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EVROPSKÁ UNIE
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Univerzita Palackého v Olomouci

Interdisciplinární výzkum hudební kultury I.

Sborník přednášek a tezí

Olomouc 2012

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1. vydání

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Obsah

Předmluva

Sborník představuje první ze dvou výstupů seminářů a workshopů projektu Interdisciplinární výzkum hudební kultury, uskutečňovaného na Katedře hudební výchovy Pedagogické fakulty Univerzity Palackého v Olomouci v letech 2009 až 2012. Jednou z jeho klíčových aktivit bylo uspořádat dvanáct seminářů a workshopů, na nichž se setkali pozvané osobnosti muzikologického světa se zájemci o interdisciplinární výzkumné přesahy. Byť byla řada vystoupení zaznamenána na audiovideo záznamech, jejich převážná část je publikována také v klasické tištěné podobě.

V průběhu projektu se vyprofilovaly dvě podoby výstupů. Texty, jichž se jejich autoři více či méně přidržovali při svých vystoupeních, jsou obsaženy v tomto sborníku a seřazeny chronologicky, jak se postupně jednotlivé prezentace uskutečňovaly. Příspěvek Jiřího Lusky, prezentovaný 31. 8. 2009, se koncentruje na vybrané otázky hudebně kognitivních výzkumů z období přibližně posledních dvaceti let. Rozsáhlejší studie Davida Rosenbooma z kalifornské umělecké vysoké školy Cal Arts v Los Angeles přináší řadu problémů, které nesou rukopis soudobého komponisty, experimentátora a sečtělého teoretika. Součástí sborníku jsou i programové teze D. Rosenbooma úzce spjaté s jeho performačním projektem prezentovaným v Uměleckém centru UP v Olomouci 8. prosince 2010.

Hudebně akustickou problematikou se zabývají texty Pavla Klapila a Petra Koukala, které zazněly na semináři 24.9.2010.

Olomouc duben 2012

prof. PaedDr. Jiří Luska, CSc.
hlavní řešitel projektu

Kognitivní a metodologické aspekty hudebně psychologického a pedagogického výzkumu

Jiří Luska

Přednáška se zabývá metodologickými a kognitivními aspekty hudební apercepce. Zaměřuje se na hlavní oblasti, které byly rozpracovány jak teoreticky, tak v experimentálních výzkumech mentální reprezentace a hudebního kognitivního vývoje. Problematika psychologie vnímání hudby a psychologie hudebních schopností se v posledních dvaceti letech stala objektem oživeného zájmu o jejich výzkum. Podněty přišly především díky rozvíjející se kognitivní psychologii a její aplikaci v oblasti hudební psychologie.

V procesu vnímání dochází k dvojímu procesu transformace. 1. Jedná se o přetvoření vnějšího fyzikálního stimulu, vnější fyzikální energie v excitaci receptoru (receptorů) do proudu nervových impulzů. 2. Druhý transformační proces zahrnuje přeměnu nervových impulzů (v Neisserově pojetí nervového modelu vnímaného objektu) ve výsledný vjem psychické povahy. V této dvojí transformaci se vyskytují jevy a) fyzikální, b) neurofyziologické a c) psychické. Ve výzkumu hudebního vnímání byly reflektovány většinou tyto jevy v kombinacích buď a-b, nebo a-c.

V hudbě, oblasti operující s uměleckými a estetickými zážitky, se také ustálil pojem apercepce, který kromě výše uvedených vlastností vjemových kvalit zahrnuje šířeji pojaté response vnímatele (apercipienta) emocionálně – afektivní a eventuálně i behaviorální povahy. Pokud použijeme v naší studii pojem apercepce, vyjadřujeme jím zejména již zmíněný aktivní vztah subjektu ke zpracování tónového nebo hudebního podnětu, ale bez záměrného sledování prožívacích atributů.

Kognitivní přístup v současném psychologickém pojetí pohlíží na lidskou aktivitu, a reakce na hudbu v sobě vždy nese jistou míru aktivity subjektu, nikoli jen jako na pasivní responzi na podnět, ale jako na způsoby zpracování vstupních informací za spoluúčasti paměti, představ a dalších psychických funkcí. Pojem kognitivní je používán v širokém významovém rozptylu. V širším významu slova se jím označují všechny poznávací procesy bez rozlišení, jakými metodami nebo z jakých teoretických pozic jsou zkoumány. V užším slova smyslu znamená psychologický směr, který redukuje poznávací procesy na procesy zpracování informací. V kontextu hudební psychologie jsou významné a hojně studované zejména procesy mentální reprezentace, otázky psychického obsahu a kategorie znaku a významu a procesy vytváření mentálních modelů.

Proces percepce se vymezuje termínem obecnějšího významu, tedy jako zpracování informace, která je zprostředkována percepčním stimulem. Procesuální a informační charakter zpracování informací jako podstatný rys kognitivního psychologického přístupu je dále doplněn o strukturaci ve smyslu hierarchizace a modelování poznávacích procesů. Hovoří se pak o zpracování informace na vyšších či nižších úrovních. Kognitivní procesy probíhají paralelně i sériově a je mezi nimi interakce. Podstatnou stránkou kognitivní psychologie aplikované i při studiu percepčních procesů v kontextu hudebních struktur je modulárnost. Modely poznávacích procesů překonávají tradiční klasifikace psychických funkcí zejména rozčleňováním procesů na další dílčí úrovně, na nichž probíhá zpracování informací. Ty mohou vystupovat jako proměnná. Dílčí složky poznávacích procesů jsou dále sledovány z hlediska jejich interakce.

S oporou o Ulrica Neissera (1976) je průběh vnímání charakterizován jako probíhající percepční operace, při nichž dochází k organizaci senzorických dat do psychických významných struktur. Vzájemného vztahu hudebního podnětu a psychických potencionalit nutných k jeho zpracování si všímá C. L. Krumhanslová (2001), která hovoří o objektivních hudebních vlastnostech podnětu, které jsou vnímány, pokud psychické zkušenosti subjektu korespondují s těmito vnímanými vlastnostmi hudebního objektu. To je případ aktivního vzájemného vztahu mezi objektivními a subjektivními prvky. Uvědomuje si také, že existují objektivní hudební vlastnosti, které subjektem vnímány nejsou. Jde tedy o vztah, v němž hudební zkušenosti subjektu nekorespondují s hudebními vlastnostmi objektu. Tento vlastně velmi simplifikující pohled na proces percepce má však pro laboratorní experimentální činnost podstatný metodologický dopad pro stanovení, kdy dochází k psychické restrukturaci hudebního podnětu a kdy nikoli. Bez obav však můžeme dodat, že stejně významný je tento předpoklad i v oblasti hudební edukace.

Významnou psychickou vlastností vnitřně spolupůsobící na průběh procesu hudebního vnímání je paměť, a to její krátkodobá i dlouhodobá forma. V Naisserově pojetí komentovaném výše sehrává paměť činitele, který umožňuje identifikaci významu vnímaných objektů a dotváří tak percepční cyklus do smysluplného celku. V hudebním vnímání spolu s krátkodobou pamětí vystupuje dlouhodobá paměť jako nezbytný předpoklad pro uchování melodických a tonálně harmonických vzorců spjatých se stupnicemi, tóninou apod. V kognitivních výzkumech je paměť zkoumána paralelně s některou další kognitivní operací, která v hudebním podnětu a jeho následném zpracování dominuje. Kupříkladu T. Pechman (1998) ukazuje, že podržení si v paměti stopy akordů je jednodušší než záznamy jednotlivých tónů a že posouzení změn rodového charakteru akordů je obtížnější nežli postižení změn výšky tónů.

Na rozhraní mezi tonálně harmonickým cítěním a sluchem pro konsonantnost a disonantnost akordů v tónině se nacházejí diagnostické postupy aplikované v kontextu výzkumů cítění tonálních vztahů stavějících na teoretických základech funkční harmonie a přírodní harmonické hierarchizace. Akordy jsou buď exponovány v kadencích vytvořených z kombinací všech diatonických trojzvuků ze dvou zvolených tónin (kupříkladu C dur a Fis dur), a respondenti posuzují, jak dobře znějí v kadencích nebo jen jako dvojice akordů na pozadí určité tóniny. Pocit tóniny je v těchto pokusech navozován prostým přehráním jednotlivých tónů durové nebo molové stupnice v rámci určité tóniny. Přináležitost akordů k tónině je zjišťována pomocí hodnotící škály a dále zpracována statisticky (C. Krumhanslová, 2001).

Obecně je přijímáno, že harmonie jako hudebně vyjadřovací prostředek je pro vnímání komplikovanější než tónová výška, intenzita, barva, tempo aj. hudebně vyjadřovací prostředky. Proto se od sebe odlišují také z hlediska ontogenetického. T. Justus a J. Hutsler (2005) v kontextu základních otázek evoluční hudební psychologie shrnují také současné výzkumné výsledky v podstatě potvrzující, že přijetí tonálně harmonických principů se odehrává v procesu předávání kulturních informací v pozdějším dětském vývojovém období než vnímání obrysu melodie nebo vztahu melodických tónů k stupnici a tónině. Je konstatováno, že vytváření a zpracování melodických, tonálních a harmonických vzorců má povahu sociálně enkulturační.

Vývojově orientovaná větev kognitivní psychologie se od konce 70. let zaměřila zejména na výklad vývoje mentální reprezentace a mentální stavy, tedy hypotetické konstrukty, jimž se charakterizuje stav psychiky na předreprezentační úrovni, tak i na úrovni reprezentační. Přibližně od poloviny 80. let se prosadil tento kognitivní přístup naplno i v hudební psychologii, kde v mnohém navázal na Piagetovu vývojovou kognitivní (epistemologickou) teorii chápanou jako sled čtyř vývojových stupňů, v nichž myšlení dítěte prochází v interakci s prostředím řadou reorganizací a na výzkumy M. Pfledererové, v nichž aplikovala Piagetovy závěry o vývoji konzervace v myšlení na vnímání hudebně vyjadřovacích prostředků.

V základech kognitivní psychologie nebyl ontogenetický aspekt ani původně zakomponován. V procesuálně informačním pojetí je lidské myšlení a jeho vývoj pojat v analogii s computerovým procesorem. Myšlení a chování sestává z jednoduchých procesů, které se manifestují v raných ontogenetických stádiích. V průběhu vývoje se s narůstající zkušeností zvyšuje kapacita „procesoru" i rychlost zpracovávání informací. Tyto změny mohou být subjektem ovlivňovány, mohou se zdokonalovat až k automatizaci.

Kognitivní aspekty byly shledávány v psychice a podrobovány výzkumné pozornosti již v počátcích hudební psychologie a pojmy jako mentální reprezentace či konzervace zdomácněly přímo v oblasti výzkumu psychických responzí na harmonické hudební struktury. Kupříkladu známá publikace R. Shuterové Psychology of Musical Ability z roku 1968 ve druhém vydání z roku 1981na tento trend zareagovala novým oddílem týkajícím se právě kognitivních výzkumů. Od té doby pak zejména D. Hargreaves (1986), J. A. Sloboda (2005), C. L. Krumhanslová (2001), A. Lehmann (2002), a další rozpracovali zásadní problémy, k nimž se později připojovala řada dílčích otázek hudební kognice z oblasti neurobiologie vnímání (Peretz, I., Zatorre. R, 2005), rané ontogeneze (Deliege, Sloboda, 1996) učení, hudebních schopností a hudební tvořivosti (Sloboda, J. A. 2005). Byly rozpracovány také dílčí teorie, které byly zaměřeny na aplikaci hudebních symbolů, (Davidson, L – Scripp, L. 1992) na oblast vokálních činností (Davidson, L. 1994, Stadler, S. 2002), učení novorozenců a kojenců, problémy hudební kompozice, utváření hudebních a uměleckých kompetencí nebo uměleckého interpretačního kariérního vývoje.

Prozatím, jak konstatuje M. Sedláková (2004), nebyla v kognitivní psychologii vlastně uplatněna klasická longitudinální metoda, což platí, pokud je nám známo, i o hudební psychologii, kde převažují výzkumy mentálně strukturálního charakteru a vývojový aspekt je sledován spíše tranverzální metodou. V tomto směru, ale i v řadě dalších, které nebyly v našem příspěvku zmiňovány, se dá očekávat vícero dalších výzkumných polí i aplikačních perspektiv do oblasti hudebního vzdělávání.

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Collapsing Distinctions: Interacting within Fields of Intelligence on Interstellar Scales and Parallel Musical Models

David Rosenboom

Paradigmatic parallels and complementarities among experiences in experimental musical composition and some of the primary problems in interstellar communication

Deeply and thoroughly contemplating the import of *communicating* with forms of intelligence *other* than that we believe we know, and about which all our presumptions could be arbitrary, sends us immediately to the roots of fundamental questions about our own, differentiated existence. If we consider the meanings we attach to the words in the preceding sentence, nearly any of them could lead us to fully reexamine the presumptions we carry with us in order to function in the world. Much of this article is about questioning our metaphors for understanding intelligence, time, space, information, communication, and messages, while drawing on the striking parallel explorations that occur naturally in the vast terrain of musical composition, especially when undertaken with an experimental attitude (Rosenboom 2000c). What follows should be considered a prolegomenon to a more thorough and substantiated study still to come. In the meantime, the interdisciplinary juxtaposing of fields involved in speculative musical theory and extra-terrestrial communication (ETC) yields a plethora of sparks to light the fires of conceptualizing. This chapter is meant to fan those flames.

As we open ourselves to the variety of forms in which intelligence—as we understand it—could possibly manifest itself, we confront both our a priori definitions of intelligence, and the profound ways in which these manifestations may differ. We begin to consider the range of variations and potential degrees of difference separating newly apprehended forms of intelligence from that which we associate with ourselves. First, we consider variations of intelligence we perceive among the human populations. Next, we move a bit further away and wonder about possible intelligence in other species living on our Earth. Finally, the notion of extra-terrestrial intelligence (ETI) carries our imagination and speculations further away from our self-models. Imagining ETI is not so different from imagining other intelligences nearer to us. Crossing the physical threshold of getting off the Earth, however, triggers our thoughts and forces our imagination to grapple with how fundamentally different, other forms of intelligence might be.

When we return closer to home, this expanded imagination illuminates the diversity among forms of intelligence exhibited by beings nearer to us, both inside and outside our own species, and the multiplicities of intelligence existing within our individual minds. As it will be shown in all of the interdisciplinary domains of thought this study invokes, it is important to be ever mindful of the *scales* of relationships we can consider, the scales of intrinsic similarities and differences that might become manifest and the physical and temporal scales over which intelligent relationships may be found.

Having alerted ourselves to the scales of possible manifestations of intelligence, we may ask, what of consciousness? Is intelligence dependent upon consciousness and its possible further expansions in scale: self-consciousness, consciousness of consciousness, macro/global-organism consciousness, and universe consciousness? Three kinds of descriptions may be all that are necessary to create a unified description of these things (Rosenboom 2000c): 1) *time-space* extension—frameworks defined when processes extend themselves; 2) *energy—changes* and distinctions in time-space; and 3) *information—order* and pattern underlying emerging entities.

Next, we consider the body, our bodies. To what degree are intelligence, consciousness, and the body inextricably linked? As we consider communication, we ask, how do we recognize when we are in communication with another intelligence? If this recognition requires consciousness emergent from underlying intelligence, and the manifestation of consciousness requires the configuration of matter and time-space necessary to create our bodies, and we are interested in communicating with forms of intelligence distant from our Earth, then we wonder if it is necessary to move the body around in time-space to be able to recognize, and therefore experience, that we are in communication with an ETI. If so, we are led to the large conundrums arising from the speed limits we believe are placed on the communication media we know, such as electromagnetic fields.

Again, returning closer to home, we may pay attention to the phenomena of art making among humans. What is its function? As far as we know, the functions are myriad, probably beyond any description we've yet invented. However, one hugely important aspect of art making involves taking advantage of the potential abstractness of artistic media. In art we are given a form of behavior seemingly ideally suited to the exploration of paradigms of apprehension, intelligence, perception, thought, and human functioning, which may be radically different from our learned presumptions. Furthermore, we know that such different paradigms may be imagined, learned, heard, seen, and comprehended, albeit often only through the application of great effort and disciplined practice. Sometimes these art forms may enable us to grapple with scales of information and communication that are uncommon in our daily experience and ways of regarding space and time that are radically different from our usual, primarily linear concepts. For example, forms of time exist in cultures and styles of music making that simply do not contain the notion of time extending forever forward. Rather these forms of time, deeply experienced, may be entirely cyclical, always assuming endless repetition, or they may be entirely nonlinear, only becoming ordered, collapsing into sequences when succession is apprehended among otherwise simultaneous possibilities in a configuration matrix. The qualities of change can assume radically different meanings in these alternative paradigms (Rosenboom 1984a and 1984b). Figure 1 shows a score page from another of my compositions, *And Come Up Dripping* (Rosenboom 1969), for soloist and feedback-based, electronic signal processing. The musical and control structures in this work are all entirely cyclical in form.

Elsewhere (Rosenboom 1992b) it was suggested that the ideal mental state with which a musician may approach a new kind of musical notation might be similar to that of the SETI astronomer looking for extra-terrestrial messages. An essential condition of this state would be maintaining the openness of perception and cognition required to find and recognize a form of intelligence, *the nature of which cannot be known in advance*. This is critical. This newly recognized intelligence would, no doubt, have arisen from a process of evolution that may also not be knowable. Stuart Kauffman has argued persuasively (Kaufman 2000) that it is not possible to finitely prestate the *configuration space* of a biosphere, or in fact, any process in which evolution proceeds through the co-evolution of autonomous agents with their environment and each other. Extending this argument to intelligent beings, one must conclude that the nearly limitless variety of ways in which intelligence may emerge is not predictable. Extending it to the evolving

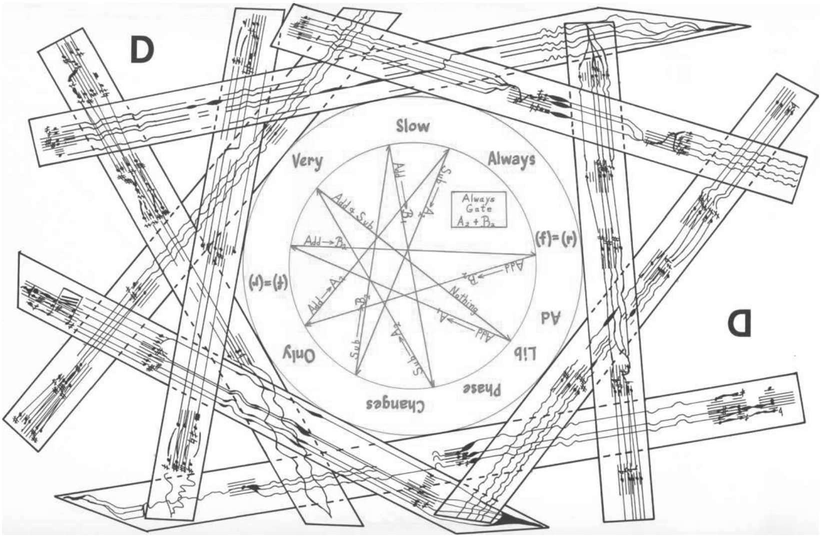
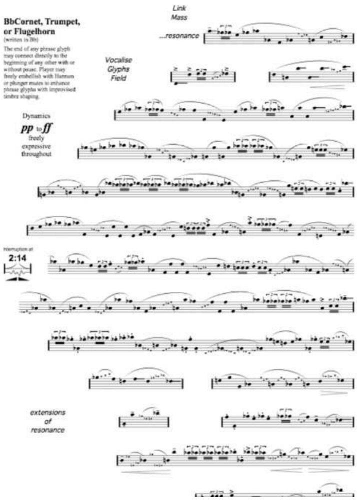


Figure 1. Score page from *And Come Up Dripping* for soloist and electronic processing in which all musical and control structures are entirely cyclical; cycles of delay and recombination of processed musical gestures produce new emergent forms.

universe as a whole (Kaufman 2000 and Smolin 1997), the future course of the current universe and universes that may follow may be fundamentally unknowable in their basic constants and characteristics. Examples of music in which the configuration of musical elements that may arise in performance cannot be prestated abound. Consequently, their evolution cannot be predicted. Figure 2 shows an excerpt from my recent composition, *Zones of Coherence* (Rosenboom 2003), for solo or multiple trumpets. The score consists of a series of *musical configuration spaces* inside which a priori time does not exist until a performer manifests a succession of events in a localized *now* shared with his audience.

We in the 21st century West are used to a standardized concert fare of classical repertoire in which the composer's score is regarded as the sacrosanct, absolute definition of the composition. Audiences often mistakenly regard this music as having specific, ideal realizations, and performances are judged according to this standard of perfection. Even this music is much more pliable in its time-space parameters than most realize. However, in the

Zones of Coherence—11a



Zones of Coherence—lib

Zones of Coherence–IVa

Zones of Coherence—lVb

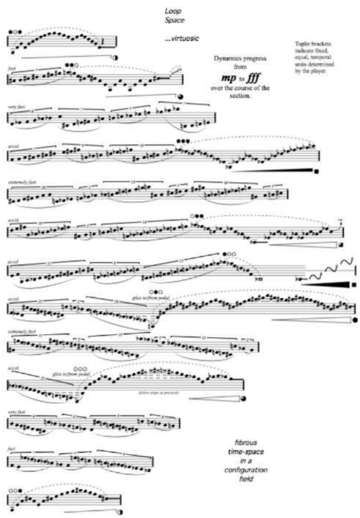


Figure 2: Score pages from *Zones of Coherence* for solo or multiple trumpets showing musical configuration spaces of simultaneous possibilities that are collapsed in performance to make local timespace realizations.

global scheme of things, we shouldn't forget that this repertoire comprises only a small percentage of the music making that exists and has existed throughout the millennia in the Earth's myriad and diverse cultures and minds. We must keep an open mind about the kinds of alternative musical paradigms that can exist. In this chapter, we will draw on broad themes that have emerged in primarily contemporary, Western experimental music, which may offer new ways of thinking about interstellar communication. The subject is vast, and in the space available we will only scratch the surface of possibilities.

Why music in this context—why is this landscape so stimulating?

Music is a stimulating and useful source of metaphors for ETC because it is such an open form of human activity. We can consider invented cognitive models and propositional realities as musical objects and regard *listening* as a compositional act, in the sense that it involves the creative synthesis of internal, mental images related to interactive experiences with sound (Rosenboom 2000). Furthermore, I assert that such *active listening* is one of the most important activities in music making and may also be a prerequisite for success in ETC. It's important to begin our investigation by taking a broad view of what music is and can be, extending the domain of activities we may consider to be music making before launching into an exploration of parallels between this form of art making and inter-stellar communication. The available musical and musicological literature is rich with excellent descriptions of these divergent musical worlds. Fundamental to many expanded views of music making is John Cage's explication of a musical philosophy, beginning with his monumentally influential *Silence* (Cage 1967) that includes among other things intentional and unintentional sound, silence, sounds in isolation, and sounds juxtaposed by chance as music. Readers may wish to explore informative sources such as (Cope 1989, Gann 1997, Nyman 1974, and Zorn 2000) to become more familiar with this musical landscape.

What can we learn from experimental music that might aid us in interstellar communication?

