whereas we find flat, featureless country most to our liking (any flaws in the terrain are easily smoothened by the application of a bulldozer), more sophisticated people are attracted by rugged country. In fact, they do not hesitate to seek out the most complicated configurations in the landscape. The most sanguine of them have been known to choose veritable eyries for their building sites – Machu Picchu, Monte Alban, the craggy bastions of the monks' republic on Mount Athos, to mention only some familiar ones.

The tendency to build on sites of difficult access can be traced no doubt to a desire for security but perhaps even more so to the need of defining a community's borders. In the old world, many towns are still solidly enclosed by moats, lagoons, glacis, or walls that have long lost their defensive value. Although the walls present no hurdles to invaders, they help to thwart undesirable expansion. The very word urbanity is linked to them, the Latin urbs meaning walled town. Hence, a town that aspires to being a work of art must be as finite as a painting, a book, or a piece of music. Innocent as we are of this sort of planned parenthood in the field of urbanistics, we exhaust ourselves in architectural proliferation. Our towns, with their air of futility, grow unchecked – an architectural eczema that defies all treatment. Ignorant as we are of the duties and privileges of people who live in older civilizations, acquiesce as we do in accepting chaos and ugliness as our foreordained fate, we neutralize any and all misgivings about the inroads of architecture on our lives with lame protests directed at nobody in particular.

Part of our troubles results from the tendency to ascribe to architects – or, for that matter, to all specialists – exceptional insight into problems of living when, in truth, most of them are concerned with problems of business and prestige. Besides, the art of living is neither taught nor encouraged in this country. We look at it as a form of debauch, little aware that its tenets are frugality, cleanliness, and a general respect for creation, not to mention Creation.

Bernard Rudofsky
born 1905 in Mähren. Studied architecture at the Technical University, Vienna, earned his PhD in 1931. Worked as an architect in Milan, Naples, and Sao Paolo, until settling in New York in 1935. Author of several books and editor of a number of architecture and design magazines. Was also a lecturer at several institutions. Died in 1982 in New York.

Exhibitions
1944 Museum of Modern Art, New York
1964 Museum of Modern Art, New York
1980 Cooper Hewitt Museum, New York
1987 Museum for Applied Arts, Vienna

Movable Architecture

Many so-called primitive peoples deplore our habit of moving (with all our belongings) from one house, or apartment, to another. Moreover, the thought of having to live in rooms that have been inhabited by strangers seems to them as humiliating as buying second hand old clothes for one's wardrobe. When they move, they prefer to build new houses or to take their old ones along.

The Air-Conditioners of Hyderabad Sind

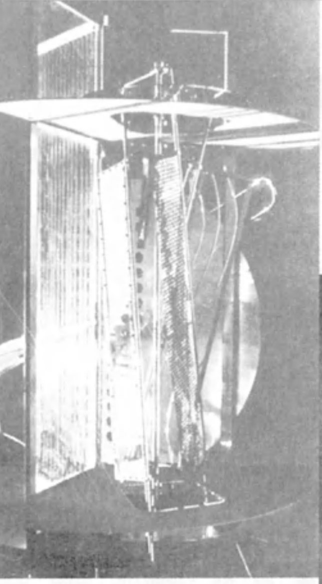
These unusual roofscapes are a prominent feature of the lower Sind district in West Pakistan. From April to June, temperatures range above 120°F, lowered by an afternoon breeze to a pleasant 95°. To channel the wind into every building, "bad-gir," windscoops, are installed on the roof, one to each room. Since the wind always blows from the same direction, the position of the windscoops is permanently fixed. In multistoried houses they reach all the way down, doubling as intramural telephones. Although the origin of this contraption is unknown, it has been in use for at least five hundred years.

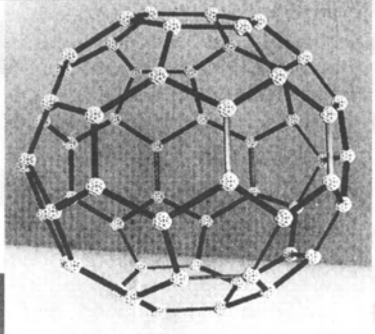
Bernard Rudofsky, *architecture without architects. A Short Introduction to Non-Pedigreed Architecture*, (New York: Doubleday & Company, Inc, 1964).

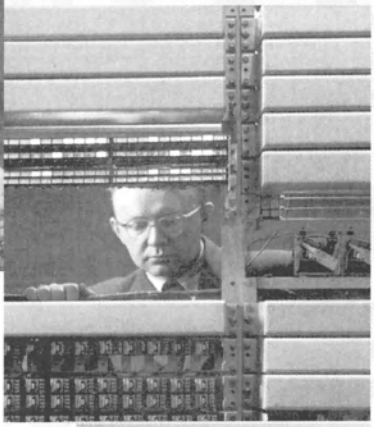
visual communication

In all Austrian and Hungarian media, from graphics to the digital, there has been crucial emphasis on the simplified visual presentation of complicated contents of communication, as well as on the simplification of visual communication itself, especially in the public realm. Herbert Bayer, born and educated in Austria, immigrated to Germany at the age of twenty. He later taught at the Bauhaus and was one of the most successful communications designers in the world. His abilities in design were universal, extending from the design of a typefont (Universal Type) to the organization of exhibitions. Bayer's graphic language was brilliant, especially in print media. Some of his photo montages have become standard international symbols. Joseph Binder is another Austrian artist who made an international contribution to public communications graphic design. Less doubtful than Bayer's repertoire (Rolf Sachsse), which could be applied to all contents and ideologies, is the visual program developed by Otto Neurath, the organizational motor of the Vienna Circle (Angela Jansen). As a socialist, he was interested more in pictorial pedagogy than pictorial art. The education of the masses and adult education were his concerns, which is why he developed an informational graphic system that makes it possible to visually grasp the essential parts of a piece of information at first glance: the Viennese method of picture statistics (1925). This "International System of Typographic Picture Education," or ISOTYPE, combined from two Greek terms ("iso" means "same"), established itself internationally in the age of mass media. In today's information society, where people are constantly confronted with visual information everywhere, from public buildings to electronic media, the job of the info-graphic designer is increasingly important: the portrayal of complex facts in an attractive and simplified way. Bayer developed a typographic system for capital, goods, and products. Neurath developed a typographic system for enlightenment, information, and education. Ecke Bonk elevated typography to a form of thought, called typosophy, which calls on "in<=>formation."

In the 1960s, artists began to use, integrate, or subversively undermine the available information and communication systems, from posters to television. Manfred Erjautz critically investigates a new class of public symbols — trademarks — which form a tightly knit logo-culture and play a dominant role in the public visual communication in our product-oriented society (Peter Weibel). More comprehensive symbol theory is provided by world-famous semiologist Thomas A. Sebeok, who extended communication theory to animals and thus founded zoo semiotics, the study of animal sign use. Not only was a language of symbols for developed books, posters, signs, and walls, but electronic communications (CD-ROM, display monitor, website) also successfully became objects for graphic design and communication design. The societal use of technical communications equipment, supported by the belief that the apparatus mirrors the social because it has become a part of society, is at the forefront of most of these aesthetic reflections on visual communication.







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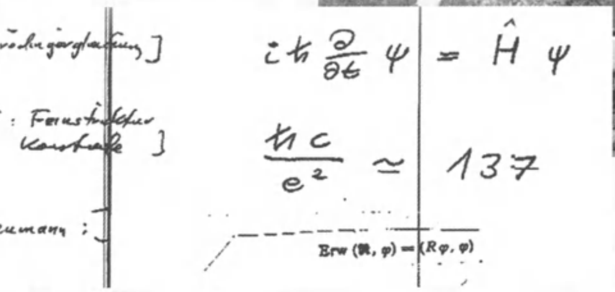

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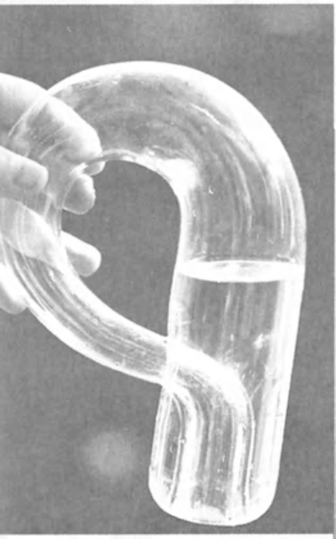

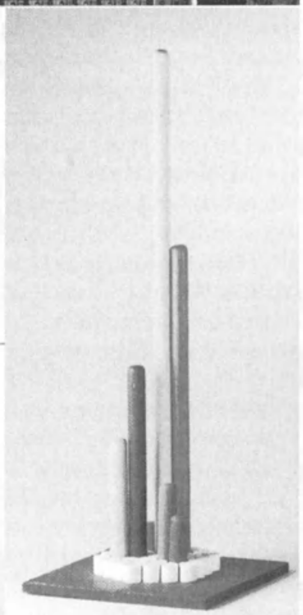

10 *visual communication*

Rolf Sachsse

Herbert Bayer or the Universal Designer

What seems surprising in retrospect is the fact that the one person at the Bauhaus whose talent seemed comparable to the gift of Midas had emerged from the group surrounding what was doubtless one of the most esoteric professors on the faculty.

Johannes Itten was an eminently talented educator who provided his students with a sound, fundamental knowledge beyond all unconventionalities. Herbert Bayer, for his part, had the gift of reducing given groups of forms to their simplest elements and then to process them autonomously. Throughout his life, however, he needed given external conditions as verbal and visual stimuli for his own work — not unlike, say, Gottfried Benn operated in the literary world.

Bayer was probably aware of this creative limitation even in his early years as a drawing student in Upper Austria. It may have been one of the reasons why he immigrated to Darmstadt, Germany, to study with Emanuel Margold, a Viennese-born student of Hoffmann's and a renowned designer. Bayer's move to Weimar to join Itten was due to the difficult economic situation after World War I and to a feeling that his abilities were not really challenged in Darmstadt. Most important, though, was his decision to stay with the Bauhaus when Itten left. This was in keeping with the continuum of Bayer's biography — his strength was in applied art, in spite of his other aspirations. In this respect, Bayer identified strongly with László Moholy-Nagy (only a few years his senior and Itten's successor in Weimar), as is demonstrated by the shifts in the well-known history of the Bauhaus, from a life-shaping course to useful industrial design.

To Herbert Bayer, pragmatism was, first of all, unquestioning loyalty toward his client, whoever it was. The dependence of his work on external impulses meant that he had a basic fear of not getting another commission after the current one and therefore losing the foundation for his actions. The decisive turn in Bayer's motivation was probably the relocation of the Bauhaus from Weimar to Dessau, which tested his decision to stay in Germany and, at the same time, meant his graduation from student to teacher. Despite the fact that he entertained a flirtatious attitude toward his own youth as a teacher, heading a workshop also meant security as long as he lived in Germany, a security that became normative for the rest of his life. Each professional change provided him with a contract that offered basic security while guaranteeing him a certain freedom, and this can be seen clearly in his work. His repertoire shows most especially (and in this, Bayer is completely modern) how all applied tools of design are reproduced again in media. Communicators love nothing more than to communicate about communication itself; what media communicate best is their own white noise.

Even the intention behind the design of a universal type is a manifestation of a discursive concept of one's own means of production, which leads away from linguistic reflection. Writing becomes its own theme, is subjected to sheer functionalism and requires, and every small letter on the every sheet of Bauhaus letterhead must be legitimized one by one.

It is precisely that use of a supposedly neutral canon that provides a report of Bayer's emigration to Germany and later to the U.S.A., and also stands for his "robust pragmatism" in his dealings with the National Socialist regime, a pragmatism that was seen as a constituent of that regime. Discursively, the designer had found a level where he believed himself able to keep the customer satisfied while preserving his identity as a designer.

This unresolved controversy between personal aspiration and anticipated compromise becomes clearly manifest in Bayer's works of propaganda — various pieces of state propaganda produced between 1933 and 1938.

All of his printed materials produced between 1928 and 1938 contain material derived from large numbers of photographs or illustrative additions from that medium without any hint of the photographer's identity. For exhibitions such as *film und foto* and in magazines, Herbert Bayer published photographs under his own name; at the same time, Irene Bayer-Hecht also worked as a photographer and probably supplied quite a few of the photographs used. Bayer is also known to have used other photographers' materials (for instance, in the case of the *Berliner Ausstellungsfaltblatt* / Berlin exhibition folder), and assistants such as Kurt Kranz have pointed out their own part in supplying Bayer with photographs. This explains inconsistencies in his use of photographic images, while his language of graphic form remained consistent — another manifestation of the robust pragmatism of this meanwhile well established man of action. Yet at the same time, it was also a manifestation of his indolence regarding the ethical claim of modernism that, even in the smallest details, it could not do without original forms or at least the conscious appropriation of anonymous materials.

In the decade from 1928 to 1938, Herbert Bayer developed his personal specialty: exhibition design. In no other field is he credited with as much innovative power as in this, and in retrospect he regarded no other field — among them his unhappy love for painting and some excursions into architecture — as important. His graphic abilities were concentrated in innumerous diagrams representing walking routes, perspectives, and the flow of traffic, where architects and contractors had to interpret and realize spatial contexts. Here the pre-lingual visual level is extended into the third dimension so that a greater complexity is achieved without verbal or textual formulation. For this transition it seems relevant that this ability was developed in the

Herbert Bayer, born 1900 in Haag, Austria. Apprentice at a crafts workshop in Linz, 1919. Studied fresco painting under O. Schlemmer and V. Kandinsky at the Bauhaus, 1921. In 1928 he left the Bauhaus for advertising, where he put on exhibitions. In 1938 he immigrated to New York, where he was a consultant for various firms; many architectural and landscape projects. Painting and graphic design after 1946. Died in Santa Barbara, California, in 1985.

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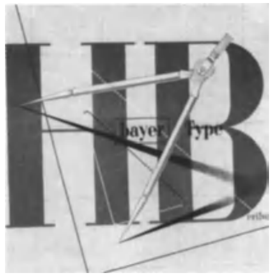
Herbert Bayer, *Universal type*, 1925 (narrow face bold)
© VBK, Vienna, 2005



Herbert Bayer, Berthold Type Foundry brochure for the *Bayer-Type*, 1933
© VBK, Vienna, 2005

Herbert Bayer, *The Human Being Wins*, 1929-1932
Photomontage from a series of ten
© VBK, Vienna, 2005

Herbert Bayer, *Lonely Metropolitan*, 1929-1932
Photomontage from a series of ten
© VBK, Vienna, 2005

context of a Werkbund exhibition organized by Walter Gropius, whose concept of architecture was based on purely textual prefiguration — a counterpoint to Bayer's position. It appears that the two were inclined toward each other, discovering each other during their respective Bauhaus periods, for it was Gropius who asked Bayer to participate in the preparations for the 1938 Bauhaus exhibition at the Museum of Modern Art in New York (getting him an exceptional travel permit like his own through his student and friend, the chief SS architect Hanns Dustmann). Between 1934 and this trip to the U.S.A., Bayer worked as a major designer for exhibitions of the Deutsche Arbeitsfront, using the entire modern repertoire as a drawing machine to superficially impress the viewer — by definition an aestheticization of politics, an original Fascist act.

The experiments of the Bauhaus stage with its liberal use of abstract formal elements in motion offered ideal models for an impressive, if monodimensionally functional application in trade fair design.

Visitors to Bayer's exhibitions were to be impressed or persuaded — either to buy something, to understand some didactic content, or to take some specific political action. All his plans aimed at a persuasive performance that could be experienced in pre-verbal terms. It could be linked to any conceivable content.

This is probably what allowed Herbert Bayer to successfully perform a mutation trick unequalled in history: The busiest of all German Nazi propagandists became a sought-after exhibition designer in the U.S.A.

And since nothing (at least in the U.S.A.) generates more success than success itself, Bayer was able to realize several exhibition projects within a very short period and enjoy a highly-paid advisor's position with the Container Corporation of America, in stark contrast to his mentor, László Moholy-Nagy, whose emigration story was full of complications and frustrations.

Like many early successes, Herbert Bayer completed his life's work at a relatively young age, the final four decades of his life comprising mere application, expansion and, in the end, trivialization of the repertoire originally found. He was denied the great fame he dreamed of as independent visual artist — rightly so, from a historical standpoint. He never got to a point where he could create his own figures without external stimulation. Two exhibitions in 1942 mark the summit of his formal creativity and the end of his career: *The Road to Victory*, the exhibition used by the U.S. government to explain to its people why the U.S. would participate in World War II; and *Airways to Peace*, a legitimation of the immense ordnance expenses for air warfare in the guise of a lesson on the changing ways of seeing. This latter exhibition consisted mainly of a model of the earth, which people could walk on, and which offered an unusual spatial experience without, however, making much sense in the given context. Buckminster Fuller, who had at the time already achieved public notice with his spectacular industrial designs, called it "a typical land-rat invention." After all, he was a sailor and knew a thing or two about maps and world projections.