Here are a few ways in which we can begin thinking about what we might learn from this human activity we call music. The material stuff of music involves *experienced time.* As such, whether we know it or not, music is a discipline in which our metaphors of time and the organic experience of time are under constant exploration and manipulation. The scope of this is profound. Time is *synthesized* in music, made up, constructed through experience with configurations that may involve quantization in a variety of ways. It does not exist as a given. We are beginning to believe this may be true in physics as well (Barbour 1999). In music, we place our hands on time, mold it, and play with its emergent forms and how they relate to the structure of our experience and the mediating capacities of our underlying neuro-physical and organic substrates. The local, physical manifestation for this *temporal clay* is acoustic waves, the diffusion of displacements in a medium experienced on both its relatively global, continuous nature, and on its discontinuous, granular, microstructure level. These wave media function as metaphors for *fields* as well, the relativistic wigglings of which are brought down into the temporal-spatial scales of human, earth-day experience by the various *speeds* of sound moving through molecular constructions. Music provides, thus, an abstract space for structuring and exploring time-space experiences in profound ways that probe the nature of perception, intelligence, cognition, consciousness, and communication. In attempting ETC, we face the daunting mental challenge of thinking in a range of time-space scales, the possible, palpable experience of which we are only beginning to imagine.

Next, music is commonly a shared experience. It involves *communication* and interactivity among what we perceive as distinct manifestations of intelligence. As such, it is fundamentally *co-creative.* Musical constructions, i.e. compositions, serve as gathering points for co-creative activity and environments for exploration. Communication in music is, and this chapter will argue that all communication is, *fundamentally co-creative.*

Finally, music involves discovering forms of intelligence, *the fundamental nature of which cannot be known in advance.* Sometimes, these may be imbedded inside musical artifacts, such as notations or interactive structures, which have been created by individuals exploring the possible extents of intelligence as part of music making activity. Sometimes they involve the most demanding discipline of music making, *improvisation,* which can be defined simply as *composition that is immediately heard rather than subsequently heard* (Rosenboom 2000). In this case, the individuals engaging in improvisation are involved in a co-creative activity that joins separate intelligences, *the nature of which must also be discovered through dynamic interaction.* This seems to me to be of paramount importance to any endeavor that involves imagining communication among intelligent entities, which cannot know each other in advance of recognizing contact. In this sense, it is fundamental that we regard communication as a collaborative process. *Communication is collaborative co-creation among two or more differentiated, autonomous agents.* If these are to be considered *intelligent agents,* then their nature must be apprehended *through the process of co-creative communication.*

Recognizing radically different forms of intelligence, the characteristics of which cannot be known in advance

How can we recognize *intelligence* unless we know what it is? Indeed, how is it possible to even *know* what intelligence is? We may have a Godel-like problem here (Casti 1991) in that any formulation we might make to define intelligence places a boundary around a system configuration within which it will always be possible to formulate a kind of intelligence that is unknowable. We tend to associate intelligence with the emergence of a cerebral cortex of minimum size and regard those relatively microcephalic by comparison to have not crossed the *intelligence threshold.* Are there minimum characteristics of a system's internal organization required for intelligence? Does intelligence emerge from a system of minimum complexity by means of crossing a catastrophic cusp (Thom 1975)? Or, does intelligence exist on a continuum of organic development?

The concept of *extra-terrestrial-ness* arises from crossing a boundary or cusp, namely, being able to move to a minimum time-space distance separating us from our local gravitational singularity. It is not very much different, however, from crossing the boundary we place around the definition of our own intelligence, reaching into the realm of *other-intelligence.* The questions to ponder are similar. Most likely, we humans have not yet progressed very far in our ability to recognize the possible forms of other-intelligence that may exist in the universe. Have we exhausted the possibilities on our own planet? Have we considered the potential range of time-space scales over which forms of intelligence may manifest themselves? Are we able to ponder forms of intelligent organization among systems that extend beyond the scales of our own lifetimes? Have we exhausted questions about the interlinking of intelligence with *consciousness?* Does intelligence require consciousness? Does consciousness require intelligence? What about organizations of autonomous agents? What is the extent of autonomy in a co-evolutionary system? Could the vast ant colony that has been discovered to cover a geographical space extending from the middle of California all the way to Argentina be behaving as a single unit? The questions are endless, but it is critical that we keep them open and not rest too easily in answers.

Extra-terrestrial-ness broadens the questions to include time-space scales that necessarily extend beyond our own lifetimes. This occurs at a moment in our evolution when some forms of terrestrial intelligence are reconsidering the very existence of time and space. Perhaps, timespace may be rethought as a cognitive tool with which one form of intelligence, the existence of which inside our own brains we are aware, manages the configuration spaces we *observe* in the universe and maps these onto the mental configuration spaces we *experience.* As such, time and space function as metaphors. Other forms of intelligence appearing to function inside our nervous systems may operate differently. Do we know them? Have we recognized them? Have we experienced them? I submit that the unexplored territory here is vast beyond our current understanding. As we move toward a proper regard for ETC, we cross several boundaries, the boundary of the small, conscious mind into a larger mind including the unconscious and beyond, the boundary of the self, the boundary of species differentiation, and the boundary of time-spaces larger in scale than our individual lifetimes.

The freedom music offers in exploring paradigms of apprehension

Music offers us opportunities to work with, interact with, and explore our interrelationships within complete, speculative realities (Rosenboom 1987a and 2000c). Music generally utilizes the medium of acoustic waveforms and auditory perception, but it can use much more than that. Events within this psychophysical medium can become symbolic of nearly anything the mind can conceive. Acoustic waves remain relatively abstract through the primary processing stages of auditory perception in the nervous system. Categorical parsing by means of acoustic feature detectors in the auditory nervous system parallels relatively closely the physical nature of sound, even at fairly high levels of signal processing in the brain. Consequently, music is an ideal medium within which to explore how we hear, process, store, associate, and recall sonic images. Within music, it is relatively easy to identify levels of abstraction and to explore the processes through which we apprehend and attach meaning to psychophysical events.

Uncovering hidden mental paradigms through musical experiences

Earthbound musical styles periodically undergo major paradigm shifts, as new ways of thinking and hearing are uncovered (Rosenboom 1987a). During these periods, the way in which we regard supposedly fundamental elements of musical construction can change radically. Dissonances cease to be heard as *dissonant.* Temporal constructions formerly regarded as *chaotic* come to be regarded as *ordered.* Active engagement with the components of such new paradigms can change how we process the abstract constructions of acoustic waves and how we construct mental representations of time. The enormous capacities of our underlying neural processing structures to adapt and change the allocation of the brain's resources to match the organism's needs clearly supports this kind of shifting. Each time we experience a new paradigm the a priori hidden mental models with which we have habitually apprehended things become exposed for re-examination. The result can be a profound opening of the doors to new apprehension.

Hearing invented cognitive models in music

The past century was just such a time during which a great range of new possibilities was uncovered. One of the results was the splitting of former stylistic mainstreams into a plethora of tributaries, each with its own notion of musical reality. The parameters of compositional form were enormously expanded, well beyond the familiar ones of pitch, harmony, timbre, and rhythm that characterized previous, Western, common practice. The act of musical composition became similar to building complete, cognitive models of music. The revelation attached to this was the clear result that these proposed models could be heard (Rosenboom 1987a). They could be tangibly experienced.

Model building, thus, is an activity that exists in music making as well as the sciences. A common link for both lies in how communication functions within these models and how we communicate about them. ETC connects them all. So, what are some of the ways we work with invented cognitive models?

Both model building and physical experiment are essentially cognitive domains, aided by proprioceptive input and output, and involving correlating our semantic networks with supposed physical experience. It seems the most we can do is provide models expressing the consequences of assumed states and actions, which can bear only a speculative relation to any physical reality. The detection of phenomena through the senses by physical experiment serves to guide us in attempting to map the behavior of our models and our experience of physical reality onto one another. These mappings are isomorphic only to the extent that our *experience* is in some measure complete.

The invention of terminology or the attachment of semantic labels to physical experience is half the battle of physical science. Finding the most evocative means to communicate or stimulate a conception in the mind, which gives form and substance to an abstract model, is a primary activity. The fine arts permit the model builder to define the degree of correlation that will be required between the model and any assumed physical reality in absolutely any manner. If the model is to be purely abstract, it then resembles pure mathematics. To this extent, model building is an important creative act in both the sciences and the fine arts.

The creativity involved in such model building activity can be phenomenal. Indulging in the beauty of abstract models may also lie at the core of real advances in our conception of physical models as well artistic ones. For, it must be a fundamental biological attribute of humans to examine the phenomenon of true beauty as what nature must really be like. In ETC, it could be fruitful to work particularly with interactive and creative cognitive models in conceiving messages.

Recognizing new forms of intelligence in music

Creative musical activity involves recognizing the musical intelligence that may be imbedded in a musical work or expression. Music is an activity emphasizing dynamical processes. The primary physical artifacts of music are: *instruments—agents* for interacting with acoustic or other wave fronts—, scores—iconic objects created to mediate dynamical experiences, and since the last century, *recordings*—electronic memories of the outcomes of dynamical processes. Now we can add interactive, evolving, complex adaptive systems created through networked electronic and computer media, which have been realized as musical works.

Musical intelligence reveals itself in dynamical forms. When we try to distinguish physical artifacts that may have been formed by an intelligent agent from those arising spontaneously in nature, our assumptions about form and cause are invoked (Rosenboom 2000c). Making such distinctions among dynamic morphologies, all of which involve some manner of evolution, involves making judgments about the existence of *ordering agents,* which all life forces are. Recognizing the existence of such agents in music requires openness to hearing that may have little to do with prior assumptions about structures or tools for detecting order. This is rarely possible without actively interacting with those forms, the most important mode of which is active listening. Similarly, active interaction with a potential ETI may be required before it can be recognized. Mere speculation about possible artifacts of intelligence, which may be difficult to distinguish from natural phenomena, may be insufficient.

While hiking up the Devil's Slide trail in the San Jacinto Mountains, I came across a fallen log with a fascinating, complex pattern of grooves carved into the wood under its shed bark. Of course, insects, now long gone, had created these. What were the essential features that made it obvious these grooves had been created by a life form? Was this form imbued with the qualities of intelligence? Could it be regarded as a musical score? With creative interpretation, it certainly could be *played* as if it were.

Communicating over large scales of space-time

Perhaps, forms of both terrestrial intelligence and ETI may be thought about best as simply multiple intelligences separated over a range of relatively large time-space scales. In that way, we may come to regard intelligence as a continuously distributed phenomenon, a particular manifestation of the universe, which may be metaphorically described as having its own diffuse field with diverse, local manifestations. ETC may occur within this field in a variety of ways, analogous to interactions of waves in hypothesized *morphic fields.* [See (Abraham 1996a and 1996b) for an example of an animated, mathematical model.]

The primary problem of *time* in interstellar communication

Regarding ourselves as time-space-bound entities of intelligence, with the requirement that we experience in localized consciousness the recognition of an ETC event highlights time as a primary problem in interstellar communication. How do we regard messages we may send as signs of our form of intelligence, when we do not expect to be alive at the time the messages may be received afar? Clearly, we must look to a higher form of collective consciousness within which such events may be experienced and owned, and/or we must find our way to alternative views of time and space, perhaps enabling us to experience parallel universes.

In many world cultures, which have relied less on musical notation than the West, musical records are maintained primarily in individual and collective, auditory memories. Often, such musical forms and what we habitually regard as pieces or compositions are owned less by individuals and more by the collective. They also evolve as does the culture, and creators and practitioners, i.e. composers and performers, are not considered distinct from one another. Many practitioners are able to contribute to the evolving forms. Consequently, the musical forms could be said to extend over the time scales of cultural evolution. Perhaps, our attitudes toward and methods for ETC could benefit from considering this kind of musical practice.

The primary problem of *time* in physics today

It is the condition of theoretical physics today that many regard time as illusive and possibly only emergent from underlying phenomena, or even not to exist at all (Barbour 1999). Classical and relativistic paradigms cling to the notion that the *configuration space* of the universe can be prestated, and within this view, no good reason for time to exist can be found (Kaufman 2000). Time may be one of the ways in which an evolving universe organizes itself. Similarly, time may be one of the ways in which intelligence manifests its own internal organization and one of the cognitive tools minds use to grapple with configurations of physical things. This mental, temporal tool determines autonomously a *succession* of differentiated entities by interactive perception and apperception, and from this, constructs a *past* and *present* and predicts a *future.* All three of these, however, exist only as components of particular present moments, particular *nows.* It is worth emphasizing that all these are *synthesized* within us, the past being that which we regard as having an effect on us, and the future as that upon which we can have an effect. In each present we assess the accuracy of our past predictions about particular futures and from this, compute *expectancy* and *surprise.*

The speed of light, which may be better regarded as a maximum velocity for the propagation of influences among differentiable asymmetries—(symmetry breakings, warpings, distortions, singularities, waves) — in the electromagnetic field, appears to have its present value in our universe for no particularly good or well-rationalized reason. It is one of the parameterizations in our current model of the universe. Another way to regard it is as a kind of *stickiness* in the universe, like a kind of chewing gum that connects everything, and creates time by slowing down reactions. Thus, if one tries to pull a wagon with a piece of chewing gum or perhaps a rubber band attached, there will be an amount of time before the wagon reacts to the pulling force. In fact, this delay is always present, but is much shorter for more rigid arrangements of molecules, like a steel handle.

The stickiness may also represent energy, that which keeps distinguished mass entities apart, and slows their influence on each other, creating time. The stickiness may be like the stretching or warping of the electromagnetic field, producing the potential energy of non-equilibrium displacement, which may be released or dissipated by the pulling together of opposites in this displacement, forces stretching in opposite directions, opposite charges, opposite kinds of matter, and so on. The enormous *tension* that is described as being imposed on super-strings, requiring many dimensions of description, may be analogous as well and also be the source of the differentiation we observe extending out into the familiar, spatial dimensions that are not tied up in the tiny scales of the strings' size.

Further contemplation leads to the merging of energy, matter, time, and space into what is referred to here as *EMTS.* (Delightfully, this can be pronounced "em-ty-ess," almost like "emptiness.") These formerly differentiated concepts are, in this view, simply not regarded different. They are the same thing, emerging in mental space as separate merely as a consequence of the internal tools we use to coordinate configurations of experience. Memory is like mass. Memory is a kind of coagulation of information orderings in the way that matter is a kind of coagulation of field asymmetries. Time and space are, thus, emergent. It is sometimes a useful mental exercise to change the way in which we use language to refer to hard topics under study like this and observe what happens in our minds. Both in what follows and what has preceded, our usual nomenclature for space-time is reversed and called, *time-space.* Each time an anomalous term like this is used, some of our neural circuits are jogged and shaken a little. This leads to an accumulation to tiny reconsiderations, a healthy state of affairs.

The stuff of music is the manipulation of *time*

Music is a medium that manipulates time. It is often stated that music can manipulate something we call psychological time. It can be easily demonstrated also that music can manipulate our perception of the passing of time and perceived time intervals (Epstein 1995). Perhaps, we may also go further and speculate that music may provide an environment for experiencing *configurations* in which time is created, —at least locally—, by those interacting within these configurations. Further, the composition of these configurations is part of the art of music making. The time created and experienced is part of the stuff of music and becomes often attached to individual experiences of drama and emotion. A particularly thorough explication of this with emphasis on Western classical music can be found in (Epstein 1995).

Musical compositions have been conceived of on time scales ranging from microseconds to those of long-term cultural evolution, analogous to the range of time scales for hypothesized, self-organizing systems (Jantsch 1980). The neuro-plasticity underlying shifts in selective attention and the perception of musical structure supports a very large range of temporal extensions. It has been demonstrated that these can be reflected in measurements of electrical brain activity, such as event-related potentials (ERPs) (Rosenboom 1997). Composers can learn to affect the likelihood that musical events will be perceived on various changing time scales and make that part of their compositional methods. The process is, however, still co-creative, in that through active listening, those experiencing the music may direct their attention, perceptual tuning, and high-level image formation toward ordering things in particular ways.

***Music* in-time *and music* out-of-time**

Contemporary practice in musical compositional now routinely includes constructing musical relationships both *inside time* and *outside time* (Xenakis 1971). Both are considered part of music. Outside-time music involves constructing possible, often hierarchical, configurations, strategies, and groupings, building probabilistic relationships in *stochastic music,* making co- creative game strategies, co-creative interactive designs, and heteronymous forms of cooperation, conflict, evaluation, and judgment in performance designs. These new configurations also include ideas about integrating the *musical parameters* used to articulate the structural forms of the music, beyond those obvious and traditional materials of pitches and sound intensities, to include such things as *degrees of order* and *temporal-spatial densities.*

To produce each, local realization, musical space is *parameterized* in this way, as are our models of time-space and EMTS. This parameterization is outside time. The configurations that result are given succession and order in acts of apperception, which synthesize time.

Figure 3 shows a page from my 1967 musical composition, *Then we wound through an aura of golden yellow gauze* (Rosenboom 1986). In a way

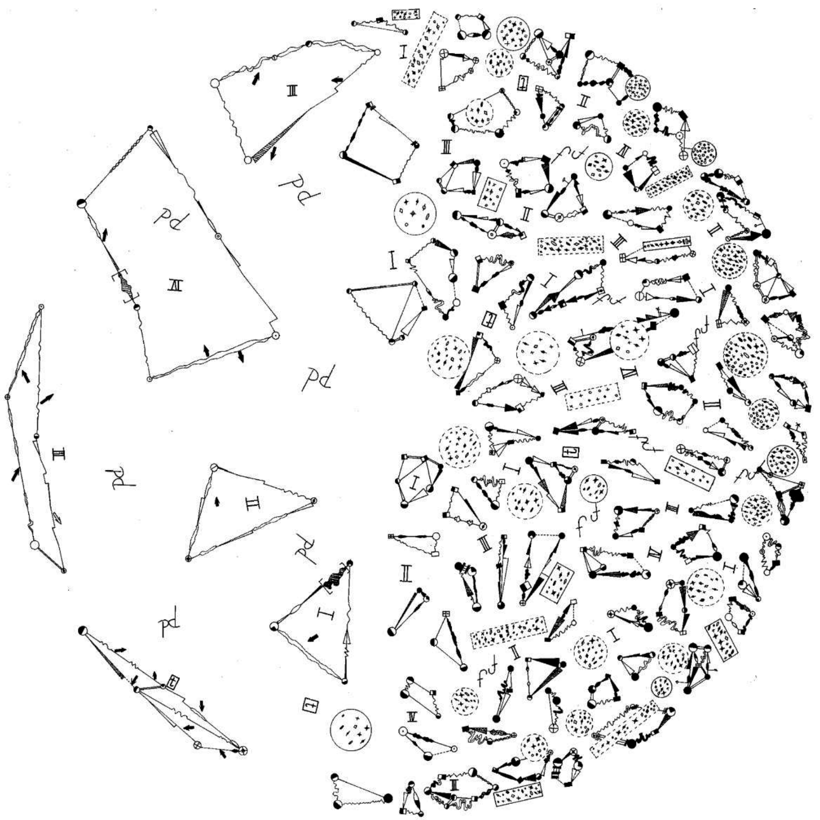


Figure 3. Score page from *Then We Wound Through an Aura of Golden Yellow Gauze* showing an interactive configuration space in which parameters of potential musical relationships are embedded in the way performers traverse the space and in adaptable symbols that can be defined for any performance medium.

that resembles diagrams of the configuration spaces one might see today in a monograph about theoretical physics, a configuration space of musical relationships is depicted. This circular space is parameterized along a set of axes—not shown in the score—corresponding to several rotated diameters. The center corresponds to a kind of origin and each diameter to a parametric axis along which values of individual musical parameters are scaled. Values extending out in opposite directions from the origin are thought of as pointing to *structural opposites,* analogous to positive and negative numbers mapping the tension between separated physical opposites like matter and anti-matter. For example, one axis corresponds to density, and results along this axis are the most visibly evident in the graphic score. A close clustering of figures can be seen on one side of the circle, while spatially disperse figures of larger spatial extent appear on the other. Each symbol is given a particular meaning relating to the starting, stopping and modulating of sounds. The symbols are further divided into sound events that can be extended in psychological time so that they are perceived as having gesture shapes imbedded inside them, and those that are so short that they can only be perceived as transients. A *performance,* which is considered to be a kind of collapsing of the configuration space into the local dimensions of musical *event,* may proceed via a limitless variety of *rules* for traversing the space. The rules may function as social orderings for several performers, analogous to agreeing to play the piece at a particular time and place, and/or they may be designed to maximize the emergence of particular relationships observed in this constellation of notations. Traversing the space makes it possible to experience its imbedded relationships. These relationships are composed out of time and, through performance, manifested in time. Similarly, the configuration space of the universe, — which may contain myriad manifestations of intelligence—, is experienced by traversing its relationships via the time-space stickiness of electromagnetic or other fields. *Experience* here is regarded as the collapsing of a field of simultaneous, possible relationships via the creation of *duration* and *extension* in a field that further coagulates these into the analogous forms of memory and mass. [Readers may wish to refer to two stimulating examinations of field ideas by (Williams 1980 and Auyang 1995)].

Parallels among musical *practice* and interstellar communication

Doing musical things requires practice in a vast array of skills. Key among these is mastering subtle forms of non-verbal communication. The ability to recognize and utilize ineffable, often inexpressible links and concurrences in time-space, —for example, among members of an ensemble—, is an essential, practical skill. Recognizing concurrences, particularly in time, are similar to detecting covariance among variables in a physical model, often a clue to possible links in a system of interacting parts with shared dynamics. Can we consider such covariance to be a form of communication? If so, we must be alert to how such covariance might link our detection and analysis exercises with the objects of our perception, —for example, possible messages. As is the case in developing musical skills, increasing our observational acumen in this regard requires regular, disciplined practice with our ways of perceiving the nature of reality.

Creative (not re-creative) musical practice

Mature musical practice is always creative, even in the supposedly re-creative acts of performing extant, relatively fixed-form, musical literature. Both generating outputs through our neuromusculature in performance and processing inputs through hearing and perceiving are creative acts engendering the synthesis of internal images for execution or storage. ETC is similar, involving the creative synthesis of messages and creative detection of correlations that could emanate from unknown intelligences. Objectivity in these endeavors is merely a form of relatively large-group agreement about observations.

Listening is as important as making sound in music; it is another form of composition—a creative manifestation of images

Listening is a compositional act. It involves self-directed attention, tuning perceptual mechanisms, activating recognizing circuits, and completing images that may be distorted or fragmented. Music is a landscape for exploration through listening. The perception and organization of internal *auditory scenes* involves an immense amount of computing and is analogous to constructing a reality (Bregman 1990). We know that our conceptual mechanisms, tools, and capacities can be developed through disciplined practice and self-exploration. We now know that the underlying neural plasticity involved can be enormous. Particular processing pathways can be greatly enlarged or diminished through practice, entrainment, repeated exposure, and experience, co-opting or releasing large amounts of the processing and memory capacity of the brain.

Listening is as important as sending in interstellar communication; it is another form of message invention—a creative interpretation of what is received

Listening in music involves the active selection of variations in a part of our physical environment, continuously presented to us through a detection system of limited scope, with which we choose to engage our musical intelligence for a constellation of individual reasons. As we practice being open to hearing, we widen the range of variations we recognize as having potential for such engagement. More and more aspects of our auditory scenes begin to have musical potential. New kinds of covariance are established between the neural substrates supporting our musical intelligence and the physical phenomena impacting our senses. Subsequently, this affects the range of possible output patterns we may synthesize when creating new music. Similarly, in ETC, a detected message is also an invented message, a creative interpretation of what is received. Concentrating on the kinds of covariance with which our message recognizing intelligence is capable of being engaged may both broaden our recognizing capability and provide new insights into message design.

The propositional music model

Previously, I have described a view of musical practice and labeled it *propositional music* (Rosenboom 1992 and 2000c). It was conceived initially in reference to the enormous period of expansion in ideas about what music could be that characterized the previous and, so far, the current centuries. It includes a view of composition as the proposition of musical realities — complete cognitive models of music—using propositional musical language accompanied by a propositional language of music theory. Composers are regarded simply as creative music makers of all kinds, who may work by first developing a model of a proposed universe and, then, proceed to make music that is consistent with that model. Interactivity within entirely invented models of whole worlds is emphasized as a driving force for evolution, and musical forms are considered to be emergent phenomena within individual works and across cultural history.