In its normality, Herbert Bayer's migration story is post-historic and postmodern. In retrospect, it matters very little whether he worked from Austria, Germany, or the U.S.A. The reduction of all forms to a slick nucleus of appealing beauty rids the work of all content on practically any discursive level. All that remains is wonderment at where his personal perception was in light of what at first sight seemed to be continually fascinating works. With it, Bayer would have become a true cosmopolitan by dissolving himself into white noise.

"Von Österreich aus," Camera Austria (46: 1994) 3-9.

Herbert Bayer, entrance to the *The Road to Victory* show, Museum of Modern Art, New York 1942, © VBK, Vienna, 2005

Herbert Bayer
Deutsche Werkbund exhibition, Paris 1930, © VBK, Vienna, 2005

Angela Jansen

What Can Information Graphic Designers Learn from Otto Neurath Today? – Isotype and Information Graphics

Pictures for Democrats: Otto Neurath's Isotype

By 1925 the scientist Otto Neurath and the graphic artist Gerd Arntz developed the "Viennese method of graphic statistics" — the first methodically conceived set of rules for popular statistical graphics for the Museum of Society and Economy in "Red Vienna." The name "Isotype," used later after emigration, is an acronym of "International System of Typographic Picture Education," based on the two Greek words *iso* and *typos*. It describes the underlying principle of the method — the same idea is expressed by the same figure. Quantities are represented by repeating objective pictograms rather than enlarging them. Neurath was convinced that real democracy could only be achieved by means of adult education. He attached great importance to the knowledge of statistical facts in order to understand society and the economy. At the same time, he was well aware that the customary mode of presenting statistics could not capture the public's attention.

> *Modern man is very much spoiled by cinema and illustrations.... If we seek to spread social science education among the general public, we must avail ourselves of similar means of representation. The advertising poster shows us the way!*[1]

As a logical consequence, Isotype pictograms represented social contexts in an eye-catching, simple, and educationally simplified manner. Neurath responded to critics who reproached him with the inaccuracy of his graphics with his guiding educational principle: "It is better to memorize simplified pictograms indicating quantities than to forget exact figures."[2] In contrast to most contemporary diagrams, Isotype pictures were always representational.

> *The purely geometrical diagram with its colored curves and colored areas has certain educational drawbacks. Not only that the little figures and trees are more pleasant to look at. If you see a row of black coffins and a row of red children, you will know that the diagram has to do with deaths and births, even after some time has passed. The red curve and the black curve, in contrast, could just as well signify births and deaths as wine production and boot polish.*[3]

Otto Neurath, born 1882 in Vienna. Studied at the Universities of Vienna and Berlin. In 1907-1914 director of the Business Academy in Vienna. In 1919 habilitation at Heidelberg University. Worked at the Museum for War Economy, Leipzig. In 1919 governmental advisor for economic planning. Founding of the Museum of House- and Urban Planning in Vienna. In 1924-1934 director of the Museum of Society and Economy in Vienna. In 1929 manifesto *Scientific World View of the Vienna Circle*. In 1933 founding of International Foundation for Visual Education in Den Haag. In 1934-1940 stay in the Netherlands; organization of the movement International Unity of Science. In 1940 escape to England. From 1941 he lived in Oxford, where he died in 1945.

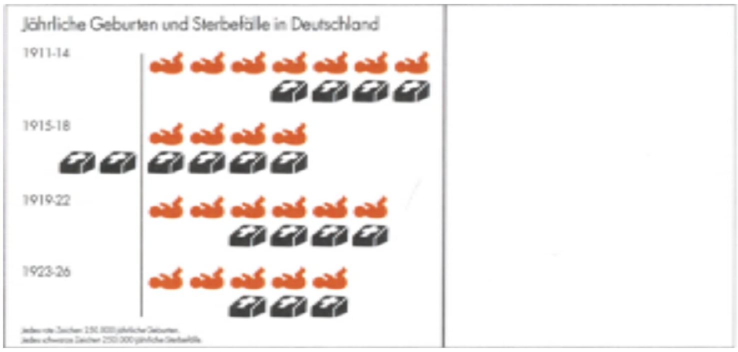


Fig. 1:
Isotype quantity diagram on annual births and deaths in Germany: The subject and quantities of the diagram are immediately evident. (Otto Neurath, *Gesammelte bildpädagogische Schriften*, Vienna 1991, p. 386.)

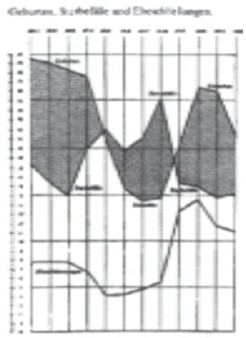


Fig. 2:
In comparison: Typical contemporary diagram of births and deaths. (Otto Neurath, ibid., p. 392.)

1. Otto Neurath, *Gesammelte bildpädagogische Schriften* (Vienna, 1991), p. 1–2.
2. Ibid., p. 245.
3. Ibid., pp. 278–279.

Information Graphics: The Renaissance of the Diagram in the Media

Modern newspapers are increasingly built on a casual presentation of topics. The aim is to cater to reader demands for fast, selective reading by chopping up large expanses of text into different text and picture elements. Information graphics play an important role in this context. They help visualize such different ideas such as party voting development, bombing patterns, or perfume manufacturer rankings. Information graphic designers see their communicative task — clearly affiliated with Neurath's approach — in providing an entertaining representation of complex facts and figures. However, the results often do not meet the demands. There are numerous illustrations, ornaments, but only very little information. Possible reasons for this can be qualification deficits and a lack of willingness to convey information. This kind of information graphics promotes the possibility of political instrumentalization. Since the designer did not question the statement at the stage of creation, it also appears to be plausible to the reader once packed into the picture. In contrast to the original statement, the picture is plausible at two levels: its impact is stronger because it is more emotional than a text; and it is harder to question its accuracy as the reader is generally not capable of translating it back into a worded statement. But information need not necessarily be neglected when facts and figures are

Otto Neurath, c. 1919

dressed up in information graphics. Despite their fashionable use in the computer world, information graphics are really just simple diagrams, which have been around for centuries. Neurath's extensive records concerning information and quantity diagrams according to the Isotype method are a source of valuable design tips.[4]

Learning Isotype: Rules for Information Graphic Designers

In the following section I will compare modern information graphics and examples of Isotype. It will emerge that the underlying principles of Isotype also work as basic rules for information graphics. The aim of this comparison is to sensitize consumers and producers of colorful newspaper pictures to the possibilities of information graphics between information and manipulation.[5]

1) Structure the Contents Clearly

Neurath formulated the principle of didactic reduction as follows:

> *At first glance the viewer should only distinguish major elements, at second glance several important factors will be added, and at third glance he will perceive the details. If, at fourth glance, the viewer notices something new, the picture is inadequate.*[6]

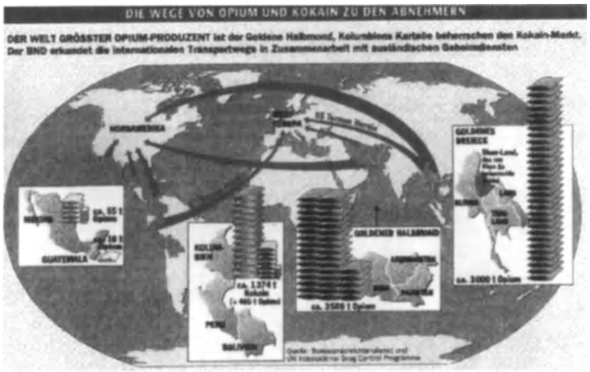


Fig. 3: At first glance the information graphic *Opium and Cocaine Routes to Consumers* appears to be interesting and catchy. When viewed more closely, this positive impression wanes because different information such as routes, quantities, types, and narcotics producing countries are presented in an unstructured manner. The diagram lacks a focus on one major statement. (*Focus*, 3/1993, p. 59.)

Fig. 4: Static Isotype map image: Clear-cut layout, attractive symbols and focus on one subject. (*Gesellschaft und Wirtschaft*, Leipzig 1930, p. 75.)

On the surface, a lot of modern information graphics are very informative because they have a complex structure and comprise numerous elements. Taking a closer look at the diagram, however, often reveals an unstructured mess of information that does not really provide any substantial insights. Neurath, on the other hand, saw Isotype developers as educators — "The picture designer must be guided by the rules of education through the eye, and he has to make a selection of material that will produce a certain learning success; it is not his aim to enumerate all the facts."[7] Even if information graphic designers do not wish to appear pedagogical to their readers they should — following the Isotype system — design well-structured, exaggerated graphics in order to fulfill the need for fast readability.