Complex adaptive processes in music

Recent developments in understanding complex adaptive processes play a significant role in this new musical landscape. Again, music provides an environment for experimentation. Complexity can be heard. It is a phenomenon of apprehension. It is tempting to regard apparent complexity as special and likely to have resulted from intelligent initiation. In perception and recognition, simplicity and complexity are relativistic and complimentary terms. Cultural artifacts may appear to have simple forms in relation to the perceived complexity of nature. A simple, large-scale form, like a building, may result from a complex arrangement of small parts. The apparent simplicity in the outer form of a sand pile may result from an immensely complex fitting together of grains. The temporal structure of music offers many analogies. A musical drone may appear simple. However, when one listens to it actively for a very long time, the subtle variations in its microstructure may reveal limitless complexity. Similar exposure to apparently random noise can activate resonant, recognizing circuits such that many recognizable things are heard inside the noise. The stochastic arrangement of a cloud of sounds may have simple direction in its overall movement. It may be a fundamental trait of adaptive organisms to develop correlations between the derived complexity-simplicity of a perception and the projected complexity-simplicity of a source or cause of that which is perceived. Such correspondence may not always be borne out and this might be critical to keep in mind when interacting with unknown intelligences. The digit sequence of π appears complex, but can be produced by applying simple rules. Similarly, we dream of discovering simple rules, which when applied, could produce a whole universe. Music composition today includes the same ideas.

Note that these notions about complexity differ from some common, impressionistic meanings in music, which tend to equate complexity with something that is difficult to hear or described as unpleasant and "hard" to listen to. We know we can hear, or learn to hear, and make fine discriminations between sound aggregates produced with different probability distributions, or different applications of set orderings. We may not be able to discern the generative methods behind these, but we can differentiate among various results. To each result, we ascribe a sound *quality.* As always, effort opens doors. Without that, the fantastic plasticity of our nervous system will dutifully allocate the brain's resources to becoming ever more efficient at tuning in what is common and tuning out what is uncommon. It isn't unreasonable to question whether this kind of adaptation in intelligence has survival value for the species.

The On Being Invisible musical model

My musical work, known by the title *On Being Invisible* (Rosenboom 1984a, 1984b, 1997, 2000a, and 2000b), is an example of a self-organizing, complex adaptive musical system. Spontaneous musical forms emerge in this system as the result of feedback interaction between the brains of one or more performers and what could be described as an artificially intelligent, computer music instrument. Figure 4 shows a schematic plan for the organization of this system. The beginning point for it is the generation of sounds by the instrument, either pre-composed or algorithmically produced, often through stochastic means. The instrument analyzes its sound output stream according to a partial model of musical perception, which resides in software and is always being refined. It looks for places in the sound stream that are likely to be perceived as natural parsing points, boundaries segmenting the stream into meaningful, perceptual categories. The system predicts which potential parsing points might be perceived as significant and tests these predictions by analyzing the performer's electroencephalogram (EEG) and looking for event-related potentials (ERPs). ERPs are commonly associated with shifts in attention to a target event. The occurrence of such ERPs supports the predictions and their absence does not. The confirmations or disconformations of the model's predictions are used to modify the generative, musical algorithms. Usually, confirmation will increase the likelihood that patterns containing changes similar to those associated with the predicted parsing points will recur and the *musical chunks* identified between the parsing boundaries are stored in memory. Disconfirmation results in these becoming less likely to recur, and the music is made to evolve by means of stochastic, mutation, or other transformation procedures. At a certain point in the process, the system changes state and begins to build hierarchical pattern groupings, based on predicting successions of previously detected groupings, and testing for concomitant ERPs. In this way, patterns of patterns emerge and a larger scale musical form is created. The result is often characterized by emerging musical forms that converge toward and diverge away from patterned relationships in sound, following fluctuations in the performer's attention and brain processing behavior. Of course, these behaviors can be influenced by volition and psychological factors. Consequently, the performer rides a thin line separating the role of being an initiator of change and simply being part of an evolving, larger system. This view of the performer's role gave rise to the title, *On Being Invisible.* Many years' work with this system has led to observations about the genesis of forms, some obvious and universal, some unique.

Extension—over the axes of experience

Extending a phenomenon over any of the parametric axes used to describe the phenomenon enables *recombinant forms,* new forms emerging by being recombined with delayed or extended versions of themselves and others. Time need not be the privileged dimension. The production of *mass* may come about this way. Mass may be an emergent form, resulting from

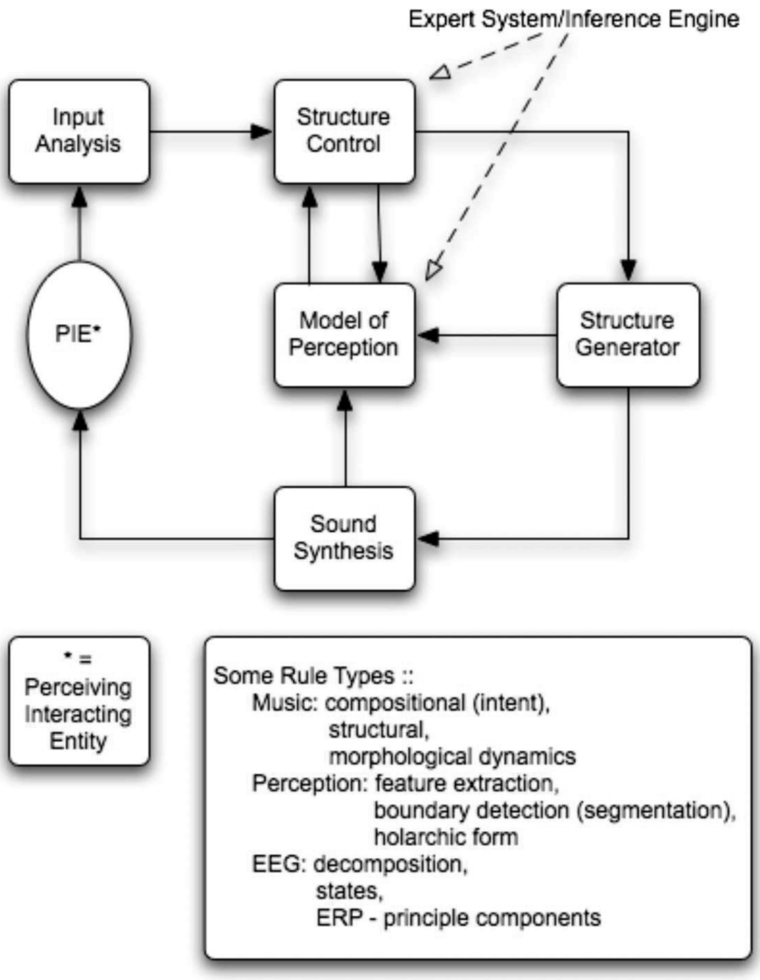


Figure 4. Score diagram from *On Being Invisible* depicting a system for co-creative performance practice in which forms emerge from a feedback loop enclosing a musical expert system and inference engine with the brain of a perceiving interacting entity (PIE).

underlying extending and recombining. Communication may be thought of as mass, the extension and recombination of distinctions through co-creative, co-participation of autonomous processing agents in feedback networks.

Feedback—a hierarchy of inner and outer—internal and external—perception and synthesis loops results in a network of form-creating extensions

Each intelligent, processing agent necessarily operates with a hierarchy of feedback paths connecting its inner and outer worlds, its internal and external environments, and interacts with these through both perception and synthesis loops. A hierarchy of feedback paths is created, those indigenous to the autonomous agents and those connecting individual agents in an environment. A network of extensions results from this. The delays involved produce a *succession* of events, engendering emergent forms. These networks may better be viewed as *holarchic,* that is, seen as a system that operates as a whole, rather than in a strictly hierarchical, bottom-up or top-down manner.

Tangible forms emerge naturally in feedback between two or more information processing agencies

Feedback between two intelligent, information processing systems, albeit one is artificial in the *On Being Invisible* system, creates *form.* Because of the stickiness in fields of relatedness described in an earlier section, feedback creates form also through the process of *extension* over one or more axes of description. Furthermore, the combination of spontaneous generation, analysis, prediction, testing, and storage creates the fine structures of particular present moments or *nows,* in which potential configuration spaces collapse into these structures, each with an emergent past, present, and future.

Delay—distance, prolongation, and directionality in musical performance and history

Delay, thus, becomes a primary principle in the creation of forms. It extends phenomena and creates substance and possibility for communication via entities of distinction. However, it may not require us to privilege the dimension of time. Delay requires first making a distinction. Then, a translation is made over one or more of the axes of description in any particular dimensionality. The time axis may not need to be privileged. Instead, these distinctions and translations may be thought of as existing in what Julian Barbour calls *time capsules* (Barbour 1999). They may not be subject to linear dependency, i.e. sequence in particular orders.

For many years, I have been involved in experiments with performance events in which the interacting participants were distributed over large geographical distances, often on different continents linked by various electromagnetic means, all of which involved unavoidable time delays. These *telecommunication concerts* included experiments with transmitted video images, audio information, computer data, and even biological signals. Instruments in one location were controlled by performance gestures sensed and transmitted from another. Brainwaves and electrically recorded muscle signals from performers were sent to control electronic and mechanical instruments distributed across continents. Special compositions were created to purposely exploit the transmission time delays. In one experiment supported by NASA, transmitting electronic signals from dancers' muscle movements and using them to generate live, electronic music in a biofeedback paradigm linked two dance companies on opposite coasts of the US. Another, six-year *telecommunication arts* project was produced in collaboration with the Electronic Café International in Santa Monica, my composer collaborator, Morton Subotnick, and other artists at the Center for Experiments in Art, Information and Technology at the California Institute of the Arts with support from AT&T. In events like these, that which is perceived as the present by distributed performers and audiences is relative to their own, local reference frame. The results have been fascinating. In every case, the musicians, dancers, actors, and other artists, who were placed in these situations requiring them to perform together while being geographically separated, were able to adjust to the emerging artistic forms that fit naturally within the particular temporal-spatial dynamics. This was true, even though the concerts perceived by audiences in each location were necessarily different. *The separations, delays, and extensions, however, were critical to the emergence of each particular form.* On an earlier occasion, I had the opportunity to send musical signals originating from a studio in Toronto around the Earth through a chain of linked communication satellites to produce the longest delays I'd experienced in one of these distributed music events. One could easily imagine vastly extending the time delays of these concerts into the realm of the time-space scales of ETC and speculate further on the results. Figure 5 shows visualizations of musical events separated in time-space with resulting, recombinant rhythms and the imagined effect of waves of cultural change transmitted, transformed, received, and recombined over greater scales of time-space.

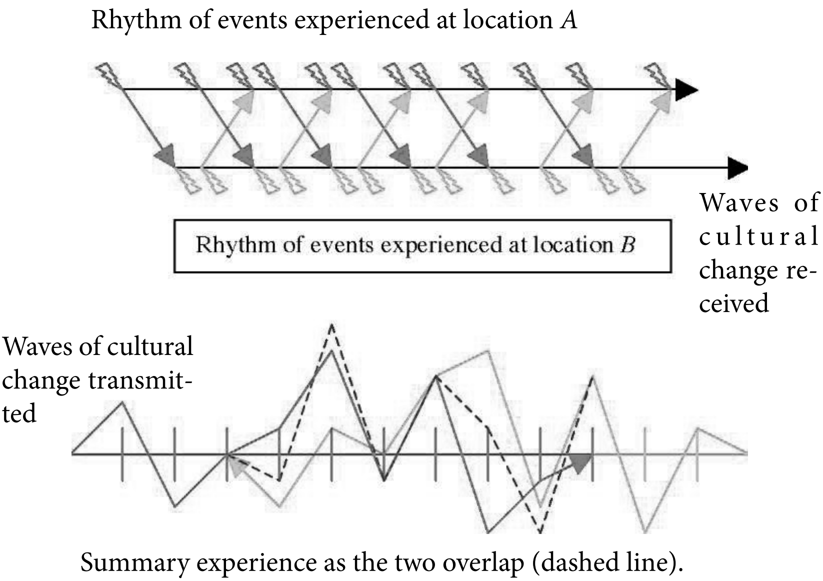


Figure 5. Visualizations of recombinant musical rhythms emerging from transmission and reaction time extensions in time-space and the imagined effect of similar experience with transmissions reflecting cultural changes over interstellar scales.

So, delay, extension, and recombination are fundamental in the emergence of patterns and forms. Short time delays are often employed in musical practice to create rich composite forms from relatively simple, initial patterns. Elongation and prolongation contribute to the evolution of forms on longer time scales as well. In Western harmonic music, one can describe the evolution of increasingly complex chromatic forms in the 19th century, which led eventually to a dissolving of tonality followed by a rebirth of new kinds of tonal relationships in the 20th century, as having come about through a process known in music theory as *prolongation*. The elements of a simpler, diatonic, harmonic matrix typical of late 18th century music became stretched and warped as if on a rubber sheet throughout the 19th and early 20th centuries. The movement of individual voices in traditional harmonic motion would be selectively delayed or prolonged, resulting in increasingly complex, composite chord types. Thus, chromatic music can be thought of as diatonic music out of sync. A similar progression took place during the development of jazz harmony, wherein certain chord voices would be *suspended* over new chord tones to produce rich, evolving forms of increasing complexity. Again, our adaptable hearing mechanisms learned to incorporate this new complexity into what came to be regarded as normal practice. In the late 20th century, new forms sometimes referred to as *gradual process music* employed delay, prolongation, and recombination to create forms that emerged from the slow evolution of patterns over extended time frames. (The use of the word *minimalism* to describe this music is, in my view, misleading.) These processes in musical evolution remind us of a related phenomenon in the evolution of biological morphologies. Here, the time is increased during which a particular part of an organism, —such as a selected organ like the brain—, is allowed to develop before the individual reaches maturation, allowing that part to grow larger or more complex. Thus, we have selective delay in the maturing of body parts changing the form of the organism.

Such distortions of normal experience with time can lead to profound questions based on real experience. For example, without raising issues about the arrow of time, we may examine *directionality* in our perception of spatial dimensions. Our ideas about direction may be tied to the fact that we have eyes only in the front of our heads. If we had eyes in the backs of our heads as well and brains capable of computing experiences commensurate with completely spherical vision, our worldview may be quite different. We may not give such distinction to the ideas of *ahead* and *behind.* This applies to our experience of time as well. We synthesize memories by making correlations in one temporal direction, giving rise to the concept of *succession* and the distinction of *before* from *after.* Of course, these are only given meaning with respect to any particular *now* or present moment. We believe we can see back in time by looking into deep space. Perhaps, however, the topology of space may be different from what we suspect, and fields may bend back on themselves. Perhaps time is expressed through a holarchy of cycles of varying scales, returning to any origin in a topology of nested, closed, naked curves. Some cosmologists have proposed universes with finite, periodic characteristics (Overbye 2003). Perhaps we can imagine a world in which we possessed a “time eye in the back of the head” (Rosenboom 1984a and 1984b). We may speculate on what this could mean for ETC.

Emergence—emerging forms are a fundamental practice in music making

Co-creation may be the only way intelligent entities not sharing a common language can communicate. In so doing, they create the basis for new language. Such practice is common in music making. Today, the growth of electronic communication networks has given rise to a new phase of experimentation in this regard. New music is being created involving interactivity with audiences on the World Wide Web, often employing *artificial life* (A-life) systems in complex, evolving structures. An interesting example, called *Verbarium* is an interactive work containing all these components (Sommerer and Mignonneau 2002). Mechanisms of evolution, including emergence of structures, selection and adaptation are all involved. It may be an important principle in ETC to create interactive, not fixed, messages that communicate our current understandings about the emergence of life and what we consider both life and intelligence to be.

- Some principles of emergent forms in art and music follow from work like this and the *On Being Invisible* system.Phase transitions toward complex structures in the system's dynamics occur at critical points in the process.
- A multiplicity of interacting parts is needed.
- Recognition of differentiation among parts is required along with the simultaneous understanding of higher-order unity.
- System components, like living organisms, include two essential components: 1) something that synthesizes their internal components and outputs, and 2) marked states that differentiate them from each other.
- Prediction and memory become part of the description of any present moment.
- What is perceived as complex is relative to the observer's perceptual reference scale.
- Extension and prolongation lead to nested, local cycles and larger, global hypercycles in an emerging structure.
- *Power law scaling* among components on small local and large-scale global extensions enables the system to exhibit *metastability,* common functioning over a wide range while considerable variation and adaptability takes place among behaviors on each individual scale (Kelso 1995).

We may speculate about the point at which the system's behavior reaches a critical transition resulting in the emergence of something we recognize as intelligence.

Apprehending musical forms and its relationship to recognizing interstellar messages

Sound, perception, hearing, listening, *and* music—how *are they distinguished in experience?*

Perhaps it may be useful to place sound, perception, hearing, and listening in a possible landscape of experience. Here's an attempt. *Sound* is simply *things as they are. Auditory perception* is a *bridge between sound and hearing,* a link between the nature of things and experience. *Hearing* is *observing our sensory input* in its totality and *knowing our mechanisms for synthesizing memory engrams, our inner representations for sound experiences. Listening* is *active practice with the interaction of our own nature and sound as it is.* If we are *making music,* we are *being ourselves with the decisions and actions we make in order to invent inner and outer worlds involving sound.* Practicing music making involves attempting to know and understand these decisions and actions.

Music as something we do with sound—i.e. waves

Waves are the physical stuff of music—acoustic waves, to be sure, but waves nonetheless. Drama and emotional content is installed in interference patterns, bending pitches in a tonal context, complex harmonic ratio structures, difference tones, and in the West, consonance and dissonance. All this is molded with the clay of waves, often emanating from sentient beings doing physical things. Acoustic experience involves modular combinations of waveforms, probabilities of prediction—engendering temporal direction—, vibrations in essential tensions among displacements and disequilibrium states seeking equilibrium—evoking past and future—, multiple dimensions of description, resonance phenomena, and the emergent geometries within which influences are propagated. Musical *solitons,* waveform entities that maintain structural integrity while passing through each other take on special meaning.

Waves and auditory knowledge

Nothing exists in isolation in music. It is no wonder that relationships among centers of gravity in the universe have been likened for centuries to musical relationships, i.e. music of the spheres (Kepler 1618). Anything identifiable exists in interaction with other things, and *directionality* ascribed to the propagation of apparent *causes* may have validity only for limited localities. Wave models can offer mental challenges, such as the physical phenomenon of *anomalous dispersion* in which the energy carried by a wave travels in a direction opposite to the wave's propagation and the possibility of a reverse Doppler effect. What is the import of these ideas for our evolving views of the cosmos?

A synthesis of auditory knowledge, wave interactions, resonance, tuning, coupling of systems, and so on are critical to deeply understand the theories of music. Helmholtz provided a landmark compendium (Helmholtz 1954), which guided developments for a long time, and recently, Chalmers has provided an important recasting of the enormous importance of tuning in the modern context (Chalmers 1993). To complement this acoustic understanding, we need to add the cognitive domains involved in how we build internal representations of auditory scenes (Bregman 1990). This involves acquiring comprehensive knowledge of sound worlds, how physical and temporal boundaries are perceived, how auditory coherence is synthesized, what contributes to perceiving continuity, how auditory streams are segmented, fused, and grouped, and understand the difference between the musical and psychoacoustical meanings of things like dissonance and harmonicity.

Relying on wave spectra in communicating messages and interactive processes—a musical perspective

As with the physical principle of least action, it may be a quality of intelligence to put constraints on processes so as to minimize the energy required to implement them. In relying on wave spectra for communication and interaction, we find a tendency to gravitate toward simple harmonic ratios. This may be because such relationships require less energy on the part of the processing entity, such as the brain, to recognize and compute them. Imbedding more information in harmonic structures requires employing higher overtones with more complex frequency ratios, increasing the processing time and energy. Modulating these with information not easily related to the waveform structure further abstracts the relationship between the information imbedded in the waves and the structure of the wave complex itself. Perhaps, working with the *structure of the wave complex as a message* would be a fruitful direction in designing messages for ETC.

The point of view of waves

Thinking in relativistic terms and imagining the point of view of a massless entity like a light wave traveling at the presumed speed limit of the universe as if it were an organic being, such a wave would perceive zero time passing as it travels from point to point. This raises a conceptual difficulty in thinking about what it means to define a frequency for a waveform without invoking measurement against a hidden, absolute background clock. Space, time, distance, scale, and resultant causality seem to be emergent properties. They appear as a kind of coagulation of distinguishable, extended phenomena, each with its own, independent, emergent time-space. The coagulation of such phenomena into mass or memory seems to require a slowing down, but slowing down with reference to what? Perceiving a frequency—a pattern or structure that repeats—requires time, memory, and the ability to compare a past with a present. Furthermore, either the wave must move in some sense past the perceiver or the perceiver must move past a fixed, or standing pattern. Another way to reveal the frequency of an acoustic wave to an observer is to enclose the wave in a bounded medium, such as a string with fixed endpoints, a drum head, a concert hall, a canyon, a limited atmosphere, or a box of air, within which wave structures form, as energy is imparted into the system, reflect off boundaries, and interact as they dissipate the non-equilibrium state of the system and return it to equilibrium. Perhaps we should ponder these conundrums in imagining how to best imbed the content of messages inside the structure of waves. Can we communicate the state of our knowledge about the universe by the way in which we use waves themselves?

Perhaps all that we perceive as *stuff*—the masses, memories, and energy that often have underlying waveform descriptions—is information superimposed on one underlying principle. This unfolding is the modulation of that principle—introducing time—through the information. Modulation involves cause-effect-action-perpetuation dualities. Again, we have a cognitive dilemma. The creation of motion and the creation of space are complementary, congruent, and equivalent, as are energy, matter, and time, components into which we dissect experience. We are organisms whose particular arrangements of EMTS compute a self-contained image of time through transience. It may not be a reasonable assumption that other localizations—local concentrations—of life would be constructed so as to manifest the same invention of time. Memories are that part of *who we are today,* which we choose to label as belonging to a concept we synthesize from the likelihood or probabilities we compute for how the present we experience might be organized, and call the past. It follows that from the point of view of *the now we experience,* movement toward the past equates with *moving toward the improbable,* and movement toward the future equates with *moving toward the probable.* Each being may be thought of as an articulation of intricately related and self-organized compactings of polarity elements — like virtual particles emerging from a vacuum potential — , which *moves* in a configuration space of these elements constantly reorganizing and incorporating them into its ineffable form. Other than that, greater, impenetrable substance may be illusory.

Notation—its role in co-creation

Notation in music, a relative fixing of forms in musical artifacts, plays a variety of roles in this context. It is related to our discussion about waves, because both deal with diagramming time. Both involve metaphors for time. A convenient collection of interesting examples of 20th century notation can be found in (Cage 1969) and other sources.

Notation and time

It is not clear at what point this began, but musicians can be credited for having invented some of the earliest parametric-time graphs as notation. Music involves a succession of events, and early notation may have been no more that a list of events to take place, one after the other. At some point, the idea occurred to conceive of the passage of time on a linear, spatial axis, and, eventually, to give it a scale of values. However, this is not the only way. Consider the possibilities for choosing other parametric axes to distinguish as the axes of differentiation—the axes for the derivative—the dimension of difference

In the 20th century, composers began experimenting with ways to separate the dimension of time from various musical actions. The American composer, Earl Brown, experimented extensively with notation in which time is not indicated mechanistically, as it is in common rhythm notations. In Brown, it is articulated, but not interpreted, for each performer.

Consequently, performers of this music become intensely aware of the overall, ensemble result that grows out of individual decisions, and how the sounds made or actions performed contribute to the construction of a time form that emerges. His notations involve improvisation in an open-form compositional structure. This profoundly changes the way in which the performers interact with the composition, the audience, and the performance experience. [See (Cope 1989 and Gann 1997) for more descriptions.]