2) Use Elements of Design Functionally

In modern information graphics, illustrative elements often overpower the actual content. There are presumably two causes for this. Either the actual core information is not seen as being entertaining and thus adorned with decorative elements, or the graphic designer's knowledge of the subject is insufficient (Fig. 5). In both cases the graphic design work is focused on creating embellishing, entertaining elements, as a result of which the reader may only take in the illustration and not remember the actual information. Neurath polemicized against this kind of pseudo-informative graphics. In Isotype diagrams, information is always the main focus (Fig. 6).

> *Roughly a decade of the Viennese method has shown us ... that you can arouse the interest of hundreds of thousands of people with the aid of well-designed, logically conceived diagrams and models, without having to resort to pointless variation, gimmickry, or so-called funny drawings.... Making the wealth of reality comprehensible is colorful and appealing enough; there is no lack of stimulation.*[8]

Neurath remains up to date. Information diagrams are created in the mind, too. Informative and aesthetic graphics are formed by linking all elements of design such as typography, color, or decoration with the core statement in a meaningful manner and by underscoring these elements.

4. Almost published in full in: Otto Neurath, *Gesammelte bildpädagogische Schriften*.
5. See also: Angela Jansen, "Chartjunk, Infographik und Isotype," in Sozialismus [Hamburg] 12 (1995): 31-34; and "Info light? 6 Regeln für Ihre Infographiken," in Page [Hamburg], no. 1 (1996): 32–36.
6. Neurath, *Gesammelte bildpädagogische Schriften*, p. 338.
7. Ibid., p. 364.
8. Ibid., p. 282.

Fig. 5:
The caption of this information graphic (*Double block: The antitoxin Interleukin-16 inhibits immune deficiency viruses from docking on to host cells and virus reproduction in affected cells. At least, this is one of the hypotheses.*) tells us that the graphic designer has only added minor embellishments to the text without having any deeper knowledge of the subject. The result is perforce a rather exiguous information content. (*Der Tagesspiegel*, 8.12.1995)

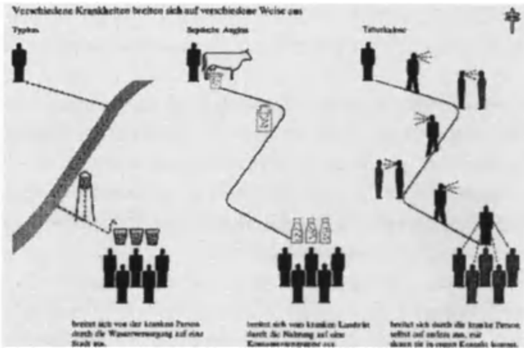


Fig. 6:
This isotype diagram, aimed at educating people about tuberculosis, commissioned by the National Tuberculosis Association, describes in an eye-catching manner the various modes of transmission of diseases. Graphic elements have been intentionally minimized and serve merely to illustrate the statement. (Otto Neurath, *Gesammelte bildpädagogische Schriften*, Vienna 1991, p. 426.)

Angela Jansen, born 1958. Studied communication design in Kassel and Darmstadt. Worked in publishing. Director of an agency for ecological public relations in Hamburg. Interested in communication graphics in connection with operative management consultancy, the popularization of technical facts and the theory of info graphics. Teachings in the training of journalists (a. o. at the Hamburger University), publications on information graphics and isotype. Lives in Hamburg.

References:

Angela Jansen, Wolfgang Scharfe, *Handbuch der Infografik* (Springer, 1999).
Angela Jansen, Johannes Steffen, *Bilanz der Ära Kohl. Sozialabbau und Umverteilung in Zahlen und Infografiken* (Hamburg, 1998).

9. Ibid., p. 273.
10. Ibid., p. 388.

3) Visualise Relative Quantities Correctly

Neurath's statistical diagrams presented quantities so clearly that he was able to do without any numbers. Neurath prescribed that the quantities — as in bar charts — should only vary in one dimension (Fig. 7). "A large number of objects is displayed by a large number of symbols."[9] He rejected the comparison of two-dimensional and three-dimensional quantities, as he held such a comparison to be unclear:

> *The fact that one square has twice the surface of another square can be calculated but not seen with the eye. However, it is easy to compare the amount of two adjacent rectangles with that of one isolated rectangle.*"[10]

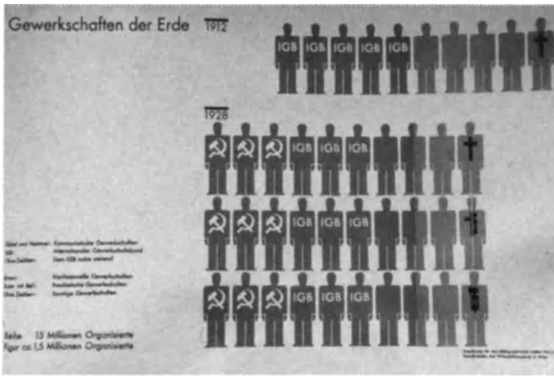
Isotype diagrams not only offer greater insights because the relative quantities are made visible at first glance, they also avoid making a logical error: the objects seem to grow or shrink, although it is actually the number of objects that changes. The modern popular trick of omitting the zero mark, thus heightening the effect of what is essentially a trivial curve, is not found in Isotype diagrams. It is no accident that these diagrams do without perspective, as this often results in incorrect relations. These three principles of correct visualization of quantities can be derived from Isotype without making pictograms into a dogma.

In summary, I would like to say that without recourse to its theoretical heritage, pictorial communication is heading for a visual overkill. If we rule the educational principles of Isotype to be defunct and cast them aside, we automatically reject educational diagrams in mass communication. If, today, information graphic designers want to design informative graphics — against the prevailing trend of superficial illustration — they will have to take a very close look at the history of the diagram, particularly the Isotype.

Producer qualification alone, however, will not suffice to counteract the — to some extent — intentional influence on the masses by means of propagandist information graphics. Sensitization of consumers is also essential. Textual criticism is an established subject at schools. Curricula should equally include criticism of mass-circulated information graphics. For also the mystique of visual demagogy must and can be shattered — among other ways with the aid of Neurath's Isotype.

E. Nemeth and F. Stadler (eds.), *Encyclopedia and Utopia: The Life and Work of Otto Neurath (1882–1945)* (Kluwer Academic Publishers, 1996).

Fig. 7:
The Isotype diagram *Trade Unions of the World* contains various levels of comparison. At first glance, we see the trebling of the number of members. At second glance, we recognize a distinct shift in favor of the progressive trade unions (red symbols). And finally, the increasing differentiation within the various trade union groups becomes evident. A clear and yet compact information diagram. (*Arbeiterbildung in der Zwischenkriegszeit*, Vienna/Munich 1982, p. 357.)



10

Joseph Binder

Graphic Design

Joseph Binder
born 1898 in Vienna. In 1912-1916 he attended the School of Arts Robert Scheffler, Vienna. From 1919 freelance painter and graphical designer in Vienna. In 1922 class for painting (Berthold Löffler), School for Arts and Crafts, Vienna. In 1924 study tour to Italy; founding of the Atelier Joseph Binder. In 1933-1935 several guest lectures in the U.S.A., e. g., at the Art Institute of Chicago. Worked as freelance graphical designer. In 1944 American citizenship. In 1945 member of the Art Directors Club, New York. In 1948 art director, designer for the U.S. Navy Dept., Washington D.C. In 1955 member of Alliance Graphique Internationale, Paris. In 1972 return to Vienna. Died in 1972.

1937 *Posters*, Architectural League, New York
1940 International Poster Exhibition, Tokyo
1942 *Buy American Art*, National Poster Campaign Committee, Fortune Magazine, New York
1956 National Offset Lithograph Exhibition, New York
1957 Summer Art Class Hans Hofmann, Provincetown, Mass.
1963 Academy of the Fine Arts, Vienna
1965-1969 Rose Fried Gallery, New York
1968 Museum of Fine Arts, St. Petersburg, Florida
Art Directors Club, New York
1972 *binder, new york, nonobjective art*, Museum for Applied Art, Vienna

Participations and awards at several, mainly American, poster competitions.

References:
Joseph Binder, *Colour in Advertising* (London: The Studio Ltd., 1934).

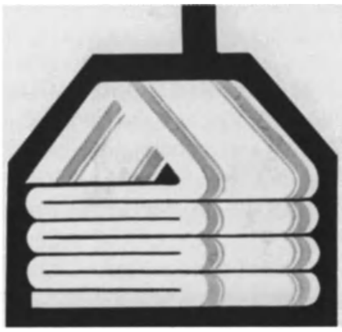
Everything has a function in design. Design has the function of representation. Design has the function of communication. Design has the function of motivation. (1934)

Europe thinks about art education in an abstract way, which influences the style of advertisements. The billboards of Europe confirm this concept of pictorial design. Put up at conspicuous places in the main streets, the boulevards of the cities, and in public transport, they dominate the field of vision. The presence of billboard advertisements surpasses by far the advertisements in European newspapers and magazines, partly because their circulations were not large enough. In America the budget for billboard advertising is relatively small. Its creation results from the "teamwork" of advertising agencies.