Notation as an evolving, interactive medium

Other approaches to notation make it an interactive medium with results that evolve. In my work, *A Precipice in Time* (Rosenboom 1966 and 1991), notations with measured degrees of freedom were created by beginning with relatively standard notation figures and systematically stripping off layers of specificity to make a play with kinds of openness that still maintains the integrity of the counterpoint and transformations of shapes involved. This work also employs a system of proportions spanning all of its temporal scales, from the length of the piece, which determines the longest possible, fundamental wavelength in the musical construction, up through the smallest time scales of its acoustic structures, and finally to the light frequencies (colors) with which parts of the performance are to be seen. A more recent work, *Naked Curvature, (four memories of the Daimon)* (Rosenboom 2001), presents the musicians a large, modular score with music, text, and interactive software components that can be assembled and reassembled to make the form of each particular performance emerge from the musicians interactions with each other. A large work by Karlheinz Stockhausen, *Plus minus, 2 x 7 seiten für ausarbeitungen, nr. 14* (Stockhausen 1965), offers a huge construction kit, in which performers are given elements and rules for constructing their own, complete, individual compositions. Figure 6 shows a page from another of my compositions, *In the Beginning: Etude III,* in which the wave shapes of sentic forms, recorded initially in the neuro-musculature of individuals expressing emotions through physical gestures, are plotted in a temporal construction that is adaptable to a variety of performance mediums and scales. The essential elements that are preserved in the notation are the forms of gestures and how they are placed in counterpoint articulating a proportional time stucture.

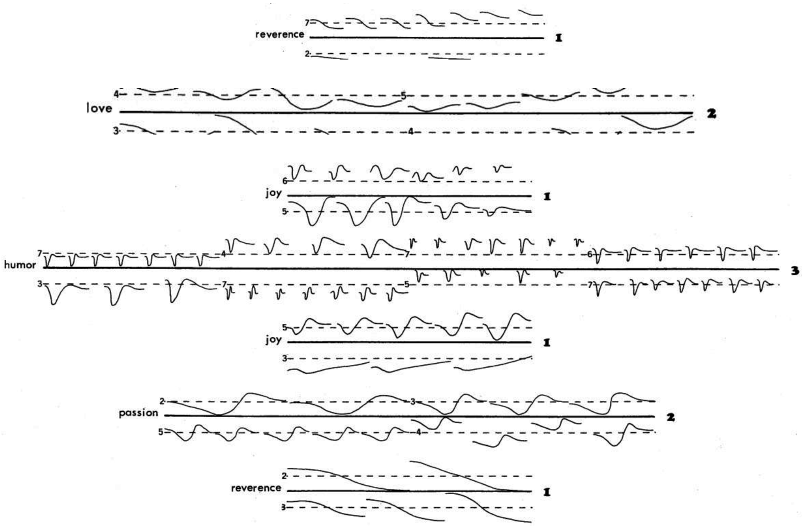


Figure 6. Score page from *In the Beginning: Etude III* in which *sentic waveforms* associated with various emotions and thought to be fundamental in the brain's feature processing are drawn on time vs. pitch height graphs; numbers indicate proportions for duration and gesture rhythms; score could be realized in almost any performance medium.

Musical notation can, thus, be pliable, flexible, interactive, and adaptable to contexts. The signifiers of notation can be adaptive and not regarded as fixed artifacts. Message designing for ETC might benefit from considering content that is less iconic and fixed in meaning than has been used in the past. In a marvelous treatise on notation (Gaburo 1977), Virginia Gaburo describes musical notation as a constantly changing, living, entity in which the generalized identity of things is derived moment to moment only through "that which is agreed to be significant by a particular linguistic community." That is, notation acquires its functionality and meaning through communal, co-creation.

More about time and how music can help

Psychological context of time in music

Music is an art form in which time is manufactured. Music is not *of time*, —though it is thought of as a *time-based* art form —, music *creates* *time.* Temporality is a domain of expression about the relationships we perceive among distinguishable entities that involves memory—the coagulation of successive experiences—like mass is a coagulation of time-space.

Musical manipulation of perceived time

Music manipulates perceived time (Epstein 1995). Time delays and phase shifts in human action synthesis and physical reflexes, —a vast persistent structure that attempts to maintain, refine, and strengthen itself through repetition —, helps structure time as musicians experience it in performance (Kelso 1995). The brain's cerebellum is heavily involved in learning musical action algorithms and giving them temporal order. The temporal fine structure of its highly parallel, computation capacities is tuned and ordered through practice and is subject to the limits of processing delays. These delays help separate events in succession.

It is hypothesized that there is a temporal fine structure in the brain limiting the speed with which successive perceptual chunks can be processed (Epstein 1995). Various theorists have used values in the range of 20–40 milliseconds, with 33 milliseconds gaining a certain preference by some. As we examine how perception and learning function on increasingly extended time scales, we find that both operate similarly across a wide range described by *power law scaling,* which means they have *no characteristic time scale* (Kelso 1995). For example, typically, when a person listens to a repetitive stimulus, perception initially locks to that stimulus, but eventually shifts intermittently. Kelso found that the time during which such a percept is maintained in the brain before it switches to another can be described by a power law relating the duration of this event to the number of times it has occurred, and that this applies over several orders of magnitude. Experiments with an even greater range of scales may be in order. Through malleable time forms in composition, musicians work actively with these processing limits and scaling factors to change intuitions about temporality, duration, and speed. Varieties in speeds are used to change time perceptions and establish dramatic structure. These speeds evoke emotion- thought feedback processes encouraging assignment of *meaning.*

The fine structure of the musical present

Large-scale time forms emerge from concrete details at smaller scales. These details are calculated in the brain, which makes decisions about the order of things on many scales (Austin 1998). The decisions may or may not correspond to the order of events inferred by other observers. Many factors are involved in constructing *time capsules* associated with what is called the *psychological moment*. These are intimately tied with developing a concept of *self*. The image of self requires a sense of temporal order on the short-term scales of perception and the long-term scales constructed in association with memory. The brain receives energy activations from the senses, parses these into potentially useful units and, then, proceeds to construct a sequence ordering for these units. It is important to emphasize that this is constructed, *emergent time*. Time is inferred from things, and this is critical to the development of a self-image. Other forms of intelligence, which may have different means of constructing self-images, may have radically different relationships to time.

Our experience with both the temporal *present* and *musical moments* have detailed fine structures. We think of tangible, temporal forms often as being teleological. They are directed toward target goal states. Extension and prolongation create durations, which support this. Duration gives us a measure of difference. However, a musical piece is a time-space construction that does not require a global background. It establishes its own internal structure as a succession of time capsules within configuration spaces. In communication, these are co-creative instants, recognized in particular manifestations of each now. Each has its own fine structure, consisting of its own past, its own present, and its own future. In other nows, this fine structure is completely different. Different constructed pasts and projected futures distinguish different nows. Musical pasts are synthesized in memory and are strongly related to forms existing *out-of- time*. Creating a past is part of skilled musical practice. It places the present in the context of a constructed past. Correlations over past time coupled with directional predictions create each particular, projected future, which resides in each moment. Our information and correlation systems enable prediction, expectation, and by extension, confirmation of predictions or disconfirmation and surprise. These are all part of each now (Figure 7). [Consult (Jantsch 1980) for an insightful description of the fine structure of the temporal present.] Our models of entropy and correlation provide analytical tools and give directionality to what we call experience (Lindgren 1991)

Memories are filters, but possibly not always *in-time*. They are also not absolute or literal records, but means with which to synthesize experiences that somehow contain coincident structures with other recognized experiences, but again, maybe not *in-time*. Memories are that part of who

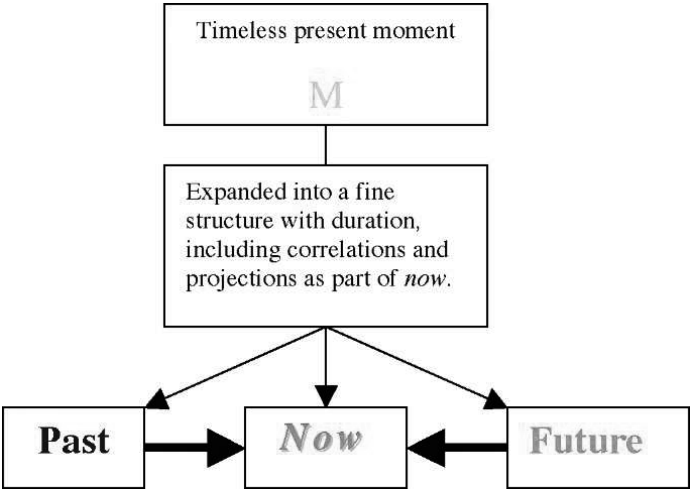


Figure 7: *Fine structure* of a temporal present, a now; see (Jantsch 1980) for elaboration.

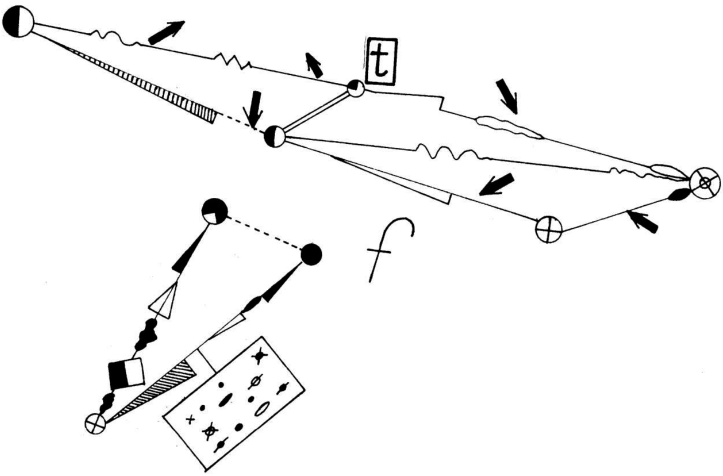


Figure 8: Notation excerpt from *Golden Gestures* (Rosenboom 1984), showing a phrase or gesture that can be oriented in time-space in any way and realized by any performing forces; adaptable symbols are defined in the score according to a system for describing the beginnings and ends of events and how they evolve through the course of their duration.

we are today (now), which we choose to label as belonging to a concept we synthesize and call the past. That's also how we create perceptions of musical forms.

Some musical forms are not tied to an arrow of time. In these forms, correlation doesn't automatically imply *cause.* Some are symmetrical forms that do not change when we change the temporal direction of executing them (Figure 8), some are entirely cyclical with no beginning or end (Figure 9), and some are forms made available to be scanned in a wide variety of ways (Figure 10). These interpretive actions *collapse* the forms into a local temporal arrow upon realization in a particular performance.

As unseen presumptions about time can limit our potential experiences of music, hidden predictions imbedded in ETC message design may also become problematic. It is very difficult to avoid them.

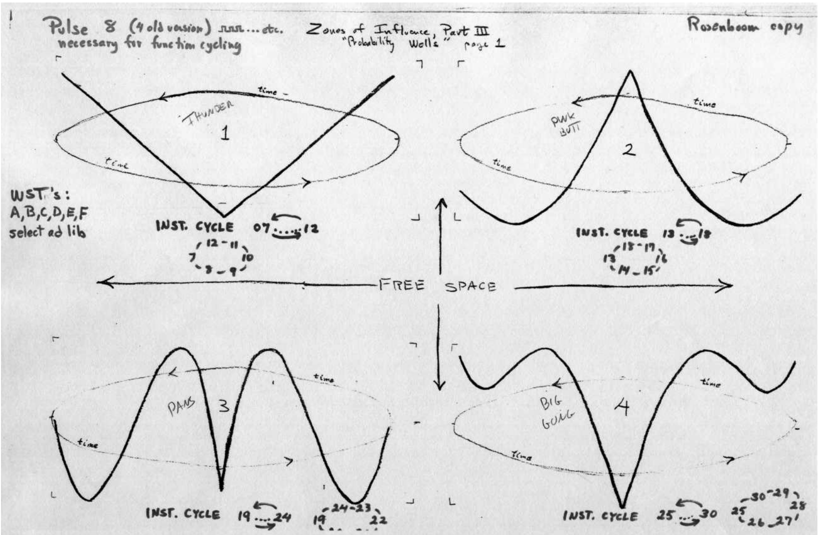


Figure 9: Page from manuscript of *Zones of Influence, Part HI, Closed Attracting Trajectories* for percussionist and interactive, computer music system (Rosenboom 1983–1984), depicting an array of endless, cyclical functions that tell the performer how probabilities change in the way the computer system may respond to what (s)he plays.

A section of extreme range improvisation—play within a „moving window" of seven notes, starting with the first group of seven, then dropping the first note and adding a new one. and so on throughout the part. Make the improvisation with these note groups. Move the window at will, staying fairly close together, but not coordinated. Look for lines, linear streams within them. Select noes from chords at will. Each chord counts as one note within the window. Play the notes that are in your range, don't transpose. Cello has the option to improvise freely against this, out of time, as a solo line. The curves in each cell indicate fluctuations in speed over an extreme range. Always use these in articulating each group of seven. When moving into a new cell, adopt the new speed curve and dynamic. These should produce a commonality in gestures, a kind of tempo melody articulated by all. but not synchronously. Percussion may add non-pitched instruments, but stay within the time structure. This should be very energetic, even when soft.

Naked Curvature, Part 5.2: *Sevens Transfoarmations* David Rosenboom

Figure 10: Score page from *Naked Curvature (Four Memories of the Daimon)* (Rosenboom 2001) for six instruments, whispering voices, and interactive electronics, showing array of pitch materials to be scanned by each performer through a moving window of selections; curves show tempo melodies, gestures of speeding up and slowing down, with which each performer articulates their window's time frames.

Communicating the current state of our understanding about time as an integral part of message construction

Engaging an ETI with our understanding of temporality, possibly through interactive, co- creative, emergent process of communication, may be fundamental in revealing our nature. The more we contemplate this, the more it seems time does not flow like a river with us riding upon it. We, and everything else, create emergent time with every fluctuation of energy or essential, elastic tension with which we are associated. Music is a perfect medium within which to explore how we cognize time. We live daily with our concept of years, relating only to our spinning Earth, and our physical-mental programs giving everything order and succession in this local context. For an ETI there may not be a correspondence of reality with the succession of events emanating from sequential algorithms, whether they are embodied in organic structures or computers. We are organisms whose particular arrangements of the congruent quantifiers of EMTS compute a self-contained image of time through transience. It may not be a reasonable assumption that other localizations-local concentrations—of life would be constructed so as to manifest the same invention of time. The time problem in ETC is also entwined—entangled— with the meanings of absolute scale and the meaning of distance. Space may be one of the qualities we use to separate the simultaneity of all experience into non-simultaneous events and could be an illusion as much as time. It certainly seems to be a primary metaphor for distinguishing things and enables change to be understood metaphorically in terms of motion (Lakoff and Nunez 2000).

Some musical forms attempt to squeeze distances together in perception and cognition, resulting in simultaneities and meaningful coincidences among events that would otherwise be viewed as distinct. Some of the mechanisms involve fusing elements in perception by psychoacoustic means, resonant coupling of otherwise separate systems, exploiting unpredictable, opportunistic, rhythmic (time) coincidences, and other associations that are instrumental in perceiving forms. I and other composers have experimented with collapsing spatial distances by means of highspeed telecommunications or by exploring means for coordinating concurrent, physically separated performances with notations or instructions that allow for open interaction with what musicians *imagine* to be taking place in each location. Then, different mixtures of the resultant music may be transmitted to the separate locations. The musicians may later compare their experiences.

Creative co-communication may be comprised of co-creative instances recognized in the resonances occurring among all distinguished entities in any *now.* A fibrous view of time-space emerges in which networks of resonant couplings manifest independent, localized time-spaces for each coupling, replacing the need for a global, background reference field

(Figure 11). Each of us may be individually comprised of and determined by configuration spaces for the entire universe, manifested from each particular, unforeseeable point of view through such resonances. Since each has a different experience, a different now, what we think of as temporal realities are individually synthesized. Of course, a timeless view of physical reality requires a complete reconsideration of gravity. In combination with timeless quantum theory a surprising picture emerges. Probabilities only come into play because when the wave field equations are applied to a timeless configuration space, —an abstract but not featureless space, not including time, but linking the dimensions needed to describe relationships among differentiated things and to produce simultaneous possibilities for any now—, a differentiated observer who is also part of the whole thing must have a way to choose just one of these possibilities. Gravity, being attractive, but also possibly in a counterpoint of tension with dark energy, becomes a source of the otherwise highly improbable order we see all around us in nature. Entropy would otherwise make such order

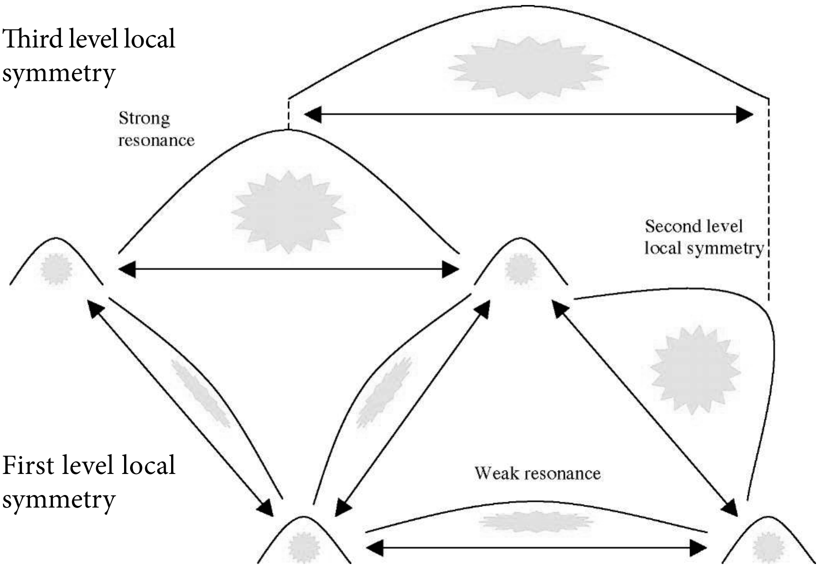


Figure 11. *Fibrous nature of time-space:* relationships created along network of imaginary lines connecting differentiated local symmetry systems with strong or weak resonant coupling; web of connections on different extents, each manifesting its own, local, time-space, replaces concept of global background field.

unbelievably unlikely. Another idea is to view space and its physical limits — (ex. maximum speed for electromagnetic motion)—as a kind of glue—an EMTS stickiness again—that binds things together through a set of rules (Barbour 1999) that are purely cognitive inventions. Of course, it's terribly hard to describe what can appear to be a clear vision of this. That's part of the art and practice needed in ETC message design.

Within a model of the universe wherein absolute distance has been eliminated, and consequently, absolute size has no meaning, communication over large time-space quantities may be psychologically manageable and the natural way of things. The cognitive logic we use to handle succession among events would be different, however. A shift in consciousness necessary to absorb this—with hard inner work—would also be required in order to grasp the naturalness of the new kinds of content such communications may carry. At present, I know of no other way to arrive at this than by application of hard inner work on understanding the vast part of our consciousness that is so much greater in extent than the much smaller, thinking and interacting mind on which we normally rely. Here, *greater* and *extent* apply to aspects of consciousness for which we struggle to find a language of description. It is our apprehension of our self—and the metaphors we use to describe it—, our consciousness of our consciousness, in turn apprehending the world that produces the soil from which the *laws* of physics grow. Thus, they will always be limited by the extent of our own self-knowledge.

The problem of concrete forms in communication

Meaning plus structure produces form. Isn't it interesting how each generation and culture finds its utterances, words, to connect with emotions and feelings. We witness the development of language all the time; a kind of *emotional syntax* is developed to go with semantics and the binding of structure with feeling.

In the 1950's, Charles Osgood and collaborators developed powerful techniques using multidimensional scaling to create maps of the internal semantic structure of individuals (Osgood 1957). These explored how *signs* can become related to their *significants*. Combined with parallel developments in methods for evaluating the content of messages, particularly those in the media, (Pool 1959), effective tools for exploring how meaning structures are formed were created. They also underscored the degree to which seemingly fundamental assignments of meaning within individual languages can vary across individuals. We can construct relationships of signs to significants, as in composition, and these relationships can be developed through associations. Consideration of how meaning may be attached to pictorial components in interstellar messages has been given in (Vakoch 2000).

The requirement of **concurrent imagination** *for the recognition of signs and labels*

For ETC, this points up a problem with sending signs of things. To accurately represent an object, the communication object must be the *thing* itself, rather than a sign of a significant. The sign and the significant are distinct. The sign is illusory. The relationship between them has to be imagined. Communication, then, only takes place if the imaginations of the various parties in communication are the same. For human beings on Earth, this may not seem important. For intelligences that could be vastly different from humans, it may be a serious matter. Different intelligences may attach different meanings to *things themselves,* of course, further exacerbating the problem of relying on signs.

An approach to correcting the problem might be to imbed the thing being communicated about inside the structure of the medium of communication. Music involving emergent processes may provide examples. The forms that emerge from these processes are the things themselves. No frozen representation of signs, such as musical symbols, could represent the object. The essence of music like this lies in being immersed in an emergent, dynamical process with all its attendant layers, which may include opportunities to apply particular meanings and drama to the generalized forms. The process is offered to others as an invitation to experience the object in interactive, co-creation, not in a set of fixed signs requiring referential speculation. A principle of extreme importance in message design is to recognizing the individual synthesis of apprehensions, perceptions, and understandings in the recognition of signs.

Relationship of this to the incommensurability problem

The problem of interpretation of signs and the problem of their requiring *concurrent imagination* among two or more beings for mutual understanding is directly related to the much discussed *incommensurability problem* in ETC (Vakoch 1998). A challenge for ETC message design is to overcome hidden requirements for and presumptions about mutually understood views of reality among senders and receivers before any understanding to take place. Nevertheless, as communication develops, it may be important to build some consensus views that incorporate both those of the senders and receivers. A possible solution may be to send dynamical objects that unfold, not icons. Make the dynamical objects interactive so that their evolution is co- creative and both parties share in the results. Make the dynamical objects model the state of our understanding about evolutionary succession and the emergence of time-space. For example, interactive, evolving automata with variable time-space scales and outputs synthesized in displays covering wave spectra from very long times to light frequencies and beyond might be an approach worth considering.

The two-way-ness of communication

Communication requires two-way co-creation to exist in any form. Communication is a form of relatedness and an interaction that brings about new forms. The emergent forms of our culture provide many examples. Even large-scale, cultural forms like cities can be thought of as emergent patterns in time, an aspect of hidden order (Holland 1995). It could be that merely by existing in the context of our large-scale environment of the universe we may already be in communication with more than we know, a state of mutual inter-affecting over large time-space scales. Time-space limitations may constrain our conscious apprehension of this within short life spans. For ETC, we are better off not sending labels, but rather, sending processes that unfold and invite response. Labels rely on the coincidence of imaginations and are one-way. We could draw on the two-way music of active, co-creative processes in ETC.

Practical steps

The time bases of information patterns contained in electromagnetic spectra from other intelligences could be very different than our own. Intelligence may exist on a wide range of time scales. Perhaps, we should be doing long-time-base correlation studies in SETI listening experiments. The enormous capacity for archival storage of signal information required in very- long-time-base correlation studies may require cooperation across long-time-scale cultural lineages. This amounts to making the search a cultural tradition to be maintained. We must be able to develop trans-generational, cultural ownership of SETI in order to be ready—on both our own and ETI's evolutionary time scales—to participate in ETI interactions.

Forms of information that become increasingly separated, in reference to the local time scales associated with the biological concentration of the observer, may seem unlinked. This may not be the case. We must develop the ability to imagine links when the separation is much, much greater, and then imagine drawing all the separated forms of information back together, possibly creating a total simultaneity, in which everything is linked. This is a mental exercise in opening the doors to refining our analytical skills. These speculations and observations lead to a selection of ideas for practical steps in considering ETC message recognition and design.