The use of the poster or billboard is increased by the growing demand of the developing industry. The poster artists of our time founded the new art form of realism that is independent of the prior period of l'art-pour-l'art poster art. They are the real creators of "graphic design" in the present form with their inventions and developments.

Lecture of Joseph Binder at the Austrian Museum for Art and Industry, Vienna, 1935, in: Joseph Binder, *Ein Gestalter seiner Umwelt. Plakate* (Vienna/Munich: Anton Schroll & Co., 1976), pp. 20, 25.

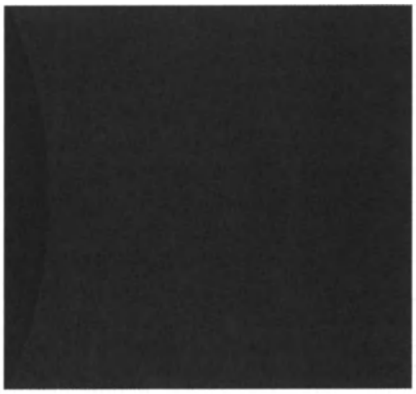
Joseph Binder
Persil Washing Powder, 1930
Persil company, Vienna



Joseph Binder
Pepperell textiles
Boston, 1944

Joseh Binder
The Most Important Wheels, 1952
American Railroads, Washington

Joseph Binder
Join in the New Era, 1955
U.S. Navy Dept., Washington



Joseph Binder
Opus 10, Indigo-Ultramarine, 1967
Oil on canvas, 116 × 128 cm

Ecke Bonk

in<=>formation [The Speech of Weimar]

Among the virtually boundless wealth of possible combinations of the twenty-six letters of the alphabet, non-sense combinations are more probable, considering our conventions regarding the orthographically correct sequence of letters. Considering the many different ways to combine letters and the high number of possibilities, then the chance of making a correct — or meaningful — combination is far more unlikely than drawing a prize in a lottery or winning at roulette. Consequently, the flawless text in our common language can be described as the rare special case of alphabet soup. What does this tell us? Everybody knows how hard it is to pick the right six numbers in the lottery. If only the laws of probability could be just slightly relaxed, if only the unicorn and the lucky draw in Monte Carlo were just slightly less improbable, if luck were malleable and coincidences could be manipulated (meaning, a human category), then this world, the universe itself, our cosmos, would have a different face.

However, cosmos means order, and probability and improbability are most closely linked to order and disorder. The laws controlling this relationship are some of the most powerful rules in nature; they have controlled even the most improbable turns in its development, the seemingly most accidental change.

More than one hundred years ago, Stephane Mallarmé wrote, "un coup de dés jamais abolirais le hasard!" (A throw of the dice would never abolish coincidence!) Mallarmé made this statement shortly before the discovery in quantum mechanics of the quantum of action, which soon led to a statistical description of matter based on indeterminism and non-causality. Order is a special case of disorder, just as the improbable is always a special case of the probable. And it is always disorder that constitutes the far more probable condition. This is expressed by the unrestrained and irrepressible effort of ordered conditions to achieve a more probable state — disorder — or at least to descend to it almost unnoticed. Along the path toward this more probable condition, distinctions and differences level out; but these very distinctions and differences (differentiations) are also a measure for order and thus for the improbable.

If we are looking for the first information scientist, then we ought to mention Sisyphus. Because he at least briefly outwitted Thanatos — death — the gods punished Sisyphus by forcing him, for the rest of time, to study the laws of order and disorder, of probability and improbability: the inexorable law of entropy. The stone must roll down the hill over and over again, because everything that we raise to higher levels is condemned to descend, to slide back down. Apart from this, Sisyphus was also the first typographer. Considered one of the cleverest figures of the ancient world, he invented metal typesetting, even linotype (i.e. line-of-type). In order to outwit his criminal adversary Autolykos — a son of Hermes, messenger of the gods — he poured lead into the hooves of his cattle, so that if they were stolen, the words "stolen by Autolykos" appeared on the road.

Each freely combinable abstract system of signs contains or conceals a proximity to non-sense and strangeness that is, in fact, just as astounding as the great economy achieved at the same time. It seems as if it were precisely this economy, the unrestricted ability to combine signs, that can only be achieved at the expense of omnipresent disorder — that is, the probability of sense-less combinations. Text and tectonics, structure and order, shape and creation, form and format, formula and formation, scheme and trick, building and education. Or to express it in a highly contracted manner: such a concept cannot be separated from perception, but must refer to perception. Perception is always a kind of selection, irrespective of the type of stimulus. Selection, as in selective admission of information, the collection of information. The original meaning of the term was collecting, amassing. The stone that fell into water must be reconstructed from the waves it made. *Aesthesis* also means perception. Accordingly, *an-aesthesis* means narcosis: anaesthesia and aesthetics. One should not forget this when talking about formation, about information. Perception is not only a kind of shaping, a kind of design. Perception requires formation, requires shaping, requires something that is found in in<=>formation, or at least should be.

Since the photophile or photophobe beginnings of the stimulus structure, perception and recognition has been something that is opposed to plain, leveling probability — with the addition of distinctions, of things that can be differentiated. Information processes are processes in formation, amounting to order, always aiming at the improbable; they are neg-entropy: they are opposed to entropy, because entropy could be described as loss of information. Thus information includes form and shaping, comprises all areas essential to us both with regard to spirit and matter. One might say, "the universe in formation = universal information" or even "information keeps body and soul together!"

Everything that appears or that can be perceived could be described and termed much better and more generally with the term information in its root sense. No other term encompasses both the tension between the order and disorder that characterizes every nanosecond of our existence and the billions of years that have determined and will continue to determine the evolution of the universe. Only consciousness — mainly western consciousness — and most of its manifestations seem to be dangerously unimpressed by this contingency.

Ecke Bonk, born 1953. Grew up in Germany and Switzerland. Studied typography and typesetting in Wolfenbüttel and Kassel, later under Herbert Bayer in Aspen, Colorado. During this time, worked on dyes (preferred color: bottle green). Taught "stereoscopy" at the military academy in Lhasa, Tibet, 1988. Later was a typographical consultant to NASA for the space shuttle mission. Founded the Typosophic Society in 1994 in Primersdorf, to research information aesthetics. Exhibited at the documenta X (1997) and XI (2002) in Kassel. In 2000 art director of the festival steirischer herbst, Graz. He lives in Primersdorf and Karlsruhe.

References:

Ecke Bonk, *Marcel Duchamp. Die Große Schachtel* (Munich: Inventar einer Edition, 1989).
Ecke Bonk, *Maschinenzeichen,* (Vienna: Passagen, 1991; 2. ed. 1996).
Ecke Bonk (ed.), *Kleine Bibliothek für das 21. Jahrhundert,* vol. 1: G.Th. Fechner, *Atomenlehre,* 1995; vol. 2: H.L. von Helmholtz, *Erkenntnislehre,* 1996.

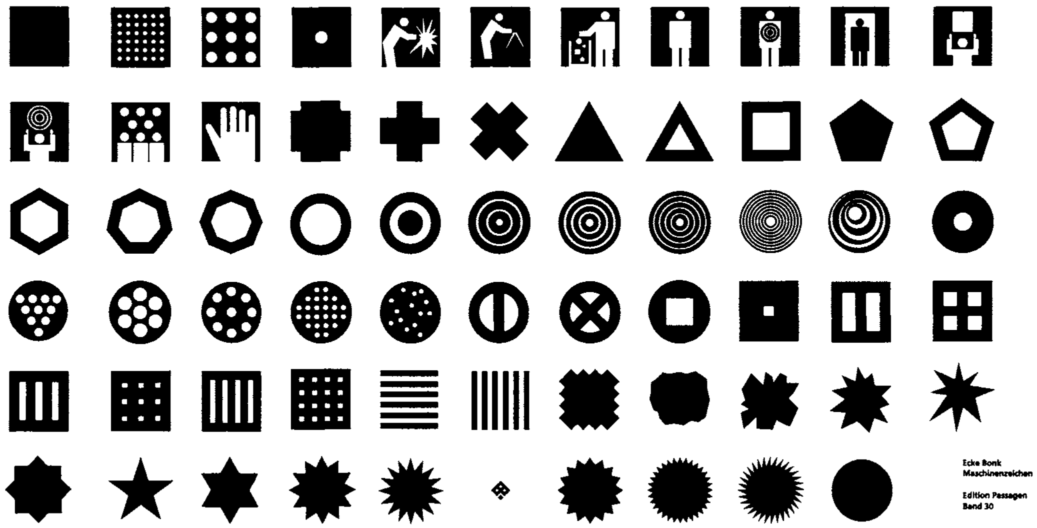
Ecke Bonk

A little example intended to illustrate the magic of chain reactions and laws of large numbers, which is no doubt also of importance for general life-sustaining processes and consequently for the special case of perception as well: Imagine four billion mousetraps, their springs set. Each trap is given a space of a quarter of a square meter. This arrangement would cover about one thousand square kilometers. This is not really descriptive, but this space corresponds to a circle with a diameter of only about twenty-five kilometers.