Interactivity

The value of composing messages that encourage active involvement and co-creation by the recipients

Examples of co-creative, interactive music systems abound. Many that employ electronic media are described in (Chadabe 1997). Co-creative strategies emphasizing improvisation and including interacting species are described in (Zorn 2000). A section on interactive music in (Gann 1997) describes several of my works, including *Systems of Judgment* (Rosenboom 1989a), which make use of compositional *concept spaces,* in this particular case, mapping several views about the evolution of language and how they interact in the emergence of the compositional form. This is shown in Figure 12. The idea may have a bearing on possible message designs.

Other works I've written, also described in that text, involve environments for improvisation and organically grown music from seeded plans that are animated in performance. Various postCage' conceptualists in America, for example, the Sonic Arts Union, David Tudor, Richard Teitelbaum, George Lewis, and many others have employed interactivity as an energizer of musical evolution and the field is very broad and vigorously active. These examples underscore the value of communicating by means of co-creative processes. The results produce shared experiences that emanate from all the linked parties and do not depend upon one-way transmission of icons or signs, which are hard to interpret because there is no co-ownership.

Time-space scales of interactive processes

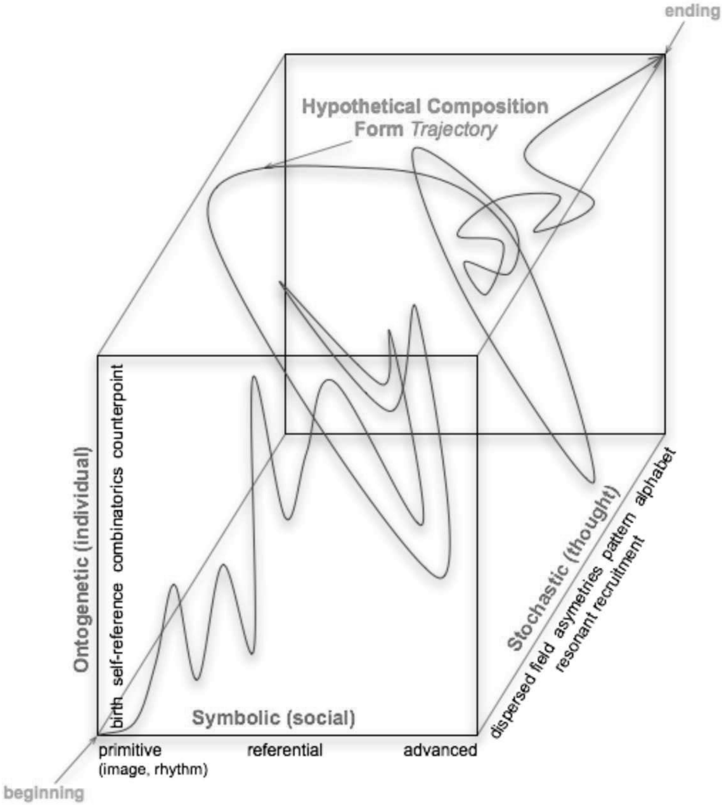


Figure 12. Example of musical concept space depicting top-level organization in *Systems of Judgment* (Rosenboom 1989a); three ways of viewing the possible evolution of language are shown on three spatial axes. Compositional form moves in time along *composition form trajectory,* mixing music that is symbolic of the three views in different amounts to produce the final composition.

Again, the time-space scales required for ETC interaction may be large, larger than our lifetimes. Consequently, we may not have been looking long enough at this point in history to know if some ETC interaction isn't already happening. Perhaps, though, our collective consciousness can be much larger than ourselves as individuals. To bring things into our individual, time-space scales, so that we can know that something is occurring in a particular *now,* involves employing a *distinguished simplifier* (Barbour

1999) to collapse a configuration space into that now. Most of the time, that distinguished simplifier is our own self-reference. To keep in our minds some idea of distance scales in the universe, the size of a super-string is about 10^{-33} centimeters, and the size of some of the more distant galaxies we've studied is about 10^{26} meters (10^{10} light years). Within our own brains, the size of a neural synapse is about 1 micron and the cortex is about 30 centimeters across. A transformation of consciousness may be needed to enable us to conceive life as substantial and mentally palpable on a larger range of time-space scales. The small-scale, local individual may be maintained as an energy source to fuel the broader, vaster consciousness without loosing the distinguished individual.

Information may also be packed into tiny time-space scales. A general principle suggests that the smaller the dimensionality and time-space scales of a physical phenomenon the more energy or essential tension is packed inside that distinguished entity. It is thought that unimaginably huge amounts of energy are packed inside the tiniest super-strings. This may also apply on communication-information dimensions. If the parameters of an energetic impulse can be known with enough precision, their values can encode large amounts of information. Thus, the parameters of a singularity could contain enough information to model a universe. Interactive music constructions, particularly those involving networked interactions over long time-scales along with those involving micro-sounds (Roads 2002), can offer help in extending our normal range of apprehensions.

Music of participatory forms and interactions in time

Thinking within the confines of communications initially limited to electromagnetic field transmissions, participatory forms of music involving message completion come to mind. Recipients could be invited to participate in extending open-ended, incomplete patterns or fragmented images with multiple possibilities for co-creative completion. First, an incomplete pattern would be sent. Next, suggested ways to extend or complete the patterns would follow. Then, more beginnings of incomplete patterns would be sent to invite recipients to join in by inventing ways to complete them. Communications with rhythms would be particularly appropriate. Patterns could be sent and, then, subsequently elaborated in modular fashion, in the way composite rhythms are often built up in African drumming, Latin American rhythms, Indian music, and some kinds of contemporary Western percussion, for example. Then, basic patterns would be resent, inviting participatory elaboration. Such things are easy to compose and might provide good, beginning steps towards interactivity. Drawing on the many cyclical, gradual process, musical forms from the past half-century or so, patterns with delayed, recombinant time forms could be composed for ETC, suggesting how patterns could be recombined with themselves by the participants to extend the structures they receive.

Making use of inherent delays in recombinant forms could illustrate the idea of creating communication *mass* analogous to the time-space stickiness underlying the emergence of substantive forms. These could also lead to illustrating emergence by means of resonance with delayed waveforms, in which selected harmonic components are reinforced or reduced during recombination. As noted before, waveforms are ideal for imbedding message content in the structure of the communication medium. Harmonic structures, timbres, tonalities, and tunings may illustrate a host of fundamental physical principles, as we understand them. Musical drones—which are never really static—could be sent with information imbedded in the structures of their moving overtones. These should not be thought of as limited to the time scales of acoustic waves on earth. Rather the waveforms used should cover a very large range of time- scales. Perhaps, harmonic fundamentals, or the longest possible waves in a structure, could be chosen according to the physical aspects of local star systems, target star systems, or even to the dimensions of possible, closed forms for the universe, (perhaps, a toroidal form folding back on itself).

Messages could be constructed inviting recipients to participate in elaborating pattern combinations by inserting additional material in rhythms (hocketing), adding accompaniments, or adding new material to existing accompaniments. Harmonies built of basic waveform types with sequences could also be constructed and sent with beginnings, completions—like cadences — , and then, more beginnings with open-ended possibilities for continuing the sequences. This might lead to similar experiments with language forms, mimicking natural language learning paradigms. Messages containing gesture shapes in time, perhaps encoded in waveform structures may provide important content. These shapes may also be transformed and recombined to illustrate the origins of language. Interactive versions of gesture transforming systems could be devised as well.

Experienced performing arts teachers often work by: 1) demonstrating, 2) waiting for imitation, and then 3) continuing to perform with the learner. Message paradigms drawing on this well tested, interactive, pedagogical technique could be developed. Message completion might also be one way to work with visual forms, perhaps drawing on examples from biological morphology. Such forms could be sent first in complete form and, then, in incomplete form, inviting speculation on possible evolutionary outcomes. All of this might also take the form of *play,* playing with ETI in a grand improvisation. After all, playing is one of the most important forms of interactive, human learning.

Music of emerging forms and interactions out of time

Examples of Internet-based art and music hint at extending the scales of forms of interactivity. They also emphasize *many to many* communication paradigms, interactive communication among groups of participants, in addition to the familiar *one to one* models we tend to emphasize in engineering and psychology. Some practitioners have found that when participants work together on collaborative projects by interacting with tangible, co-creative, emerging forms, the results are more fruitful than when individuals work with their separate, computer-based production tools, even though the outputs from these tools can be shared (Popat and Smith-Autard 2002). Possibly these make for more open and longer time-scale, human-to-human interactions (Hinkle-Turner 1999). Abandoning the idea of the temporal river that flows, a multiplicity of relating forms seems to drive the emergence of time in several Internet-based music systems, titled *Cathedral, Integer, FMOL,* and *Telemusic* (Tanzi 2001). The scaling of listening times in these musical examples can assume dimensions suiting individual, interactive situations and are not artificially bounded. Temporal reasoning is not driven by any pre-imposed structure. Interactive music in this form becomes a landscape of multiple possibilities and opportunities. Musical configuration spaces, often used in out-of-time musical notation, could be recast in interactive, electronic form such that the recipients could collapse them into realizations with co-participation. The observers or message receivers in the case of ETC would be able to create their own realities within a co-evolving system of this kind and, thereby, learn its characteristics. These very characteristics may, indeed, be *the message sent!*

Scales of biological information processing, linked events, and the brain

In his analysis of dynamical patterns in self-organizing systems, Kelso stresses the conclusion that linkage between coherent events at different scales of observation is by virtue of the underlying, shared dynamics that produce them (Kelso 1995). This suggests that correlations and covariance observed on a broad range of scales may result from common, underlying phenomena. It is also suggested further that it may be possible to derive clues about broad-scale, temporal-spatial, co-creation in ETC on various individual scales of extent. The time scales of information processing in the brain range from about 1 millisecond at the level of the synapse to about 200 seconds at the level of the cortex, extended, of course, by memory to encompass the lifetime of the organism. We may also speculate on the information processing time scales of the biomass. Clues to self-organizing dynamics may be found at any particular level of analysis. Patterns created by oscillations generally result from collective phenomena and the significance of oscillations do not become apparent until they are coupled or temporally correlated with other events on various scales. This is seen in tendencies towards phase locking and frequency synchronization reminiscent of resonant phenomena. Kelso also observes, however, that power law scaling is typically a sign of long-range, temporal anticorrelation, emphasizing the variation and adaptability of phenomena needed on an event-to-event basis to keep systems from becoming inflexible. Degrees of correlation on various spatial and temporal scales reflect this as well.

In order to design forms of communication applicable to an extended range of time-space processes, we need modeling tools that also apply over an extended range of interacting, local and global phenomena. Recently, new local/global, dynamical theories of brain function have emerged in which distinct, but interacting, local processes drive bottom-up, macroscopic, global dynamics observed in electrical brain activity, and global processes arising from functional integration facilitate top-down, synchronous activity in cell groups simultaneously on a range of spatial scales (Nunez 2000). There are striking similarities among concepts that can be applied to pattern analysis on the scales of neurological functioning and those that may also be applied in SETI and ETC. The brain and the universe are, after all, massively coupled systems, our observations of which tend to be on different time scales. Since they are both made up of EMTS, however, they may be coupled on all time scales. The language of pattern-forming, dynamical systems could become part of a language for co-creative communication.

Participating as entities on relatively small local scales of duration and extent in processes involving relatively larger scales of recognized interaction—communication

Relativistic thinking about communication may apply equally on all time-space extension scales by adjusting the life-consciousness extension scales in a similar manner. The impact on communication-relatedness of relativism at small scales for high-speed phenomena—like an electron spinning—or short life-span, consciousness extensions—like a mouse running—may be just as great as for slow-speed, long life-span consciousness—like human beings, elephants, the biomass, species, cultures, distributed intelligence, interstellar cultures, or universes — , engendering similar effects. Some suggest there must already be emergent phenomena at the level of the universe from the existence of a multiplicity of distributed intelligent cultures in the inter-stellar medium (Wolfram 2002). If so, Earth-based cultures are a part of that, too.

Our co-evolution with other forms of intelligence in the universe can certainly be expected to take place eventually, or it may already be taking place. We humans, currently from Earth, seem, by engaging in exercises like this investigation, to be trying to increase conscious awareness — memory coagulation—of our ongoing relatedness to and participation in the processes of evolution in the universe. There are many neurons in our brains the behavior of which we don't understand; there are long sequences in our DNA code the function of which we don't understand. Attempting to engage in ETC is presently a behavior trait for some humans. In other words, this exploratory activity can be seen as characteristic, human species behavior in relating to other intelligences in the universe. In a sense, we are engaging in an anthropological study of ourselves, as the time-space extension of our cognition grows ever larger.

Covariance as communication

Signals extracted from noise, because some covariance with an observer has been detected, may correspond to messages. If confirmed, they will develop meaningful correlations through interactive co-creation, a further kind of covariance between two or more systems with their own, individual reference frames. However, it may be worth pointing out that regularity in the carrier signals used to encode ETC messages reduces the rate with which information—in the mathematical sense—can be imbedded in the carrier. More complex signals offer more ways to compact information by modulating the multiple waveform components that may be combined to make up the carrier with information in the message. This, though, results in a signal that looks more complex to us and more easily confused with purely uncorrelated noise. Signals nested inside signals nested inside signals compact information. One way to unpack them is to use complexity dimension analysis. This has been applied in music as well, for example in my composition, *Two Lines* (Rosenboom 1989b, 1995, and 1996). This piece is an examination of apparent instability and how the fine sensitivities of the ear can detect hidden order inside very complex patterns, which, at first glance, may appear to be noise-like. The perceptual powers of the auditory recognizing system are phenomenal in this regard. (Complexity dimension analysis is a technique used in studying chaotic systems and involves calculating the correlation dimension of a time series, roughly the number of dimensions required to describe the behavior of the signal. Highly complex signals, like stochastic sequences, require many dimensions, while more simple and regular ones require fewer dimensions.)

In the 18th century, Roger Joseph Boscovich described a kind of relativistic covariance focused on the internal motions of the parts making up the observer, leading to the conclusion that the observer exists primarily on the interface or boundary between its macro-form and the universe (Rossler 1991). Poincaré conjectured that the makeup of the internal parts of the brain must contain a group structure that is coincident enough with the order of the component parts of the universe that knowing the universe will eventually become a natural characteristic of the brain. Only a sufficient amount of inner exploration producing self-knowledge would be required. Perhaps, there is a potential, embodied calculating engine of such immense power in us that what has become conscious so far is only a mere hint at what is to come. This engine may involve correlations among the component parts of the brain with the component parts of the universe, to say nothing of groups of brains.

Such speculations have led to a suggestion for increasing our capacities in ETC message recognition. The suggestion may sound outlandish at first, but may be worth contemplating for whatever useful spin-offs it may engender. Following the composition, *Two Lines,* a second experiment involving a composition called *Four Lines* (Rosenboom 2001a) was carried out, in which comparisons were made between the dimensional complexity of the temporal sequence of brain event-related potentials (ERPs) generated during work with the *On Being Invisible,* self- organizing, music system described earlier, and the dimensional complexity of electronic sounds created at the time the ERPs were recorded. Interesting correlations were observed.

This followed a study described in (Birnbaumer et. al. 1996) in which the dimensional complexity of brain signals was correlated with the dimensional complexity of music heard by active listeners and processed by their brains. Their experiments explored what is known as the *non-linear resonance hypothesis* of music perception in which relationships are drawn between the complexity of music stimuli, the complexity of observed EEG waveforms, musical training and experience, and the presumed activation of neural assemblies necessary to process rich associations. The complexity of EEG waveforms and music stimuli were strongly related, but also strongly affected by the level of subjects' musical training and experience. Nevertheless, for experienced, active listeners, a coupling between EEG complexity and sound complexity is strongly suggested.

At this moment, a widely distributed array of perhaps thousands of computers are probably processing radio telescope data from the SETI@home project, http://setiathome.berkeley.edu/, all looking for patterns in these noise-like signals from space. Perhaps this is not enough analytical power. Suppose these signals were presented in sonic form to highly experienced, open-minded musical listeners, while complexity dimension analyses were being carried out simultaneously on these signals and the electromagnetic brain activity of the listeners, perhaps via multi-channel EEGs or magneto-encephalograms (MEGs). Variations in the correlations among the analysis of each might lead to clues. The listeners need not achieve conscious awareness of the results. In fact, it might be better if they were not encouraged to do so. Too much consciously directed, focusing of attention might reflect a priori presumptions about listening and result in some possibilities being filtered out. Better, perhaps, that the experimenters allow the brain activity be simply coupled with the signals and freely influenced by them. Perhaps the proper state for the listeners would be that of alert, zazen meditation. Given how good the brain can be at discerning subtle differences in complex arrays of musical sounds, and given how many very large computer programs have been debugged in the history of computing by listening to the bit streams of program readouts and finding the anomalous patterns of malfunctions that couldn't be found any other way, it might be worth a try.

Large-scale physical processes

It is intriguing to imagine what kinds of large-scale physical processes beyond methods known for using electromagnetic fields could be taped for ETC. Ideas about *resonance* are important here. They are fundamental and familiar in many musical processes, and their conception extends well beyond the usual notions of acoustic or waveform resonance. Ideas about resonance described as the *topological coupling of influences* in interactive processes (Thom 1975) and informational coupling via *mutual information* measures have been applied in music (Rosenboom 2000c). Mutual information, —a measure of the complexity of computations required to compute a phenomenon from information already known in a prior phenomenon—, has particular bearing on evolving life forms as well (Chaitin 1970, 1979, and Casti 1991). In this arena, a complex interdependency among the parts of a distinguishable entity—like an organism—, modeled partially through this concept of mutual information, is essential in defining a living organism. Furthermore, Chaitin writes, "In summary, the case is the whole versus the sum of its parts. If both are equally complex, the parts are independent (do not interact). If the whole is very much simpler than the sum of its parts, we have the interdependence that characterizes a living being."

Here are some speculative questions intended to stimulate thinking. Could a signal be designed that would resonate with the configuration space of a galaxy or cluster of inter-stellar objects in the environment of possible ETI? Would it be distinguishable from the physical configuration itself? Could this resonance maintain the signal for a period of time and support modulation by message sequences, such as patterns derived from human DNA sequences. Could electromagnetic field transmissions be made self-regenerative, renewing themselves by borrowing energy from other encountered fields—gravitational, electromagnetic, black hole spaces, or stars? Could resonant tuning among fields produce a kind of coherent universe laser or maser? We might call it a *user.*

Could an electromagnetic reaction-diffusion reaction be generated with the Earth's magnetic field—a strong one would, in turn, affect the Earth—resulting in a strong transmission field for messages? Could such a field be modulated with DNA sequences? If the wild speculation were true that message sequences from possible ETI could already be imbedded in our DNA (Wolfram 2002), why not send them on outward again? If no message is so imbedded, why not send it on anyway? Can these resonance models lead to understanding possible communication through morphic fields, perhaps modeled by arrays of coupled oscillators (Abraham 1996a, 1996b, and Goodwin 1991)? All this is meant for brainstorming possibilities without a priori limits.

Implications of a point of view that considers entities communicating are already in interaction prior to sending or receiving messages

The extent of the unconscious and its types is most likely even vaster than Jung communicated. Since consciousness is an emergent, localized phenomena in individuals rising out of the interactions of a critical mass of subordinate parts of the unconscious, the unconscious, too, must be imbued with the natural forms of the universe and the processes by which it has formed. These may be accessible to consciousness if it can visit and interact deeply and actively with the unconscious substrate. Knowing one's self therefore may indeed, result in knowing the universe. The depth of this return of the ego into the unconscious mist is great and the work involved vast. This kind of work is needed for us to be able to evolve our physical and mathematical metaphors

further, understand the meaning of communication better, deal with large time-space scales (Smolin 1997), and learn to relate to what is individual and what is universal in intelligence. As we learn more about thought itself as a system (Bohm 1994) with observable dynamics we understand more the place of language, with all its flexibility and plasticity, in the work of disciplines like physics, which function more like a dynamical system of communication about reality than a representational form for that reality.

Principles for constructing interactive processes— music of many *nows*

Here are a few guidelines for constructing interactive proceses:

- Consider all interaction to be a process of co-evolution of autonomous agents with each other and their environment, the procedures of which lead to emergent order. These are potentially best implemented with an adaptive network structure (Kauffman 1993 and 2000).
- Begin with procedures that return to first principles of composition: 1) choose the universal set or domain of compositional attention and the kinds of distinctions that will be made as a result of compositional thought and choice; 2) list the potential generative relationships among distinctions in the universal set, i.e. how it will be ordered; 3) determine the dimensions of description and scales of measure for parametric

values to be used; 4) determine the levels of significant difference for each parameter; 5) design the compositional pragmatics needed to make arrangements among the distinctions in the universal set. [See (Rosenboom 2000c) for further description of this approach and (Rosenboom 1987b) for compositional thought exercises in *intuition, context, purpose, unison, listening,* and *intelligence*.]

- Consider *interaction states* as communication and compositional objects, i.e. each condition and/or mode of interaction becomes an element for compositional design. An example could be a particular relationship of a musician—or an ETI — to an artificially intelligent instrument (Rosenboom 1992a).
- Make messages be *in interaction with* versus *in response to.* Acting upon or in response to something like a message engenders illusions of self-localities as central in interacting, rather than as part of a larger process. Note that an individual inter-acting with something else is different than two or more things interacting, just as a process that is information is different than objectified information units. These are points of view in our use of language, always good to keep in mind.
- Consider all interactive processes to have many *nows,* many versions of the present.
- Initiate co-creative processes by: 1) send intention, invite into co-creative participation; 2) send messages with delays designed over long cultural time frames and consider interactive messages to be recombinant as they come in; 3) consider and make interactive responses; and 4) examine the co-creative forms that emerge.
- Consider the necessary cultural evolution as important as technological evolution for this to work with our species.

Potential of genetic algorithms and neural networks in message design

Communicating by employing hypothetical models of evolutionary processes may offer a fruitful approach to co-creative message design. An excellent introduction to the principles of genetic algorithms (GAs) can be found in (Mitchell 1998). GAs and *connectionist* models with neural networks have been employed in music for some time (Todd and Loy 1991). Of particular relevance to our discussion of time-space are experiments using neural nets in *quantizing musical time—i.e.* separating discrete and continuous components in the experience of musical time. GAs are often used to interactively explore the very large parameter spaces commonly encountered in computer models for musical sound synthesis, algorithms for composition, simulating adaptive, musical, perceptual processes, recognizing unpredictable, physical gestures of performers, and creating somewhat autonomous musical organisms (Degazio 1997).

One of the problems of open, interactive interface designs for music performance is that the possible vocabulary of performance gestures cannot always be known in advance. This seems analogous to the co-creative interaction paradigm involving an unknown form of intelligence encountering a dynamic object sent as a message. GAs have been successfully employed in the classification and estimation of parameter values involved in gesture movements and adapting musical instrument responses to them (Lee et. al. 1992 and Lee & Wessel 1992). In this work, neural net structures in a computer music program were able to learn gestures and link them to multi-dimensional mappings of perceptual spaces for musical timbre, providing data to guide a synthesis engine. This linking of gestures to multi-dimensional perceptual spaces could be adapted to interactions with other life forms, as it often is in compositional concept spaces in music (Rosenboom 1987a).

Ideally, these interactive processes can be made worthy of continuous practice and learning, so that through continued exposure and experience, the results become richer with deeper information about the nuances and subtleties contained in the evolving message system. In music, particular *interaction states* correlating two or more intelligent systems become compositional, musical objects that can be directly considered in the form of a work (Rosenboom 1992a). Examples of such interacting entities include performers, intelligent instruments, and interactive, compositional models.