On the poised spring of each trap are two Ping-Pong balls. If we were to take one additional ball and let it fall from a balloon into the middle of the circle, thereby causing the first trap to "fire," and assuming in the ideal case that the two balls then catapulted off the trap would always hit two further traps, and if each of these processes took a quarter of a second, in a sort of slow motion, then how long would the chain reaction run until the signal has reached all four billion nodes, or mousetraps? No more than about nine seconds. In a corresponding arrangement, 128 billion traps would be reached after a further 1.25 seconds.

A highly primitive model of stimuli transmission and the possibilities of a chain reaction limited to this plane, which "visualizes" the four percent of our brain involved in the incredible luxury of perception, of a mirrored consciousness, the peripheral phenomenon of the one hundred billion neurons of the brain, so to speak.

Photosynthesis — the original model of sensorial processing — has, on the other hand, worked in the range of pico-seconds for millions of years.



Unimpressed by the dance of improbability on a tightrope strung across an abyss of the probable. And the only net that can catch us — which at the same time keeps us captive — is the net in our heads. In Greek, complex means "network" and the anagram places *urtext* alongside *texture*.

Thinking is plastic form, an expansion of space and time. Consciousness, perception, and realization are the special evolutionary case of photosynthesis. All that we perceive must be read, in the sense of selected; everything must be translated, transformed, and re-formed from sound waves or luminous stimuli. Thus the individual form(ation) in which a thought is shaped or an image imagined — what computer science would call background process — is always much more complex than the most complex operations we (seemingly consciously) experience, although always against a backdrop of inhibiting and reinforcing "informed circles." To quote Carl Friedrich von Weizsäcker: "consciousness is an unconscious act." When we perceive, we structure. Perception is a process of selection, a filter, a transformation from the gigabyte of stimuli our senses offer us. It is only this groundwork that allows us to form a creation and then to perceive the creation as a form again.

1997
Dedicated to Maxwell's demon

Peter Weibel

Logo Culture

From the Symbol to the Logo: Signs of the Real

In our contemporary history of culture, art is defined as a kind of symbolic language and the artwork as a symbolic expression. The idea of the symbol is of so much importance to art theory that entire art movements have been based upon it. Our observation, however, is that symbols have long vanished, along with the objects they denoted, because "all, or at least the majority of products take the form of commodities" (Karl Marx, *Capital I*). Symbols vanished around the advent of the "golden age of trademarks," as it was referred to in a text dating back to 1905. Today, we no longer call things by their names, but rather assign goods to a logo. You won't get anywhere by going into a shop with an idea of something in your mind and naming it. If you say mineral water, the shop assistant will shake his head and ask you, "Which one, please?," as if you were an extra-terrestrial or a simpleton setting foot in civilized territory for the first time. You'll cooperatively name the product by its logo and say Evian or Vichy Nouveau or Perrier if you want to get some mineral water. Mineral water no longer exists as an object, but rather, as a commodity only, and communication no longer works via the names of things but rather via the trademarks (logos) of the commodities. Accordingly, there are no cars any more, only Fords, Fiats, Volkswagen, etc. The trademark has come to replace symbols and names. It is the new sign of the real — albeit a real that appears extremely alien to us. For the real, as we knew it, has vanished along with objects and their symbols.

Logo Culture

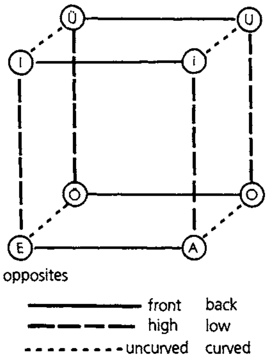
In order to recognize the essence of the logo, it is necessary to extend the class of signs. Around 1900, Charles S. Peirce divided the sign into three classes in its relationship to the object: the icon, the index, and the symbol. His definition of the sign itself is, "a sign, or representation, is something which stands to somebody for something in some respect or capacity." The icon bears a similarity to the object it signifies, such as a drawing of a leaf, a dog, a car, or a map. The icon is a faithful graphic representation of the object. The index is physically related to the signified object. The index is part of the signified object, *pars pro toto*. It may be visual, like smoke is an index of fire, or a car door *(pars pro toto)* is the index of a car. The index may also be acoustic. For example, barking may signify a dog, a horn may signify a car, or a ringing sound may signify a doorbell. The symbol is originally an arbitrary representative of the signified object, but is invested with meaning as a result of habit, repetition, and social convention. Around 1910, Ferdinand de Saussure added another division to the nature of the sign. He defined the sign as a Janus face, something that actually exists in the mind, which has two sides and can be described by the following diagram:

MENTAL CONCEPT	SIGNIFIED
SOUND IMAGE	SIGNIFIER

Thus, the word sign implies the whole. The mental construct is replaced by the word signified and the phonetic representation by the word signifier, "The band that joins the signified with the signifier is arbitrary," Saussure says, "the linguistic sign is arbitrary." I can use any signifiers to signify the concept 'dog' (signified): Hund, dog, chien. The concept "sister," he says, "is in no way connected to the phonetic representation of 'sister'." From this we can deduce the important insight of "differentiation" for our logothetic method:

> *In language, as in any semiotic system, a sign is only formed by what distinguishes it. Linguistic signs, comprised of a signified and a signifier, rely on their reciprocal isolation and delimitation. The important fact is not that one is different from another, but rather that one exists alongside and opposite all others. And the whole mechanism of language...is based upon this kind of opposition.*
>
> **(from *Course in General Linguistics*, 1913)**

In 1972 Jean Baudrillard published *Pour une critique de l'économie politique du signe*, a rejoinder to Marx's *Critique of Political Economy* (1859). In this, and in his later works, *Le Miroir de la Production* (1973) and *Symbolic Exchange and Death* (1976), Baudrillard attempted to detect an extension of the laws of commodity values to the level of the sign with the aid of a "political economy of the sign." This structural revolution is essentially an attempt to demonstrate how Marx's division of the commodity into utility and exchange values was repeated some fifty years later in Saussure's division of the sign into the signified and signifier. The replacement of linguistic signs in the circulation of meaning follows the replacement of commodities in the circulation of capital. According to the laws of commodity values, the classical essence of the linguistic sign is the interchangeability of all signs. We understand the functional dimension of language to include the relationship of the expression to what it signifies, the relationship of the signified to its signifier, just as a coin refers to what can be purchased in exchange for it. Yet the relationship of the signified to its signifier is



interrupted, broken. The structural dimension of language is increasingly coming to be a concept of the value (meaning the ability of all expressions to refer to each other) inherent in the entire system and derived from distinctive oppositions.

In the synoptic masterpiece of his linguistic theory, *Sound Shape of Language* (co-authored with Linda R. Waugh, 1986), Roman Jakobson writes:

> *The concept of opposition is the root both of the phonological and the grammatical system of language. As opposed to every pair of purely coincidental elements providing no predicative information about each other, the opposition is an intuitive logical operation that produces the simultaneous existence of the one element and, necessarily, its opposing element. Thus the components of pairs of abstract concepts such as movable/immovable, far/near, expensive/cheap are inseparably linked in our minds.*

The concept of opposition as a relation of reciprocal implication between two opposite elements that must necessarily be linked in our minds (such as cold/hot) is thus of key importance in Jakobson's linguistic theory. For us, this means that the double form in which the sign appears is subjected to oppositional binarism, where all distinctive features can only have two values.

The free-floating signifier moves within these distinctive oppositions, as in a cube constructed of oppositions and dichotomies, for example. Just as a phoneme falling into this cube could only move within these dichotomies and oppositions, the signifier, too, is a prisoner of the distinctive opposition in its movement. The vacancy of the symbol becomes binarism in the logo. For all that we have heard about the sign under the commodity value laws must also apply particularly to the class of signs that refers directly to commodities. As we know, the classical signs (index, icon, symbol) refer to objects. Our contemporary world, however, is comprised almost exclusively of commodities. Thus, it is necessary to add to the class of signs a sign that refers to commodities. This kind of trademark is generally called a "logo." In a symbol, the signifier can become detached from the signified — for example, wages from labor, and monetary signs from the product. For "money is the first commodity to achieve the status of a sign and escape its utility value" (Baudrillard, *Symbolic Exchange and Death*). The logo even escapes its exchange value. The utility value of a watch is increased by the symbol of gold. Yet a gilded watch has little symbolic value today. The symbol of gold is replaced by the trademark (logo) of the watch and gold. Rolex gold is better than gold. Every sign thrives on its difference. The logo confirms this distinction, this class difference. In the logo, the sign itself becomes a commodity. This is the other meaning of the word "trademark" (in German, *Warenzeichen*, or literally, commodity sign).