One problem with many current applications of GAs in the arts is that they mirror the engineering approaches of using GAs to narrow the search space of a problem to produce a desired outcome that is known in advance. It is very different to think in terms of generative systems producing desired outcomes versus outcomes that just happen in adaptive, interactive systems. Interacting without expectation is a very different activity than being a controller of processes. Neither humans nor ETIs may know what to expect from an interactive process with an unknown intelligence. However, for ETI, the particular response modes of such processes could hint at human characteristics. For example, vocal tract synthesis could be used or rhythm generation with the typical human metrical processes emphasizing the multiples of neural time quanta often seen in music combined in simple ratios, such as 1:1, 1:2, 2:3, and 3:4 (Epstein 1995).

In ETC, what might an interactive message artifact with GAs and neural networks sense and generate? Perhaps, the positions of the nearest astronomical bodies and strong gravitational centers could seed GAs which could, then, evolve physical outputs based on the local, astronomical configuration spaces. Repetitive gesture patterns could be sensed through image receptors, measurements of variations in light intensity and spectrum, physical vibrations (sounds), changes in radio or other electromagnetic sources, variations in local chemistry, or physical motion, i.e. being picked up and moved in relation to local gravity, anything that could conceivably result from interaction with another autonomous organism. Gestures could be generated in response with adaptive, neural nets aiding the GAs' interactions. Notions about potential universalities in the forms of human gesture messages or emotional expressions—*sentic* forms—could be employed, as in (Vakoch 1999) and in my score, *In the Beginning: Etude III,* shown in Figure 6. If the forms of sentic communications are indeed durable with some broad commonalities among traits, as has been observed on Earth, then these may be good candidates for ETC over long time-space scales.

The limitation of sending objects into space, of course, lies in the fact that they have to go somewhere in particular. An electromagnetic field disturbance—i.e. wave—, on the other hand, can expand in all directions, though the diminishing strength of a wide beam over distance is a disadvantage. Expanding or contracting regions of space through which the waves may travel can also warp them and shift their frequencies. These are strength and scaling problems. To compensate, we may try to adjust our perceptual assumptions about distance and size. A new challenge might be to imagine how all these ideas about interactivity could be initially imbedded in physical fields rather than objects. Then, once an electromagnetic or other field message has been received, interactive objects could be sent in the direction of the source. In effect, this interaction results in producing a local simplifier on the domain of communication. The future of interactive object design may benefit from developments underway in miniature, evolving, and self-organizing hardware with circuitry that can change and grow (Burton and Vladimirova 1999, Hand 2002, Stoica and Salazar-Lazaro 2002a and 2002b, and Stoica 2002). These evolving objects may use dust-like swarms of micron-sized sensors in laser-shaped clouds of controllable, granular matter that can report information back about the nature of newly encountered environments (Quadrelli 2003). Though these exciting developments are mere beginnings, it is clear that interactive objects for use in ETC will eventually acquire the ability to self-replicate, evolve, implement self-repairs, and adapt to unknown environments and interactions with unknown intelligences, all the while carrying messages from Earth imbedded in their very makeup.

It is important not to fall into the trap of the *creator and critic paradigm* when using GAs for open interactivity wherein the purpose of the GAs is to produce responses that *please* the interactive participants or score high in some selected measure (Johnson and Cardalada 2002). This works against the idea of evolutionary composition as a genre. The results desired from the GA are, in effect, known in advance and all inconsistent results are rejected. The critic directs the evolution. This will not work for ETC, in spite of the likelihood that some kind of fitness landscape, though not prestated, may operate in co-evolutionary systems (Kaufman 1993).

Adaptive capacity through controlled feedback, such as in my *On Being Invisible* model described earlier, in which the participants ride the fine line separating making choices from evolving naturally as part of a larger system, may be better for ETC. A version of this system might be implemented in which interactions from ETI might replace the brain ERP testing of the earlier models. In *On Being Invisible,* perception is not equated with evolution. It is a mechanism in a process. The participants must be *open to hearing* to get beyond the presumptuous of a priori evaluating systems. There must be no grandstand evaluation of fitness in true evolutionary systems.

The engineering solution approach to the use of GAs and A-life systems is, to be sure, useful in tool building, self-organizing space ships, habitation systems, and medical treatment systems. A potential model for an evolving, networked approach to world health, called IRIS (Individual Resource Information System), was suggested in (Rosenboom 1975). Today, GAs and A-life systems could carry this approach further by evolving tools with which to analyze the vast arrays of data associated with world health trends and generate responses to changing indicators in a global feedback model intended to improve fitness. However, this would not be the best approach to use in communicating with unknown intelligences. Evolution happens. GAs enfold our consciousness of this back into processes, implying *succession* and *extension* of locally collapsed events from fields of possibilities, and enabling co-creative communication.

More recently, some of the criticisms levied at early artistic and musical work with GAs and neural nets have been addressed and new ideas advanced for practical projects in the areas of imbedding adaptive rule systems inside interactive compositions that change during performances (Bresin et. al. 1992), interactive composer's assistants (Nishijima and Watanabe 1992), exploring large spaces of musical objects (Todd 1992), and the spontaneous generation of musical forms by applying models of perception to improvised musical input that can not be known in advance (Rosenboom 1992c and Rosenboom and Braxton 1995). All of these show great promise and potential.

Avoiding thinking in terms of linear time and concurrent imagination

Thought provoking schemes for characterizing cyberspace and the timespace aspects of communication within it have been advanced by artist/thinkers like (Anders 2001). A dimensionalized environment of thought and experience is described in which space is regarded as an artifact of memory. The process may not be the result, however, of the linear concatenation of things in sequence. This invokes again the principle described earlier of *extension* in timespace creating mass, in this case extension beyond bodies through media as the genesis of a new kind of substance, which is quite palpable and ponderable. This is a space, however, of routinely changing dimensions, expanding and contracting through interactive, often non-linear processes. In it, the dimensions of copies, so easily produced electronically, can seem to amplify the source through its absence and the application of imagination and projection. These imaginations may or may not be concurrent and coincident among multiple participants, and the co-creative communication that results may not depend upon it. „In electronic media, the scale of an effect is a product of speed and distance," Anders asserts. This brings up the relation of transmission speed to the tightness of coupling between a message and its source. In electronic musical instruments, digital media have never achieved the tightness of coupling between performer and instrument that were inherent in analog media. The translation of gestures into codes creates and inherent distance. In view of this, we may need to carefully consider the distancing effects produced by using codes in ETC. Gestures, however, can easily be rescaled through these media and scale factors can be manipulated in ways that are not correlated with natural experience. A mouse can be as big as an elephant and distance can be collapsed or expanded at will. Replication and repetition can alter the perceived scale of a source message in profound ways. How can we use this to alter the way we cognize the relationship of large time-space scales to presupposed *human* scales? The brain itself is like a cyberspace, particularly if we view it on appropriate scales and adjust our perceptual assumptions about size.

Sending processes that co-evolve—even in ways we may not be able to predict—may communicate far more about us than sending signifiers of cultural or scientific objects.

In an excellent cataloging and examination of approaches to A-life and their implications for art (Etxeberria 2002), a point of view that considers evolution itself as an organism is developed. Evolution is considered to be something instantiated by living systems. This is a stimulating thought in its implications for interactive art making, though there are still some limitations brought on by initial assumptions and conditions. Partly through contrasting synchronic views— vertical or bottom up—with diachronic, horizontal or transformational approaches that develop by extension over generations like genetic algorithms do, a meta-view of the *evolution of evolution* emerges. Interesting parallels immediately come to mind with Smolin's meta- evolutionary picture of the cosmos, which involve natural selection among particular parameters limiting the development of universes—and thus, laws of physics—and favoring those that generate lots of black holes from which daughter universes could emanate (Smolin 1997).

For adaptive systems, an agent's efficacy is increased more if all the rules for adaptation are always considered hypotheses under continuous testing and verification, with alternative hypotheses always ready to be tried when contradictions are revealed, rather than attempting to make new rules achieve consistency with other rule sets modeling the environment. This is especially important in open, co-creative communication. Coherence and persistence under change require interaction, adaptation, and learning. Co-evolution involves the generation of spontaneous order plus selection, and adaptation leads to unmistakable delineation and identity for the adapting agent (Kauffman 1993).

In a view of meta-co-evolution as a dynamical process, any particular diversity configuration may be thought of as a dynamical standing wave, a pattern in time (Holland 1995). Viewed as a holarchy, such co-evolution is intuitively different from design activity in that nothing outside the system intervenes in the process. However, human beings do design and are likely to initiate some designs in ETC, though they should carefully choose when to initiate action and when to simply be part of larger processes, as in *On Being Invisible.* Such designs will consider organization and functionality, which necessarily imposes external goals on a co-evolution system. Kauffman's mathematical models of genetic regulatory systems implemented within networks of connection may lead to solutions for co-communication with unknown intelligences (Kauffman 1993). These may help designers design while avoiding the generative entrenchment problems of being ontogenetically locked into pre-configured fitness solutions. In this way, functionality can be made to emerge through embodied design constraints.

Constructing messages outside the context of a universal background of evaluation

ETC message design must avoid the problem of empirical evaluation (Moreno 2002), which in effect, establishes a universal background of evaluation, analogous to that of Einstein's prison, the background of classical time-space. This conundrum of dialectic duality is difficult to surpass. If expectations for results of emergent forms can be forecast in any measure, then how can their interpretation be justified? If they cannot be forecast, then the results may be misjudged as trivial. If we approach ETC in this way, we fall into hermeneutic circularity in communication. We employ models to elucidate our theoretical expectations for the interaction and, then, use them to interpret the interaction that results.

Again, the *On Being Invisible* system may offer a way out. Simply by building interactive, co- creative, communication networks among autonomous, intelligent agents, each of which has its own internal order for building time capsules out of nows, synthesized pasts, and predicted futures, and implementing internal and external feedback paths in linked hypercycles, substantive forms are likely to emerge with salience and meaning for all participating agents. In such systems, each agent is free to be an initiator of action, collapsing the field of possibilities into particular asymmetries, or to be a relatively invisible processor of forms within the network., substantive forms emerge with salience and meaning to all participating agents. Furthermore, each agent is free to be an initiator of action, collapsing the field of possibilities into particular asymmetries, or to be a relatively invisible processor of forms within the network. No universal background is needed.

Possible deleterious effects of presenting terrestrial understandings and examples of music as completed compositions

The problem of the perception of objects dissolving the objects of perception

There is a parallel between the observation from Zen practice that the perception of a phenomenon dissolves the phenomenon—the perception of an inner form dissolves the totality of that form—, and the collapse of parameters associated with the observation and measurement of a quantum phenomenon in the physical world. Similarly, formal perception—the perception of form objects, such as in music or messages—is derived from a cognitive contraction, a limitation that dissolves the perception of context and totality. The perception-observation of a totality is dissolved by perception-observation of the particular. Through practice, *in-formal perception*— awareness of perceptions in the process of being formed—arising from coenaesthesis and de- contraction of the self can be developed. Through these means we can observe the movement of intelligence through thought-emotion reflexes. That these two observational worlds, the inner, universal world of limitless mind, and the world of physical models behave in the same way should come as no surprise. Some ETIs may have already evolved through this process.

In physics, it is questionable whether we are searching for computational reducibility in an irreducible universe. We must be wary of falling into the trap of looking for computational reducibility in potential ETC messages. We become the distinguished simplifier with our limiting focus. Understanding or comprehending ETC interactions may not involve reduction to simple, generative terms. We may need to step outside of our systems of thought to conceive of kinds of ETC that may be normal for some ETIs.

Forwarding already completed compositions as part of ETC may lead us into that aforementioned trap. Through singular exclusivity, it limits the efficacy of our messages and precludes the forward-looking emergence of common understanding. Of course, the normal nature of perceiving is to be selective. This collapses the potentialities of consciousness in singular attention. This is a manifestation of the individual, a selective attention.

However, if we focus on developing a long common history in our interactive strategies with time extensions far beyond the individual, we are forced to balance our selectivity with openness. This is difficult until it becomes easy. We may have to learn to consider this collective experience as primary- give it primacy over individual experience—and also learn to appreciate the individual as a part of this as well. These are not mutually exclusive points of view.

Issues regarding possible misrepresentation of human culture

Cultural artifacts may appear to be simple and, in fact, the simpler they are the more difficult it is to tell if they were created with a purpose (Wolfram 2002). An element of imaginative projection is required and must be accepted. Sending artifacts in ETC, therefore, involves an inherent potential for misrepresentation through imaginative interpretation by unknown, imagining intelligences. Presuming definite purpose is a conjecture. Interactive strategies avoid this because they are co-owned. Furthermore, interactive processes may reveal more about the nature of humanity at a future time when our messages are received than will be revealed by sending icons.

If we wish to communicate something about who we are, then who are we? Do we know? We tend to want to represent the state of our scientific and engineering knowledge. It may be more important to communicate something about our evolutionary *state.* An advanced ETI may employ minimal technology, possibly resulting from having achieved a simple, effective understanding of universe with its own notion of prediction. It would likely be inconsequential for such ETI to receive a message showing that the sender has a working model for the states of the hydrogen atom. That would be obvious to the ETI recognizing receiver.

What does it mean to take action—i.e. construct and send messages—in this framework? A potentially important message might involve what we consider *imagination* to be and how does an aggregation of the stuff of the universe manifest itself in such a way to develop imagination. If we could communicate something about the nature of our understanding of imagination, we might provide ETI with critical instruction on the nature of human beings. The possible implications are vast and difficult to grapple with. To aid human culture with this, we may need new mythologies to help illuminate the darkness of incomprehensible change.

If we work at stripping away the presumptions evident in our language, we glimpse the transformation of ourselves needed to comprehend the next stages of evolution. For example, we can dissect the phrase represented by the acronym, SETI: *Search* for—describing a quality of us, a behavioral state characteristic of human beings; *Extra—a* word describing a difference logic, a mode of differentiation; *Terrestrial—a* label for our locality context; *Intelligence—an* attribute ascribed to ourselves and speculatively attributed to other species. Next, these components can be reintegrated into an expression of expanded meaning.

In designing and sending self-organizing, interactive, evolving processes, we may project into the future and ask, "Will culture and consciousness transform themselves in a similar way by the *time* the messages are received?" Ralph Abraham provides us with metaphors for applying the science of dynamics to history (Abraham 1986). From this we can see cultural evolution proceeding through cycles of advancement, opening and closing, as the dynamics of *memes*— waves of cultural themes passing through the medium of society—are revealed. Developers of strategies for ETC will have to keep this in mind, given the long time-space scales that will be involved in interactive processes. Cultural ownership will need to become as palpable in the experience of individuals as individual ownership is now.

***Can we—*should *we—even attempt to create responses in advance—lest they not be true* responses?**

We are in the habit of needing to be able to foresee the implications of receiving a message or artifact. This is a teleological position, related to how complex systems and representations of time-space have developed in the brain. As has been asserted earlier, in SETI, listening is more important than sending. However, we send anyway—we cant stop ourselves—we are always in interaction—we are always who we are—we are always our nature. If we try too hard to create our response prior to receiving a message, then the answer will not be in response to the message. If we treat detection of a message as simply recognizing that we are already in interaction, then perhaps, there are reasons to work on a response with this mindset while carefully considering a dialogic model of responding that values differences, like that described in (Vakoch 1998).

Ascendancy of empathy, altruism, and self-consciousness

Recently, a reconsideration of the evolutionary emergence of love, compassion, and caring among species that may not be based on selfish reward has emerged (Loye 2000). This gives another perspective on altruism. Deep consideration of ETC demands us to question how we might best focus this work on the highest imperative of evolution. Can human beings serve as an agency for such evolutionary advancement?

Is the ascendancy of empathy instinctual and reflexive? The automatic sensation of repulsion and horror upon viewing brutality inflicted upon another seems like an instinctive reflex. Is it the result of the human species' ability to imagine what the experience of another would be like if experienced by one's self? This underscores the trait of imagination among human species and, consequently, the ability to imagine another's experience. A moral agency may then be required to differentiate among the possible results of imagining and taking on another's experience, such as jealousy versus shared joy—when the experience is perceived as good and rewarding—, or repulsion and looking away versus compassion and outreach—when the experience is judged as bad and damaging. Imagination and altruism are, in these respects, intimately linked.

The development of self-consciousness would seem to be required for all this. However, without the parallel development of understanding the non-differentiated self—as in zazen—the differentiated self (ego mind) is easily led toward self-maintenance in response to imagining the experience of others rather than altruistic consciousness and compassion born of understanding unity and universality. From this perspective, acquisition of deep self-knowledge seems to be a primary prerequisite for consciousness to reach higher orders and, in turn, a prerequisite for all higher human evolution. (Human evolution as an agency for higher evolution in general is, of course, only a symbol, recognizing the certain existence of other high levels of consciousness throughout the cosmos.) This may be a requirement for ETC to succeed, particularly when large- scale time-space interactions require collective engagement. Co-creative, interactive, co- communication may only be possible among forms of intelligence in which altruism and empathy have ascended naturally in evolution. What better way to begin communicating altruistic intentions than by inviting co-creative interaction? What better way to recognize being in communication than by participating in co-creative processes?

Intelligence and the distinction of species from each other

A great deal of this inquiry has been framed by considering what kind of mindset might best enable us to recognize and interact with forms of intelligence *the nature of which we cannot know in advance.* Part of this requires us to question and strip away all our assumptions about what intelligence might be and on what scales of physical and temporal manifestation it could possibly exist. We have looked to music as an arena in which hypothetical, invented, cognitive worlds, embodied in real performance and interactive forms, are routinely explored. Here we ask further, if information about the physical and temporal forms with which sources of intelligent communications may be embodied were not available to us, how would we make distinctions among these sources and differentiate them one from another in the way we do the species of our local biosphere? Indeed, would such a categorization be appropriate?

The system of metaphors we use in describing the embodiment of our own minds connects our presuppositions about intelligence very closely to our own makeup (Brockman 1999). Our assumptions about intelligence may not yet be abstracted such that they can be disentangled from us as particular embodiments of biological evolution. They may also result from our inability to avoid differentiating humans as particularly distinguished examples of self-organization. It follows, extending Godel's assertions (Casti 1991), that we may ask, is it possible for human intelligence to define general, non-human intelligence? By analogy with the incompleteness theorem, it may be impossible to incorporate within any particular, delimited definition of intelligence an ability to conceive of other possible forms of intelligence outside this definition.

Self-organization is common and normal in nature. Each self-referential instance manifesting intelligence is fundamentally a localizing phenomenon of time-space binding (Jantsch 1980). The temporal-spatial extent of each localization may range from instants of apperception within an individual, to realizations of the many kinds of intelligent agents within each single individual of a species, to varieties of intelligence existing within a species, to possible species intelligence, cultural intelligence, and on through broader and broader scales of extension. Viewed in the broadest sense, intelligence may be described as a self-referential or self-knowing quality of the universe. It is very difficult for a highly localized manifestation of intelligence to realize how different other such manifestations, those of possibly vast extent or even those within apparently similar organisms, can be.

We tend to look toward our species' capacity with what we consider to be our most abstract and, therefore, universal, constructions, like mathematics, as providing both yardsticks for measuring intelligence and guidelines for message design. If, as Lakoff asserts, however, "...mathematics as we know it is a product of the human body and brain; it is not part of the objective structure of the universe." (Brockman 1999), what are the implications for SETI? This underscores the potential differences in paradigms of intelligence, the metaphors we use in describing them, and may involve the degree to which we can recognize differences among our own species and how these balance with species universals. Do we trust our recognizing capacity, here? The brain- body's enormous capacity for plasticity, adaptation, and alternate paths of development and evolution must be factored in. This also applies to the evolution and adaptability of intelligence.

One of the implications of this reconsideration of intelligence, once fully worked out, may be that we will see yet another recasting of the *anthropic principle* (Zimmerman 1991). A quality of the universe may be that it only exists *out there*—as separate—as a result of our capacity as particular embodiments of intelligence to *know* it and that our metaphorical powers have in turn created descriptive languages like mathematics with which to describe this *knowledge.* Another related twist in a more familiar form has been stated recently as, ".. .human consciousness can question the terms required for its existence only in a world in which those terms have been met" (Wright 2001).

In the score of one of my works for chamber orchestra, electronic speech, text, and film, *In the Beginning V (The Story),* one of the characters in a dialogue, a hypothetical form of global consciousness emerging from the collective phenomena of intelligent beings on Earth, referred to as *The Double,* speaks its definition of intelligence (Rosenboom 1987b). "An entity exhibits intelligence if it is engaged in increasing comprehension of the process of its own evolution and that of the supra- and infra-organisms in relation to itself and if it demonstrates a facility to operate in contrapuntal symbiosis with and is engaged in synergetic facilitation of this process, as an integral part of it, with a degree of self-originated and willful motivation. This is by inalienable and universally evident design a necessarily self-referential definition." This libretto excerpt is offered as a musician's perspective on the matter.

Recognizing and re-cognizing species and intelligence differentiation

What is the essence of true intelligence, and how does it differ from our understanding of human intelligence? Some believe that no reasonable definition of intelligence can be given that is independent of the details of life on Earth (Wolfram 2002). Again, invoking analyses of Godel's assertions about the fundamental incompleteness of systems (Casti 1991), we may question if alternative intelligences can be defined from inside the characteristics of the intelligence trying to do the defining. To what extent would ETI have to show similar characteristics and details to the characteristic of human intelligence for us to be able to recognize it? What about ETI's consciousness and its relationship to embodied intelligence? Conversely, what differences would ETI have to show for us to recognize it as being *separate* from us?

Wolfram states that the principle of "Computational irreducibility implies that it can be arbitrarily difficult to find minimal or optimal rules. Yet given any procedure for trying to do this it is certainly always possible that the procedure could just occur in nature without any purpose or intelligence being involved (Wolfram 2002)." The search is still going on. Perhaps human beings just occurred in nature in exactly the same way—as the minimal solution to producing advanced intelligence. The repertoire of partially autonomous intelligences within humans is only beginning to be understood, and consequently, the possible extension of this to other species in the universe is relatively unexplored.

Recognizing the existence of other intelligences and revealing our existence

How will we know the existence of possible ETI and how will we reveal our existence in ETC? Given our present understanding, we may only be able to recognize ETI to the extent that it is different than our own. Can we learn to represent the fundamental forms and processes of unknown intelligence with ordinary language?

Nature is about interactions. Cognition strives to manage knowledge of interactions with intelligence. Looking for a best match among intelligences is a part of the co-creative aspect of communication. So, we may consider these ways to reveal ourselves:

By means of reflecting things back

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Using mimicry and transformation of what is received as a structural technique.

By means of emanating original things

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Revealing characteristics of the active, autonomous functioning of the mind.

By means of affecting interactions

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Engaging in co-creative communications for the purpose of maximizing the opportunity for shared, emergent forms.

Is all of this always happening?

How can music help?

The universe speaks to us through whatever means we are willing to listen. We rest in doing.

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The Author

David Rosenboom (b. 1947) is a composer, performer, conductor, interdisciplinary artist, author and educator. He has explored ideas in his work about the spontaneous evolution of forms, languages for improvisation, new techniques in scoring for ensembles, cross-cultural collaborations, performance art, computer music systems, interactive multi-media, compositional algorithms and extended musical interface with the human nervous system since the 1960's. His work is widely distributed and presented around the world and he is known as a pioneer in American experimental music.

Rosenboom holds the Richard Seaver Distinguished Chair in Music at California Institute of the Arts where he has been Dean of the School of Music and Conductor with the New Century Players since 1990 and was Co-Director of the Center for Experiments in Art, Information and Technology from 1990 to 1998. He taught at Mills College from 1979 to 1990, was Professor of Music, Head of the Music Department, and Director of the Center for Contemporary Music and held the Darius Milhaud Chair from 1987 to 1990.