Just like the vowel cube, we can also draw up a topology of signifiers for logos, where the signifier has cut the link with its signified but cannot escape its distinctive features within the binary structure. At best, it can arrive at its oppositive neighbor, with the effect that the signifier does not ring the doorbell at its own signified, but rather at its neighbor's. This is why Cage calls one of the most important works on music *Silence*.

The logothetic method investigates such conversions of signifiers. If a company is international and does business with machines, such as International Business Machines (IBM), its logo is of course exactly the opposite. Eight lines resembling stripes from the American flag form the letters. Instead of machines, modern times, and power we see the distinctive opponent, a signifier of powerlessness, an outlaw, someone who made a film protesting "modern times" — Charlie Chaplin.

Peter Weibel, *Im Bauch des Biestes. Logokultur* (Vienna: Academy of Applied Art, 1987) pp. 4-25.

Manfred Erjautz

One of the starting points of Manfred Erjautz's works is the art object's own function as a signifié, its characteristic way of serving as a visual text, which is able to convey to the observer the cultural and ideological codes in the form of images and sculptures. Since any form of interpretation can be understood as an act of selecting meaning, and this finding of significance itself does not exclusively result from the visual experience but also from information previously obtained through reading, it seems to be reasonable to determine language in its different manifestations as the starting point for artistic modes of creation. Language as an image and the work of art as a text form a multi-layered network of interrelations in twentieth-century art history, to which Manfred Erjautz adds a contemporary formulation.

The reference to language Erjautz chooses to use in many of his works employs the regulatory mechanisms of coding and decoding as ways of disguising and transforming language into "images." The spectrum of the "language images" produced ranges from the camouflage of language — meaning its extinction as an immediate means of communication in the binary bar-code system — to the emphasis of its signal-like, medial, and design-like illustration in the form of commercially circulating logos and stickers. In both cases, the artist uses common and approved language systems that determine our social correlation of exploitation and, due to their omnipresence in everyday life, also determine images to identify with, ways of behavior, and consumption habits. And they do this all the more intensively the more one starts to internalize these systems and apparently begins to overlook them.

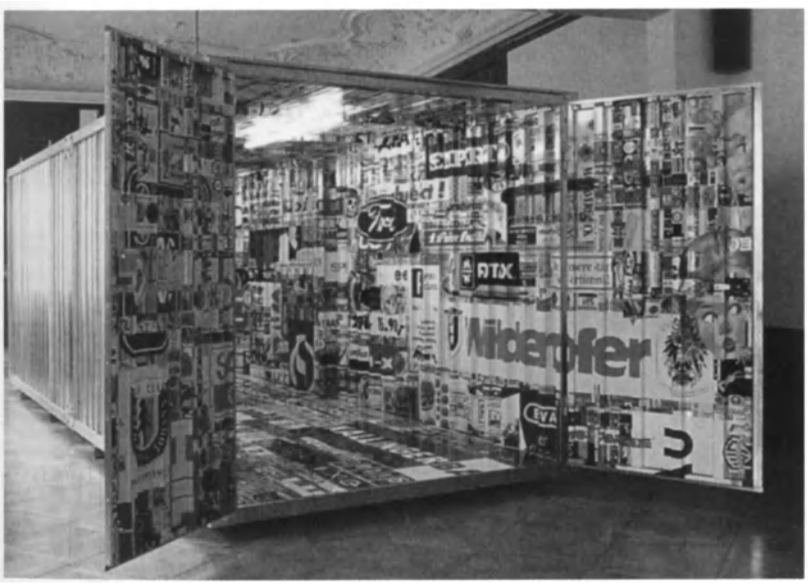
Erjautz's objects and installations put up a resistance to these internalizations. As "show pieces," they return automated knowledge to our consciousness and interrupt the mere flow of texts.

Rainer Fuchs, *FROM mmmh TO aaah*, Manfred Erjautz, ed. (1996) p. 27.

Manfred Erjautz
born 1966 in Graz. Studied under Bruno Gironcoli at the Akademie der bildenden Künste in Vienna. Lives in Vienna.

1993/94 Galerie Grita Insam, Vienna
1999 *As the Matter Stands*, Los Angeles Biennial
Catchment Area, Neue Galerie, Graz
2002 Secession, Vienna
2004 *Nothingness*, Galerie Lendl, Graz

Group shows
1993 Venice Biennial
1995 *Self Construction*, Museum des 20. Jahrhunderts, Vienna
1998 *Freeze Frame*, Claude Doyon Gallery, Miami
1998 *The Normal Ones*, Austrian Cultural Institute, London
1999 The Living Art Museum, Reykjavik, Iceland
2001 *Lives and Works in Vienna...*, Kunsthalle, Vienna
2002 *Papers*, Galerie Eugen Lendl, Graz
2003 *M_ARS. Art and War*, Neue Galerie, Graz
Außer Atem, Naussauischer Kunstverein, Wiesbaden
2004 *Farbige Plastik*, Rupertinum, Salzburg



Manfred Erjautz, *Container*, 1995
Material container, neon lights, 600 × 220 × 230 cm
Installation view, Kulturhaus, Graz

Manfred Erjautz, *SBR 70 FRME 91*, 1991
Rubber strips, coat rack
204 × 200 × 126 cm

10

Jeff Bernard

Thomas A. Sebeok and the Signs of Life

Thomas A. Sebeok

References:
Spoken Hungarian (1945), *Spoken Finnish* (1947), *Studies in Cheremis Folklore* (1952), *Psycholinguistics. A Survey of Theory and Research Problems* (1953), *Myth* (1955; ed.), *Studies in Cheremis 2. The Supernatural* (1955; and additional volumes on this subject), *American Studies in Uralic Linguistics* (1960; ed.), *Style in Language* (1960), *Soviet and East European Linguistics* (1963; ed.), *Approaches to Semiotics. Cultural Anthropology, Education, Linguistics, Psychiatry, Psychology* (1964; ed.), *Selected Writings of Gyula Laziczius* (1966; ed.), *Theoretical Foundations* (1966; ed.), *Communication Systems and Resources in the Behavioral Sciences* (1967), *Linguistics in East Asia and South East Asia* (1967; ed.), *Animal Communication. Techniques of Study and Results of Research* (1968; ed.), *Ibero-American and Caribbean Linguistics* (1968; ed.), *Approaches to Animal Communication* (1969; ed.), *Linguistics in South West Asia and North Africa* (1970; ed.), *Linguistics in Sub-Saharan Africa* (1971; ed.), *Linguistics in Oceania* (1971; ed.), *Paralinguistica e cinesica* (1971; ed.), *Linguistics in Western Europe* (1972; ed.), *Perspectives in Zoosemiotics* (1972), *Linguistics in North America* (1972; ed.), *Diachronic, Areal, and Typological Linguistics* (1973; ed.),

Thomas A. Sebeok, though already considered one of the classic proponents of modern semiotics, continues to be en route all over the world as the still youthfully agile spiritus rector of the semiotic scene and as an appreciated and much sought-after lecturer. Sebeok is the editor of the flagship of semiotic publishing, *Semiotica*, as well as the journal of the International Association for Semiotic Studies/Association, *Internationale des Sémiotique IASS–AIS* (co-founded, of course, by Sebeok himself). He is also editor of several pertinent book series, and every insider knows that, even though he is a professor emeritus now, he is still in a position to subtly pull the strings of the network (or web, alluding to the title of his recently co-edited semiotic yearbook, *The Semiotic Web*) that make up this scientific community.

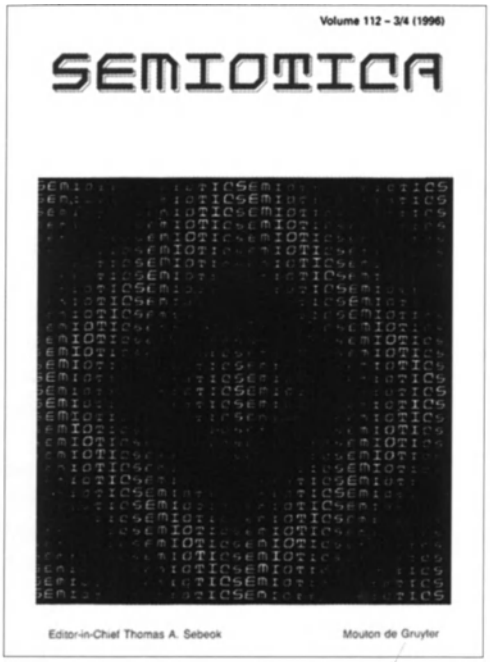
Sebeok (born 1920 in Budapest, died 2001 in Bloomington, Indiana) studied with Charles William Morris and Roman Jakobson, among others, both of who were progenitors of the modern discipline — or rather, transdiscipline — baptized as semiotics. (By the way, "semiotics" meaning sign theory, the doctrine of sign systems and sign processes, also comprises what is called structuralism). Sebeok founded and directed for many decades the Research Center for Language and Semiotic Studies (RCLSS) at Indiana University, in Bloomington, Indiana, USA. Now, in his eventful retirement, he heads up the Semiotic Publications department there. He acted as professor of linguistics, semiotics, anthropology, folklore, and Ural-Altaic studies. As a polymath, teacher, and editor, Sebeok belongs to the most renowned exponents of semiotics in the second half of the twentieth century. This claim is based on his numerous books and even more numerous essays and other writings on general semiotics, biosemiotics, zoosemiotics, and linguistics, as well as his further remarkable texts in and on fields such as psycholinguistics, mythology, folklore, ethology, stylistics, theory of art, and so on.

Among other his academic duties, Sebeok presided over the Linguistic Society of America and the Semiotic Society of America, and since his involvement in the foundation of the IASS–AIS (1969), he has remained a permanent member of the IASS–AIS board to this day. Besides editing *Semiotica*, he has for decades been the editor responsible for three leading book series, *Advances in Semiotics*, *Approaches to Semiotics*, and *Topics in Contemporary Semiotics*. He has distinguished himself particularly as the general editor of the three-volume standard reference work, *Encyclopedic Dictionary of Semiotics* (1986; recently appeared in revised and enlarged form). Through his scientific, institutional, and editorial efforts, he has exerted enduring influence on the development of semiotics as a discipline for many, many years. Among other things, Sebeok and his wife, Jean Umiker-Sebeok, a professor of semiotics and information sciences at Indiana University, have co-edited the above-mentioned yearly organ, *The Semiotic Web* since 1987.

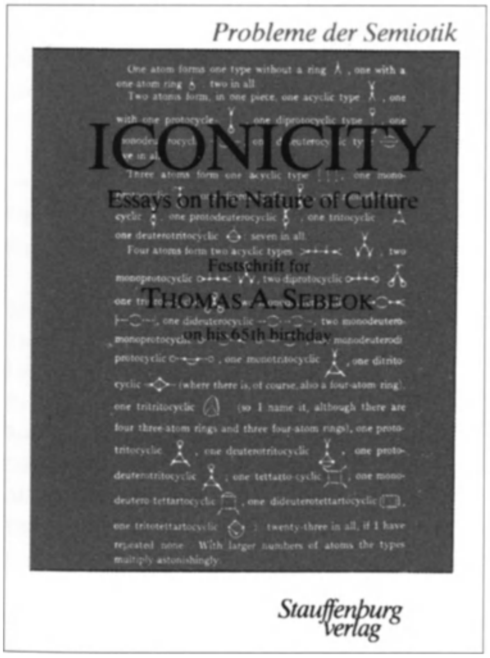
Among the broader public, Sebeok's name is primarily associated with the term "zoosemiotics," which was coined in 1963 to signify the branch of semiotics concerned with the study of animal sign use. Zoosemiotics focuses on species-specific communication systems and their foundations — that is, the so-called "language of animals," or rather, their signifying behavior — and it does so from a synchronic perspective (while ethology examines the diachronic dimension). In Sebeok's view, therefore, this discipline figures between ethology and semiotics as such. According to this definition, the discipline is reduced to anthroposemiotics, which comprises many components close to, or based on, animal communication. (According to Sebeok, therefore, human semiotics includes components of anthroposemiotics and zoosemiotic; the former comprising, for instance, language and all "verbal macro-structures," artificial languages, and more complex sign systems independent of language, while the latter includes fields such as paralinguistics, non-verbal communication, proxemics, etc.). Zoosemiotics itself is divided into zoosyntax, zoosemantics and zoopragmatics; on the other hand, Sebeok methodologically acknowledges pure, descriptive, and applied zoosemiotics. Sebeok's particular view of anthroposemiotics as an interface, so-to-speak, between two realms is a result of his finding that zoosemiotics rests on the more comprehensive science of biosemiotics — and within the scientific community, he is said to be its most prominent living representative. Biosemiotics, however, is already prefigured in Jakob von Uexküll's work, in his environmental research, which at the same time is, or contains, a theory/doctrine of signs and of meaning. In Sebeok, the influences of von Uexküll and Charles S. Peirce meet and fuse into an original, homogeneous whole, which includes evolutionary aspects and also produces new perspectives, for instance, in the distinction between exo- and endosemiotics (the former is concerned with sign events occurring inside organisms, the latter sign events occurring among organisms). In this vein, Sebeok has been dwelling more recently upon the primary conditions of life as well as of semiosis, amounting to the thesis that symbiosis and semiosis are one and the same.

Connected with the complex of biosemiotics and zoosemiotics is also Sebeok's strong interest in medical semiotics. Its roots can be traced back to antiquity, to Hippocrates and Galen, since the ancient physicians were already skilled interpreters of signs, and some of them have described and also reflected on possible theories behind their diagnostic systems. Besides what is nowadays the much better known linguistic and philosophical foundations of modern semiotics, it is certainly possible to trace medical tradition as an independent third strand throughout history, which maintains its relevance to this day. It is a remarkable fact that the terms "semiotics" and/or "semeiotics" were used until the end of the nineteenth century in the field of medical diagnostics and symptomatology (primarily in veterinary medicine). But there is no doubt that the relationship between semiotics and medicine is much more intricate, and it is exactly this complex interplay that is the focus of Sebeok's research. He has also proven to be a meritorious historiographer of medical semiotics. Apart from all this, he has authored countless essays on more established semiotic and linguistic topics, as well as other subjects, which, however, more often than not imply references to the biosemiotic paradigm.

Continuing in this, a selection of Thomas A. Sebeok's most pertinent works is attached, in order to demonstrate the broad scope of his scientific interests and activities.



Cover of *Semiotica* magazine, 1969, founded by Thomas A. Sebeok



Cover of a volume dedicated to Thomas A. Sebeok

Linguistics and Adjacent Arts and Sciences (1974/75; 4 vols.; ed.), *Six Species of the Sign. Some Propositions and Structures* (1974), *Structure and Texture: Selected Essays* (1974), *Historiography of Linguistics* (1975; ed.), *The Tell-Tale Sign* (1975; ed.), *Contributions to the Doctrine of Signs* (1976), *Native Languages of the Americas 1 & 2* (1976/77; ed.), *How Animals Communicate* (1977; ed.), *A Perfusion of Signs* (1977; ed.), *Aboriginal Sign Languages of the Americas and Australia* (1978; 2 vols.; ed.), *Cheremis Literary Reader* (1978; ed.), *Sight, Sound, and Sense* (1978; ed.), *The Sign & Its Masters* (1979), *Speaking of Apes* (1979; ed.), *You Know My Method – A Juxtaposition of Charles S. Peirce and Sherlock Holmes* (1980), *The Clever Hans Phenomenon. Communication with Horses, Whales, Apes, and People* (1981; ed.), *The Play of Musement* (1981), *The Sign of Three. Holmes, Dupin, Peirce* (1983; ed.), *Sign, System and Function* (1984; ed.), *Classics of Modern Semiotics* (1985; ed.), *The Semiotic Sphere* (1986; ed.), *I Think I am a Verb (1986)*, *Monastic Sign Languages* (1987; ed.), *Essays in Zoosemiotics* (1990), *A Sign is Just a Sign* (1991), *Semiotics in the United States* (1991), *American Signatures. Semiotic Inquiry and Method* (1991), *Signs. An Introduction to Semiotics* (1994), etc.
Sebeok's works have been translated into many languages.

Jeff Bernard, born 1943. Semiotician, social and cultural scientist. Author and/or editor of around fifty books and many articles. Director of the Institute für Sozio-Semiotische Studien, Vienna. President of the Austrian Semiotics Society. General secretary of the International Association for Semiotic Studies, 1994-2004; Vice-President since 2004. Editor-in-chief of the *S-European Journal for Semiotic Studies*. Co-editor of *Semiotische Berichte*, *IASS-AIS Bulletin*. Editor of several book series on semiotics, including *Semiotics around the World* (semiotic yearbook).

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