He studied at the University of Illinois with Salvatore Martirano, Lejaren Hiller, Kenneth Gaburo, Gordon Binkerd, Bernard Goodman, Paul Rolland, Jack McKenzie, Soulima Stravinsky and John Garvey among others and has worked and taught in innovative institutions, such as the Center for Creative and Performing Arts at SUNY in Buffalo, New York's Electric Circus, York University in Toronto, where he was Professor of Music and Interdisciplinary Studies, the University of Illinois, where he was awarded the prestigious George A. Miller Professorship, New York University, the Banff Center for the Arts, Simon Fraser University, the Aesthetic Research Centre of Canada, the San Francisco Art Institute, the California College of Arts and Crafts and Bard College.

His music, performances, and productions have been recorded on various labels, most recently on Mutable Music, Centaur Records, Lovely Music Ltd., Cold Blue, Pogus Productions, Tzadik, Black Saint, West Wind, Elektra Nonesuch, Frog Peak Music and others. Examples of his recent projects include *Bell Solaris (Twelve Movements for Piano) and Seeing the Small in the Large (Six Movements for Orchestra),* both exploring new ideas about counterpoint and musical transformation, *Chanteuse,* a CD of new song forms with performance artist, Jacqueline Humbert, *On Being Invisible II (Hypatia Speaks to Jefferson in a Dream),* a self organizing, multi-media opera involving brain signals, *Naked Curvature,* a modular score on the mystical writings of Yeats and others for instruments, whispering voices, and interactive computer music systems composed for the California EAR

Unit, performances of little known pioneering music from the David Tudor Archives at the Getty Research Institute with colleagues, Vicki Ray, Mark Trayle, and Ron Kuivila, a new CD of *Zones of Influence,* a concert length work written for percussionist, William Winant, and the *Touché,* an innovative electronic instrument designed in collaboration with Donald Buchla in 1979–1980, a new recording of *And Come Up Dripping* for oboe and computer signal processing, with soloist, Libby van Cleve, two works exploring a new scoring technique involving notational *configuration spaces, Zones of Coherence* for solo or multiple trumpets written for Daniel Rosenboom and recently released on a CD of new trumpet works and *Twilight Language* for solo piano referring to a mystical language of Tibetan *Siddahs* and written for Vicki Ray, and, in collaboration with director, Travis Preston, *Bell Solaris- Twelve Metamorphoses in Piano Theater,* a ground-breaking, visual theatrical expansion of this earlier solo piano work into a full-evening production with a live video ensemble.

Rosenboom is author of influential books such as *Biofeedback and the Arts* and *Extended Musical Interface with the Human Nervous System* and papers such as *Propositional Music: On Emergent Properties in Morphogenesis and the Evolution of Music; Essays, Propositions, Commentaries, Imponderable Forms and Compositional Methods, Improvisation and Composition-Synthesis and Integration into the Music Curriculum* and *Collapsing Distinctions: Interacting within Fields of Intelligence on Interstellar Scales and Parallel Musical Models.* He is also co-author with Phil Burk and Larry Polansky of the widely used computer software environment for experimental music, *HMSL (Hierarchical Music Specification Language).* Currently, he is working on a book about compositional models, entitled *Propositional Music,* and other writings in interdisciplinary topics combining music with neuroscience, cognition, self- organizing systems, evolution, theoretical physics and possible forms of intelligence.

More information is available at: http://music.calarts.edu/~david

Recent CD's with Rosenboom's Music

How Much Better If Plymouth Rock Had Landed On The Pilgrims, first complete recording of all nine sections of major, historic work from 1969–1971. Featured performers include Swapan Chaudhuri (tabla), Erika Duke-Kirkpatrick (cello), Vinny Golia (winds), Aashish Khan (sarode), Daniel Rosenboom (trumpets & co-production), David Rosenboom (piano, electronics, & coproduction), I Nyoman Wenten

(Balinese instruments), William «Willie» Winant (marimba & Balinese instruments), two progressive rock/new music/metal bands from Los Angeles, Plotz! & DR. MiNT, master recording engineer, John Baffa, piano technician, Alan Eder, and others. CD booklet includes two essays, musical notes and analyses by Chris Brown, and *"The '60's as an Intellectual Monster"* by philosopher-writer, Sande Cohen. New World Records, 80689-2, 2009, double-CD http://www.newworldrecords.org/

Future Travel, digital re-mastering of 1981 compositions for one of the first digital keyboard instruments, *Touché,* piano, violin, percussion and *300 Series Electric Music Box* from Buchla and Associates, all played by Rosenboom. A newly re-edited version of *And Out Come the Night Ears* with material never before released for piano and *300 Series Electric Music Box* is also included, New World Records, 80668-2, 2007, http: //www.newworldrecords .org/

Brainwave *Music 2006,* re-release of classic works form the original 1976 album on A.R.C.

Records, together with a new recording of *Four Lines (Two High)* (2001) for electronic tracks derived from auditory event-related potentials in the brain doubled by violin and oboe lines performed by Rosenboom and Libby Van Cleve, EM Records, EM1054CD, 2006, http: //www.emrecords .net/

Bloodier, Mean Son (trumpet virtuoso, Daniel Rosenboom performs world premiers of diverse new trumpet works, including two by David Rosenboom), Ninewinds Records, NWCD 0238, 2005, www.ninewinds.com & www.danielrosenboom.com

Suitable for Framing (forms of freedom for two pianos, mrdangam and kanjira, with J.B. Floyd and Trichy Sankaran), Mutable Music, 17517-2, 2004, www.mutablemusic.com

And Come Up Dripping (oboe extended techniques and interactive electronics, with Libby Van Cleve), published with the book, *Oboe Unbound,* Scarecrow Press, Lanham, MD, 2004, www .scarecrowpress.com

Chanteuse, Songs of a Different Sort (new song forms performed by Jacqueline Humbert with electronic soundscapes, arrangements and compositions by Rosenboom and others), Lovely Music, Ltd., LCD 4001, 2004, www.lovely.com

Invisible Gold (classics of live electronic music involving extended musical interface with the human nervous system), Pogus Productions, 21022-2, 2000, www.pogus.com

Music from-On Being Invisible II (Hypatia Speaks to Jefferson in a Dream) (selections from a self-organizing chamber opera for brainwaves, speaking voices, musicians, and multi-media computer performance), on *Transmigration Music,* Centaur Records, CRC 2490, 2000, www.centaurrecords .com

Two Lines, David Rosenboom and Anthony Braxton, (music for winds, MIDI piano, and interactive software), Lovely Music, Ltd., LCD 3071, 1995, www.lovely.com

A Precipice in Time, (for percussion, saxophone, cello, piano-celesta, and sound rotation), on *The Virtuoso in the Computer Age-I,* Centaur Records, CDC 2110, 1991, www.centaurrecords .com

Systems of Judgment, computer music system and auxiliary instruments, Centaur Records, CDC 2077, 1989, www.centaurrecords .com

Some other sources for Rosenboom's music and writings are:

Frog Peak Music: www.frogpeak.org Electronic Music Foundation: www.emf.org CDeMusic: www.cdemusic.org

Leonardo on-line: mitpress2.mit.edu/e-journals/Leonardo American Music Center: www.amc.net

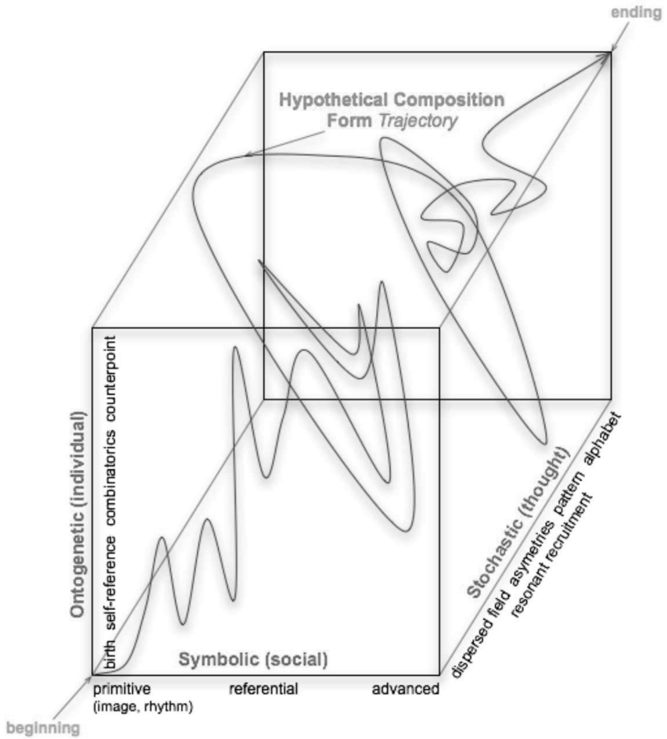
NewMusicBox: www.newmusicbox.org

Systems of Judgment: Program Notes

David Rosenboom

Systems of Judgment was composed in 1987 as the musical score for a choreographic work by Duncan MacFarland of DancArt Company, San Francisco, which also involved interactive sculpture by Australian artist, John Davis. The music has been presented extensively in liveperformances in North America, Europe, and Australia. A recorded version was released in 1989 by Centaur Records (Centaur #CRC 2077) http://www.centaur-records.com/

There is a conceptual paradigm, which guided the creation of the musical form. It attempts to elucidate parallel views of evolution by examining and speculating about processes that we, or any organism or any system,



must use to learn to make differentiations, be self-reflexive, and arrive at judgments from which language may be formulated.

The counterpoint of the form is conceived in a multi-dimensional concept space linking three views of evolution. The first focuses on an ontogenetic view, the evolution of the individual of a species. Its imagery involves using the idea of the drone, a sonic singularity, to represent birth or the beginning of self-consciousness. From there it proceeds through a process of self- reference, using smaller divisions of the drone, to develop a combinatoric view of the elements of experience, resulting in complex counterpoint and a view of harmonious relationships. The second is a stochastic view of evolution by probabilistic processes. It represents the evolution of thought. It begins with the idea of an undifferentiated field of evenly distributed energetic events. Asymmetries develop inside the field, from which arises the concept of resonance. As these resonant warpings of the field recruit more and more of the surrounding events into an ordered relationship with them, patterns result, ending with the creation of an alphabet. The third view of evolution is symbolic of social organization. It attempts to juxtapose a scale of primitive to advanced imagery against the other two views and provide a counterpoint of semantic references examining ideas of meaning and context.

The macrostructure of the work involves an enfolded fabric of golden ratio time proportions. A carefully defined set of themes and harmonic structures are subjected to transformation processes, which produce variations, but which preserve essential shape or contour characteristics. These are combined with various collected sound images, each of which becomes a player or leitmotif in the scenario for evolution that unfolds. The drama in the work involves a tension between the three views of evolution. At any point, each view has a certain strength value. All three progress in time simultaneously. The final, single evolutionary trajectory that results mixes and balances the three views in an essential tension. This provides the programmatic content for Systems of Judgment.

The music of the complete work unfolds through six sections, preceded by an environmental sound prologue.

Prologue *– The Portent of a Transporting Environment; Dreaming Pathways for Great Journeys; Passing Images of Movement; Removal from Habitual Context; Jambuwal the Rain and Thunder; The Complementarity of Major and Minor*

I. ***Initial State*** *– The Field of Birth; The Drone; The primitive; The Theme of Wonderment; Transformations on the Theme of Wonderment I; The Stream at Crawford Notch*
II. ***Central Section*** *– Rhythms of Self-Reference; Resonant Recruitment; Establishing the Alphabet; Jambuwal Returns with Friends; The Motive of Choice; Emerging Syntax; Warping the Initial Field*
III. ***Interrupt 1*** *– The Idea of Interruption of Ongoing Process; Piece for Analog Computer (+Sax); Transformations on the Theme of Wonderment II*
IV. ***Meaning*** *– Developing a Basis for Drawing Conclusions; Anticipation of Action; The Macro- Organism Begins to Reveal Itself to the Separate Entities; The Paths of Counterpoint Continuously Approach and Veer Away From One Central Attractor; Two Lines + Electric Organ + Koto Shape; JambuwalReturns Again*
V. ***Interrupt 2*** *– Continuous Interruptions Become Ongoing Process; Counterpoint Module v1A; Chart Pieces I, II, andII (Orchestral Version); Transformations on Samples from Chart Pieces*
VI. ***Meaning In Context*** *– Chart Pieces (Continuation); Transformations on the Theme of Wonderment III; Harmonic Elaborations on the Theme of Wonderment; Counterpoint Module v1B; Music for Unstable Circuits (+Drums); Combinatoric Counterpoint; The Alphabet; The Advanced; The Mt. Washington Train; Paths Which Spiral Out from a Point; Paths Which Spiral in Towards the Same Point; The Chants of York (+Strings and Brass)*

Maintaining the feeling of wonderment, perhaps the life force that drives evolution, constitutes a primary discipline in the piece. Landscape imagery helps create it. As members of an advanced culture we confront our own primitivism by invoking an elevated state of consciousness associated with looking upon a vast expanse, be it a grand Australian desert or the modern notion of entire universes being created from infinitely compact singularities, which we, in our modern primitive language, can only refer to as nothing.

The sound synthesis processes involve digital synthesis with non-linear wave-shaping algorithms, sampling and re-synthesis with digital filtering and other transformations, time domain processing, hybrid analog synthesis with computer control, unstable feedback circuits whose behavior is described by the mathematics of chaos dynamics, voltage-controlled pulse- wave frequency dividers, pitch and amplitude tracking, and analog computer circuits. Information applied on the level of compositional form sometimes results from algorithmic pattern generation or manipulation of pre-composed themes along with patterns extracted from dominant resonances contained in concrète sound sources. Concrète sources range from rainstorms and waterfalls to trains, birds, human voices, motors, engines, interesting outdoor environments, and sounds from acoustic instruments and transformed ensembles. Nonelectronic instruments used in live performance include violin, piano, and light percussion instruments from Africa, the Middle East, North America, and Aboriginal Australia.

Akustika v učitelském studiu hudební výchovy

Pavel Klapil

Původní pedagogickou aprobací autora této stati je matematika – fyzika. Na počátku svého působení na hudebně výchovné katedře přibližoval studentům průniky fyzikálního a hudebního světa. Napsal 50stránkové skriptum Akustické základy hudby, *které vyšlo ve 3 vydáních (1970, 1975, 1992). Byl na stáži u prof. Otta Goldhammera, autora přístroje zv. skalafon, na Vysoké škole pedagogické v německém Halle. Na skalafonu, jehož jeden exemplář značky Lindholm dosud katedra vlastní, pak řadu let studentům i dalším zájemcům demonstroval některé hudebně – akustické jevy, zejména ladění. Využíval akustických momentů v předmětech, jež časem přebíral, v intonaci a harmonii, což přispívalo k lepší orientaci studentů v oboru.*

Mezitím však došlo k elektronizaci demonstračních pomůcek. Proto zde již není prezentován skalafon, ale DVD nazvané Teorie ladění, hudba pohledem fyziky a fyziologie, *přinášející přehledné výklady doplněné zvukovými ukázkami. Univerzita Karlova v Praze je v r. 2004 vydala ve své ediční řadě CHARLES MULTIMEDIA CREATIONS.* V*zniklo na 1. lékařské fakultě UK v rámci výzkumného záměru MSM 111100008, rozvojový kód MŠMT 237352, FRVŠ 2742/2003, jehož hlavními řešiteli i autory DVD jsou doc. RNDr. Jan Obdržálek, CSc., a MUDr. Jiří Kofránek, CSc.*

→ **zvukové ukázky z DVD: mikrointervaly 1 až 128 centů, alikvotní tóny, srovnání jednotlivých ladění...**

Hlavním hudebně akustickým tématem jsou alikvotní tóny (též tóny svrchní, vyšší harmonické, parciální, částkové **;** zde dále jen: *alikvoty*). Úvodem ale připomeneme dva okruhy, které s nimi přímo nesouvisejí, mají však rovněž význam pro budoucí praxi našich studentů.

Jsou to především interferenční rázy (zázněje). V hudební praxi se užívají k přesnému dolaďování nebo naopak k záměrné tvorbě tremola (např. při opakovaném /dvojitém/ playbacku sólového unisona nebo v akordeonovém rejstříku označovaném ••). Nacházejí uplatnění i při sluchové analýze vícezvuků obsahujících disonující půltón**:** při vzdalování původně totožných frekvencí dvou tónových zdrojů rázy houstnou, až při dosažení půltónu působí jako vrčení (*rrr...),* které lze v analyzovaném souzvuku snadněji vyposlouchat (*vrčí to nahoře, uprostřed, dole*).

Dalším okruhem je významný Weber-Fechnerův psychofyzikální zákon (*„mění-li se fyzikální podněty působící na naše smysly řadou geometrickou, vnímáme jejich změnu v řadě aritmetické“*) a jeho praktické důsledky: velké změny podnětů vnímáme jako jen malé změny počitků. Málo efektivní je proto snaha o zvýšení celkové hlasitosti hudebního ansámblu (sboru, orchestru apod.) cestou zvyšování počtu účinkujících, efektivnější je zlepšovat podmínky pro odraz žádoucích a pohlcování rušivých frekvencí, a to změnou povrchů stěn učeben a sálů, přemístěním pódia či účinkujících apod., popř. rovnou využívat kvalitních zesilovacích zařízení.

Weber-Fechnerův zákon lze konkretizovat: kde se objektivní příčiny násobí, tam se výsledné vjemy jen sčítají. Skládání **(sčítání)** intervalů se tedy zpětně matematicky provádí **násobením** jejich tzv. relativních výšek (určujících kmitočtových poměrů plynoucích ze spektra alikvotních tónů**;** dále jen *spektra***;** viz dále), **odčítání** intervalů pak jejich **dělením.**

→ v notách: očíslované spektrum tónu C (tóny č. 1–10, 12, 15, 16, tón č. 4 zvýrazněn)

Relativní výšky (relativní = poměrné = vztažné, matematicky vyjadřované poměrem, podílem, úměrou, zlomkem) jsou kmitočtové poměry jednotlivých intervalů: čistá oktáva 2:1, čistá kvinta 3:2, čistá kvarta 4:3, velká tercie 5:4, malá tercie 6:5, velká sekunda 9:8, malá sekunda 16:15. Jsou ve všech absolutních výškách (frekvencích, udávaných v hertzích, Hz, tj. v počtech kmitů za sekundu) u téhož intervalu stejné, zatímco rozdíl frekvencí se u téhož intervalu liší podle toho, ve které absolutní výšce se nachází.

Součet velké tercie a malé tercie je čistá kvinta, což vyjádříme vynásobením relativních výšek: 5/4 (velká tercie) krát 6/5 (malá tercie) se rovná 30/20, tedy po vykrácení 3/2 (čistá kvinta). – Další příklad: oktáva bez kvinty je kvarta: 2/1 (čistá oktáva) děleno 3/2 (čistá kvinta) se rovná 4/3 (čistá kvarta).

Již se znalostmi matematiky ze ZŠ mohou studenti také pochopit, proč základní tón spektra nese již pořadové číslo 1, tedy nikoliv 0, první alikvot pak číslo 2, druhý č. 3 atd.: nulou nelze dělit žádný tón, tedy ani základní tón spektra, nemůže z podstaty věci mít nulovou frekvenci.

Tento poznatek účinně upevňují výpočty frekvencí tónů (pomocí trojčlenky /úměry/), vycházející z konstantní výchozí frekvence 440 Hz pro tón a^1 (tzv. komorní *a*) a z relativních výšek „nácestného (-ých)" intervalu (-ů), např. pro tón fis^2:

– a^1 → 440 Hz,
– tón a^2 je o oktávu (1:2) vyšší, má tedy dvojnásobný kmitočet → 880 Hz,
– tón fis^2 je pak o malou tercii níže (6:5) než a^2, tedy:

880 : x = 6 : 5 (kdyby šlo o tercii nahoru, byl by poměr opačný, tedy 5 : 6, viz dále)
6x = 5 . 880 (neboť *součin členů vnějších se rovná součinu členů vnitřních*)

x = 733 Hz

V rovnoměrně temperovaném ladění má tento tón frekvenci 740 Hz, což je v této frekvenční poloze rozdíl zanedbatelný, uvážíme-li, že temperované f^2 má 698,5 Hz.

Vypočítejme nyní kmitočet horní malé tercie od tónu a^2, tj. tónu c^3**:**

880 : x = 5 : 6
5x = 6 . 880
x = 1.056 Hz

A ještě obdobným postupem kmitočet tónu h^2, tedy horní velké sekundy od a^2**:**

880 : x = 8 : 9
8x = 9 . 880
x = 990 Hz

Oba právě provedené výpočty ukazují, že tón o kmitočtu 1.000 Hz, tzv. referenční tón, leží mezi h^2 a c^3. Je obecně dostupný jako časové znamení stanic Českého rozhlasu. Tón c^3 je tedy jen zanedbatelně (asi o polovinu půltónu) vyšší, než tón časového znamení ČRo. Pro hudebníky s dobrým relativním sluchem, tj. pro většinu z nich, je to nepochybně významné praktické zjištění.

Tóny č. 2 až 8, popř. až 10, spektra lze demonstrovat na flažoletech jedné, nejlépe nejnižší struny smyčcového chordofonu. Poměrně přesvědčivě je také možno je vyvolat pomocí jiného zdroje zvuku, umístěného v těsné blízkosti úst (bzučícího vibračního holícího strojku), když přitom nehlasně a spojitě nastavujeme pootevřenou ústní dutinu na řadu vokálů *u* → *o* → *a* → *e* → *i* ; zde je již nasnadě poučení o formantech vokálů a o tzv. alikvotním zpěvu, který se dnes těší rostoucí pozornosti i v Evropě. Všeobecně používané je vyvolání rezonujících alikvotů na klavírních strunách při odkrytých dusítkách.

Nejdostupnější prezentací spektra přináší zvuk (tón) zvonu. Jeho bezkonkurenční témbrovou atraktivitu způsobuje zaznívání totálního alikvotního „vějíře“ – spektra alikvotních tónů základního tónu (dále jen *spektra*). Exkurze do zvonařství a zejména poslech doznívajícího zvonu v jeho bezprostřední blízkosti může být pro studenty cennou zkušeností.

Zaměříme nyní pozornost na alikvot č. 4 (v našem spektru vyznačený), druhou oktávu základního tónu. Je to didakticky pozoruhodně „výživný“ rozcestník mezi melodickými a tonálně – harmonickými představami studentů.

Vývojově prvotním směrem jednohlasého vokálního melodického pohybu je směr descendenční. Klesáme-li při zpívaném glissandu od našeho alikvotu č. 4, zcela spontánně pociťujeme jako nejbližší spodní přirozený cíl alikvot č. 3. Překonali jsme přitom vzdálenost klesající čisté kvarty (*c* – *g*), což je základní směr a prostor melodického pohybu starověké hudby, tetrachord. Porovnáním dvou sousedních tetrachordů, ať již spojených autenticky či plagálně, s oktávou, která byla v hudební fylogenezi vždy přítomna jakožto atribut smíšeného (mužsko – ženského) unisona, dostaneme interval celého tónu, který se pak do tetrachordu vejde 2½krát. Tím jsou dány velikosti celého tónu a půltónu, jakož i zásada jejich střídání – diatonika. Za pomoci alikvotního spektra tedy můžeme studentům racionálně zpřístupňovat principy prvotního melodického pohybu antické i folklorní hudby.

V opačném směru, nad alikvotem č. 4, se rozprostírá durový kvintakord. Akordy tedy primárně vznikají zdola nahoru a akord 4 : 5 : 6 je základním přirozeným (= přírodním) souzvukem. Je to terciová struktura s nejnižšími sousedními alikvotními čísly (a tercie jsou,ovšemže s výjimkou primy, nejmenší konsonance). Durový akord a potažmo celý durový tónorod je tedy fyzikálního, přirozeného původu a jako takový je nezávislý na oficiální teorii hudebního ladění té které světové kultury. Je obrovskou předností evropské hudby, že přijímala za základ svých výškových relací právě jej.

Nově se objevující výstižný termín *durová dominance* lze v této souvislosti do jisté míry vztáhnout na veškeré reálné akustično *(„zvučno")*, zjevně např. na již zmíněné zvonění, z něhož lze charakteristický alikvot č. 5, durovou tercii, zřetelně vyposlouchat.

Durový kvintakord je bezesporu také nejčastějším podprahově vnímaným souzvukem, neboť je fakticky přítomen ve spektru každého témbrově specifického tónu. Je též významným faktorem, který usnadňuje západní hudbě všech žánrů pronikání do exotických zemí. Opačný směr, z východu na západ, již není – pro přílišnou spekulativitu tamních výškových struktur – tak snadný. Připadá-li nám původní orientální hudba na první poslech jakoby rozladěná, není to příznakem našeho hudebního konzervatismu ani xenofobie, nýbrž reakcí na jiné než přirozené soustavy. Lze naopak očekávat, že *tam* bude *evropský (americký?)* durový kvintakord do jisté míry všeobecně akceptovaným fenoménem mimohudebním, ozývá-li se např. v rychlých akordických rozkladech klaksonů automobilů, signálech mobilních telefonů, zvucích dětských hraček apod. Je to audiální analogie vizuálního podprahového využívání kratičce exponovaných grafických log při nekalých reklamních či předvolebních praktikách (v některých spořádaných zemích nezákonného).

Následující alikvot, onen z hudby často vypuzovaný, prý falešný, příliš nízko ležící tón č. 7, bývá přesto i hudebně rovnocennou součástí alikvotního spektra. Přirozený tvrdě malý (zv. dominantní) septakord 4 : 5 : 6 : 7 *(c – e – g – hes)* je ze septakordů bezpochyby nejlibozvučnější (tj. nejméně volající po rozvodu). Stojí-li pak opravdu na dominantní (kvintové) funkci, má jeho septima předepsaný rozvod dolů a může tedy být jakožto potenciální citlivý tón (viz dále) i sníženě intonována ($7 : 6 < 6 : 5$), což odpovídá jejímu postavení ve spektru.

Na tónice bývá tento septakord také nositelem modálního zabarvení. Myslíme zde hlavně na rozfuk fujary, v němž je přirozená malá septima objektivním mixolydizujícím faktorem.

→ **ukázka hry na fujaru (*slovakian bass overtone flute*) s rozfukem**

Autonomita tvrdě malých septakordů se projevuje v tom, že jsou „přenosné“ na všechny hlavní funkce, jakkoliv tam jsou z přísného hlediska klasické harmonie nedoškálné. Je to mj. příznačné pro jazzovou durovou kadenci zvanou bluesová dvanáctka (C^7 – F^7 – C^7 – G^7 – $C^{(7)}$). Doplníme-li nadto takový septakord o velkou sextu – tzv. *šestku* – dostaneme sled *c – e – g – a - hes* ($C^{6,7}$), jehož půvab může spočívat v tom, že ve svém rozkladu imituje spektrum: každý jeho další interval je menší než předcházející (v3 – m3 – v2 – m2).

Hudební psychologie mluví o tom, že souzvuky inverzního intervalového složení mají stejnou míru disonance. V případě tvrdě malého septakordu by takovým byl septakord zmenšeně malý (m3 – m3 – v3, např. *fis – a - c – e)*, připomeňme si jej např. v incipitu cyklu *Dumky* Antonína Dvořáka, op. 90, ukázka živě na klavír**)**. Obecná hudební praxe však tomuto akordu ani zdaleka nepřiznává stejnou míru autonomity, jakou má septakord tvrdě malý (v3 – m3 – m3), a to nepochybně proto, že nemá srovnatelnou oporu v přirozeném spektru. Na příkladu této dvojice septakordů můžeme studentům poukazovat na vývojově sekundární, spekulativní povahu descendenčních symetrických konstrukcí, a to včetně mollových akordů (mollový kvintakord bývá definován alikvotním poměrem 10 : 12 : 15, tedy mnohem vyššími a proto méně zajímavými pořadovými tóny spektra) a v důsledcích i celého mollového tónorodu, tedy konstrukcí, které souhrnně označujeme jako dualismus.

Nauka o harmonii dělí, i když poněkud vágně, alterované akordy na pravé a nepravé, a to podle toho, zda obsahují interval zmenšené tercie (zvětšené sexty). Mezi nepravé bývají zařazovány i ty, které jsou enharmonicky shodné s tvrdě malým septakordem (popř. jeho obratem). Takové si sluchová paměť vzápětí spontánně ztotožňuje s relací 4 : 5 : 6 : 7. tedy jakoby s náhle se objevivším a další rozvod neočekávajícím mimotonálním D^7.

Asi nejčastěji to bývá alterovaný septakord (v C dur) *dis – f – a – c,* v obratu a po enharmonické záměně *f – a – c – es*, tedy F^7 (Jaroslav Ježek, *Život je jen náhoda,* incipit), dále to jsou septakordy H^7, D^7, As^7, Des^7.

Označení těchto akordů za nepravé tedy lze chápat – ve srovnání s pravými – jako sice vůči hlavní tónině přísněji vzato cizí, pro posluchače však jakoby již dobře známé, tedy jako sluchové *déjà vu***:** *déjà entendu.*

Podle názvu epochálního Bachova díla znají všichni termín temperované ladění (přesněji rovnoměrně temperované (originální německý titul je *Das wohltemperierte Klavier* **;** internetový slovník toto slovo nezná, překládá však vazbu *die* ***wohl****temperierte Wohnung* jako *dobře temperovaný byt*, tedy byt vytápěný rovnoměrně; ve francouzštině *le clavier bien tempéré*) s jeho dvanácti **stejně velikými** půltóny v oktávě.

Temperované ladění je od Bachovy doby obecně přijímanou normou, vždyť hudebně sluchový výcvik standardně probíhá u takto naladěných klavírů. Je však nemyslitelné, abychom studentům tajili, že vedle něj existují dva další silné systémy, mezi nimiž je ladění temperované „jen" jakýmsi průměrem, kompromisem, a to nejen v historickém, ale i ve velmi konkrétním, fyzikálním, kmitočtů se dotýkajícím slova smyslu. Je to na jedné straně ladění pythagorejské, odvozené z kmitočtových relací mezi prvními třemi alikvoty, tedy z oktávy a kvinty, na straně druhé pak skupina ladění často souhrnně označovaných jako ladění přirozená, neboť vycházejí z vyššího počtu alikvotů. Nejčastěji to bývá prvních deset (s vynecháním sedmého) ; v tomto smyslu budeme v souladu s obecnou praxí tohoto označení užívat v jednotném čísle (*ladění přirozené*), i když právě při deseti zohledňovaných alikvotech je terminologicky přesnější označení ladění didymické.

Detailnější matematicko-fyzikální výklad překlenujících vývojových mezistupňů (nerovnoměrných temperatur), o nichž tu zasvěceně a poutavě hovořil můj předřečník PhDr. Petr Koukal, Ph.D., není pro naše studenty již tak nezbytný jako jejich již naznačená protichůdnost, polarita ladění přirozeného a pythagorejského, a to, jak ukazují následující tabulky, jednak polarita vzájemná, jednak polarita každého z nich vůči ladění rovnoměrně temperovanému**.**

Následující tabulky výšek jednotlivých stupňů durové a mollové stupnice v pythagorejském a přirozeném ladění a jejich odchylek od temperovaného ladění, udávaných v centech (= setinách temperovaného půltónu) jsou zajisté výmluvnější než jejich matematicko-fyzikální prezentace ve zlomcích:

DUR

stupeň	temperované	pythagorejské	přibylo centů	odchylka od temper.
I.	0	0	0	0
II.	200	204	204 celý tón	+ 4
III.	400	408	204 celý tón	+ 8
IV.	500	498	90 půltón pythagorejský	– 2
V.	700	702	204 atd.	+ 2
VI.	900	906	204	+ 6
VII.	1100	1110	204	+ 10
VIII.	1200	1200	90	0

Pythagorejské ladění vychází z oktáv a kvint**.** Musí se – bohužel – vyrovnávat s objektivní skutečností, že dvanáctá kvinta, která by měla být stejně vysoko jako sedmá oktáva, je poněkud vyšší, a to o necelé 24 centy, tedy asi o ¼ temperovaného půltónu, protože $(3:2)^{12} > 2^{7}$. Tento rozdíl nazýváme pythagorejské koma. Na jednu kvintu pak připadá jeho dvanáctina, tj. 2 centy (tzv. chyba temperované kvinty). O ně je pythagorejská kvinta vyšší a pythagorejská kvarta (= kvinta dolů) nižší. Ostatní stupně se odvozují kvintovým kruhem (*c – g – d – a - e – h*), v němž má proto každá další kvinta o 2 centy vyšší odchylku, a to i po přenesení do výchozí oktávy. Oba půltóny si pak rozdělují zbytek oktávy rovným dílem, takže pythagorejský půltón je o 10 centů menší než temperovaný.

Mollová stupnice je v pythagorejském ladění sestavena analogicky, tedy z celých tónů o 4 centy větších a půltónů o 10 centů menších než v ladění temperovaném:

MOLL (aiolská)

stupeň	temperované	pythagorejské	přibylo centů		odchylka od temper.
I.	0	0	0		0
II.	200	204	204	celý tón	+ 4
III.	300	294	90	půltón pythagorejský	– 6
IV.	500	498	204	celý tón	– 2
V.	700	702	204	atd.	+ 2
VI.	800	792	90		– 8
VII.	1000	996	204		– 4
VIII.	1200	1200	204		0

DUR

stupeň	temperované	přirozené	přibylo centů		odchylka od temper.
I.	0	0	0		0
II.	200	204	204	velký celý tón	+ 4
III.	400	386	182	malý celý tón	– 14
IV.	500	498	112	půltón	– 2
V.	700	702	204	velký celý tón	+ 2
VI.	900	884	182	malý celý tón	– 16
VII.	1100	1088	204	velký celý tón	– 12
VIII.	1200	1200	112	půtón	0

Přirozené ladění vychází z prvních 10 tónů spektra (s výjimkou tónu sedmého). Kvarta, kvinta a druhá kvinta, tón *d* (v C dur), jsou převzaty z ladění pythagorejského. Ve spektru platí, jak jsme již poznali, že následující interval je vždy menší než předchozí. Proto je interval *d* – *e* menší než interval *c* – *d*. Dostáváme tak dvě různé velikosti pro velkou sekundu, celý tón velký (8 : 9) a celý tón malý (9 : 10), a durovou tercii proto nižší než temperovanou. Oč je však tento tón *e* nižší, o to větší musí být půltón *e* – *f*. Jeho velikost je 15 : 16, a je tedy stejná jako alikvoty těchto pořadových čísel, tóny *h* – *c*.

Tónický durový kvintakord *c* – *e* – *g*, 8 : 10 : 12, který takto vznikl, je totožný s již poznaným kvintakordem 4 : 5 : 6, neboť poměr (podíl) je, matematicky vzato, zlomek, který lze rozšiřovat (zde dvěma), aniž se změní jeho hodnota, tedy 4 : 5 : 6 = 8 : 10 : 12 = *c* – *e* – *g* . Toto zjištění je významné i pro stanovení tónů *a* a *h* jakožto durových tercií kvintakordů subdominantního a dominantního, které se také skládají z jednoho malého a jednoho velkého celého tónu.

Všechny tři hlavní kvintakordy mají shodné kvinty složené ze dvou velkých celých tónů, jednoho malého celého tónu a jednoho půltónu. To platí i pro kvinty vedlejších stupňů, bohužel již nikoliv pro kvintu *d* – *a* (jeden velký a dva malé celé tóny a jeden půltón), která proto, stejně jako celý akord II. stupně, zní falešně (*vlčí interval*).

Je dobré poukázat, že označení *přirozené ladění* může mít zavádějící emoční sémantický náboj: nám přirozené, takže nám milé ladění. Vhodnější by proto bylo *fyzikální* či *alikvotní* ladění. Výstižnější německý termín je *die natürliche Stimmung,* což znamená ladění přirozené i přírodní; italské označení je *accordatura naturale.*

Podle stejných principů je v přirozeném ladění konstruována i mollová stupnice aiolská:

MOLL (aiolská)

stupeň	temperované	přirozené	přibylo centů		odchylka od temper.
I.	0	0	0		0
II.	200	204	204	velký celý tón	+ 4
III.	300	316	112	půltón	+ 16
IV.	500	498	182	malý celý tón	– 2
V.	700	702	204	velký celý tón	+ 2
VI.	800	814	112	půltón	+ 14
VII.	1000	1018	204	velký celý tón	+ 18
VIII.	1200	1200	182	malý celý tón	0

Připomeňme nyní slova, která na olomoucké katedře HV nedávno pronesla hostující dr. Anna Derevjaníková, Ph.D., specializující se na Prešovské univerzitě na pravoslavný liturgický zpěv a rusínský písňový folklor. Na dotaz studentů, v čem spočívá specifická zvuková atraktivita pravoslavných sborů, odpověděla, že především v náboženském prožitku, rovněž však ve snižování tercií (v durových akordech) a v úzké harmonii (parafrázoval P. K.).

Durové kvintakordy (v dur to jsou hlavní funkce, T, S a D) se při snižování tercií přibližují přirozenému ladění, průhledným („průslyšným“), rázů prostým souzvukům. Tóny těchto akordů jako by se řadily do zákrytu, splývaly, připodobňovaly se prázdnému – pro někoho snad až příliš – zvuku oktávy či kvinty.

→ dvě ukázky: lidová píseň v podání rusínského folklorního sboru (Anna Derevjaníková) sborová skladba B. Smetany *Má hvězda* (Josef Veselka)

Stejný efekt je patrný i u durových akordů v mollových tóninách, tedy u dominanty a – poněkud paradoxně – i u vedlejších stupňů.

Druhý Derevjaníkovou vyslovený postulát, úzká harmonie, vztahující se v duchu její ustálené definice na tři horní hlasy čtyřhlasu, tedy včetně tenoru, je rubem téže mince: bez přiblížení k frekvenčním relacím spektra – včetně níže položenému tónu č. 5, durové tercii – by obtížněji docházelo k očekávanému akustickému efektu tzv. diferenčních (též Tartiniho) tónů, jimiž z definice jsou – právě při sousedních pozicích v horních hlasech, tedy v úzké harmonii – základní tóny jakožto tóny č. 1 alikvotních spekter ($f^{x} - f^{x-1} = f^{1}$). Tak jsou posilovány fundamentální basy, které, jak praví i lidová moudrost, tvrdí muziku.

→ notová ukázka pravoslavného liturgického zpěvu: Anna Derevjaníková, *Пойте Богу нашему*, Pravoslávna bohoslovecká fakulta Prešovskej univerzity, Prešov, 2003

Na podobném principu je určována latentní tonalita některých intervalů. Sestupnou malou tercii (častý interval dětských říkadel nebo zpěvu kukačky), např. g^2 – e^2 spontánně chápeme jako postup od alikvotu č. 6 k č. 5 spektra tónu *c*, tedy v C dur. Zvětšení tohoto intervalu na velkou tercii *g – es* nás však nezavede do c moll, spontánně je to pro nás interval od 5. ke 4. alikvotu řady velkého Es, tedy v Es dur, zvětší-li se na kvartu *g – d,* jsme podle téhož principu v G dur, neboť jde o 4. a 3. alikvot řady G. Dodejme, že takovéto postupné zvětšování intervalu od malé tercie (na jaře) přes velkou tercii (v létě) až na kvartu, někdy až tritón (na podzim), se v ročním růstovém cyklu kukaček skutečně objevuje, sledujte to a dáte mi za pravdu.

S diferenčními tóny se naši studenti často setkávají v duetech zobcových fléten. Tóny dvou sopránových zobcových fléten znějí loco na rozmezí dvou- a tříčárkované oktávy a jejich diferenční tóny se pak pohybují na hranici jednočárkované a malé oktávy, tedy ve frekvenční oblasti jakoby jinošského třetího hlasu.

Naznačili jsme, že ladění přirozené přináší libé pocity při vnímání souzvuků. Opakem je ladění pythagorejské. Je to ladění jednohlasu. I dnes, v době melodií již latentně harmonických, stále zřetelně platí, že se, chceme-li dosáhnout melodické přesvědčivosti, spojitosti, klenby, uchylujeme k tomuto ladění, a to nejčastěji tak, že zdůrazňujeme rozdíl mezi celými tóny a půltóny (*celý tón je kus, půltón jen kousíček*). Je to patrné při jednohlasé intonaci stupňovitých melodií. Rovněž při houslové výuce platí pro hru půltónů a celých tónů jednoduché pravidlo: sousední prsty k sobě (půltón) nebo od sebe (celý tón). Prvá z těchto pozic je již z pohledu na tenké dětské prstíky na houslovém hmatníku znatelně menší než skutečná polovina pozice druhé. (Toto ladění se – historicky rovněž poněkud paradoxně – uplatňuje i v nynějším durmollovém období tím, přispívá k polaritě mezi oběma tónorody: durová tercie se intonuje ještě výše, mollová ještě níže.)

Maximální zmenšení vidíme v pythagorejském ladění u půltónu *h – c*. Je to oproti temperovanému ladění plných 10 centů. Zde již může jít o tzv. zaostřenou intonaci citlivých tónů (viz dále).

Zmiňme se však ještě o zajímavém a dobře pozorovatelném jevu v intonaci operních sólistů, z profese navyklých intonovat *melodicky*, tedy víceméně pythagorejsky. Ocitnou-li se v situaci vícehlasého komorního zpěvu typu *Rozmysli si, Mařenko, rozmysli*, znějí souzvuky v jejich podáních nepříjemně, drsně. Zcela se tomu zde nevyhnul ani Smetana, jakkoliv nechal tento soubor sólistů zpívat *a cappella*. (Tento fenomén se opět potvrdil i při nedávném televizním přenosu slavnostního koncertu k jubileu *Wiener Staatsoper*, a to v závěru prvního dějství Mozartovy opery *Don Giovanni* se zcela špičkovým mezinárodním obsazení sólistů.)

→ *Rozmysli si, Mařenko, rozmysli,* z anglické nahrávky Prodané nevěsty, Charles Mackerras

Dostáváme se tak k poslednímu oddílu tohoto referátu, k velmi malým (mikrointervalovým) odchylkám v interpretační praxi. Je známo, že studují-li sólisté (nejen houslisté, violoncellisté apod., ale, jak jsme právě slyšeli, i pěvci) svůj part příliš dlouho bez klavírního doprovodu, dochází při následných korepeticích k nepříjemným znejisťujícím výškovým střetům mezi „melodicky“ intonujícím sólistou a temperovaně naladěným klavírem.

V polovině minulého století vystoupil ruský muzikolog N. Garbuzov s monografií *Зонная природа звуковысотного слуха* (Pásmový charakter sluchu pro tónovou výšku, Moskva, 1948), která ještě dnes budí pozornost (viz google). Uvádí v ní, že jako tóny určité frekvence *x* vnímáme i tóny jejího relativně těsného (sluchově však, jak se ukázalo i při ukázkách z DVD demonstrovaného v úvodu toho referátu, již postřehnutelného) frekvenčního okolí ($x \pm a^{1,2}$), tedy jistého obalujícího pásma, a teprve při jeho překročení se začíná vnímání hudební výšky klonit k sousednímu půltónu (jeho pásmu). Na výsledcích laboratorního měření tří provedení (Oistrachova, Eľmanova a Cimbalistova) Bachovy proslulé *Air* (*na struně g*, ze Suity č. 3) Garbuzov ukazuje, že i renomovaní Mistři zmenšují, „zaostřují“ půltónové intervaly mezi citlivými a jejich rozvodnými (cílovými) tóny, a to v uvedeném úryvku až o 35 Hz (v intervalu *hes – a* u Oistracha):

e^1 / a^1 f^1 d^1 **c^1 ^ h ^ c^1** h a g / g^1 **e^1 ˘ hes ^ a d^1 ^ cis^1** g^1 f^1 / ...
intervaly zmenšeny — zvětšen — zmenšen — zmenšen

Garbuzov tím dává za pravdu své teorii pásmového slyšení, v našem kontextu to navíc dokládá oprávněnost vidět (slyšet) v citlivých tónech specifickou součást melodické intonační praxe.

Pro sluchový výcvik našich studentů z toho plyne nezbytnost navozovat představu náležité velikosti půltónu („*není to minimum, ale vzdálenost*“) a pevnou apriorní představu následného rozvodného (cílového) tónu.

Volba tónové výšky, ať již v rámci určitého systému ladění nebo u jednotlivých (např. citlivých) tónů, nemusí tedy být chladným fyzikálním aktem, ale i jedním z vyjadřovacích prostředků umění hudební interpretace, ovšemže natolik vyspělé, aby byla tohoto subtilního rozlišování vůbec schopna.

Bylo by možno nacházet i další momenty, které by racionalizovaly přístup studentů k hudbě a hudební výchově a vytvářely tak zdravou protiváhu k jejímu dnešnímu módnímu jednostrannému mystickému až obskurnímu pojímání.

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Hudební ladění mýty a legendy

Petr Koukal

Čím více se zabýváme problematikou hudebního ladění, tím zřetelněji se dostáváme do zajímavého kontextu. Zkusme si představit, že by se dnešní muzikologická konference v podobě, na jakou jsme zvyklí, konala někdy v 18. či ještě v první třetině 19. století. Dá se důvodně předpokládat, že pak by se hlavní a nejdůležitější referáty tehdejších teoretiků týkaly téměř výhradně problematiky ladění, respektive hudebních temperatur. Kam tímto přirovnáním mířím? Ke skutečnosti, že na rozdíl od minulosti je dnes otázka hudebního ladění něčím natolik samozřejmým a daným, že se o tom ani nemluví. Jako by se dnešní ladění (jak výškový normál, tak druh temperatury) používalo odjakživa a nikdy jinak. Nepřemýšlíme o tom, proč dnes ladíme právě takto, nanejvýš je řeč o tom, zda ten který umělec či orchestr hraje či zpívá čistě, aniž si uvědomujeme, co se pod pojmem čistého ladění vlastně skrývá. Znalejší hudebníci a muzikologové vědí, že ladíme v tzv. rovnoměrné temperatuře – to sice napovídá, že existuje i nějaké nerovnoměrné ladění, ale co to je, už dnes vědí jen specialisté. V poslední době však počet „zasvěcených“ vzrůstá, zejména mezi varhaníky a umělci, kteří se věnují tzv. autentické interpretaci. Nicméně i v domácí odborné literatuře a v pedagogické praxi stále nacházíme velkou názorovou a znalostní setrvačnost – a díky tomu přežívá řada mýtů a legend.

Když si uvědomíme, že ladění je jeden z nejzákladnějších kamenů hudby vůbec – protože bez našeho způsobu ladění a temperatury nebude hudba v té podobě, jakou známe – pak by mělo být zřejmé, že to má obrovské přesahy do všech ostatních oborů, jak muzikologických, tak do praktické hudební činnosti. O autentické interpretaci už zmínka padla; další přesah je např. do hudební psychologie – dnes už víme, že rovnoměrná temperatura je vnímána jinak než jiné druhy ladění. I zde existuje řada mýtů. Třeba se říká, že když necháme instrumentalistu hrát bez klavírního doprovodu, začne ladit do přirozeného ladění. Jenže v posledních letech se ukazuje, že už ne, dnes ladí spíše do rovnoměrné temperatury, která se mu „vpálila“ do mozku[1]. Začíná

[1] KOPIEZ, REINHARD: Intonation of Harmonic Intervals. Adaptability of Expert Musicians to Equal Temperament and Just Intonation. *Music Perception*, 2003, 24, č. 3, s. 383–410.

se tak ukazovat, že vliv typu ladění na samotnou hudebnost je daleko větší, než si uvědomujeme.

Pořád se jedná o proces, který má svůj vlastní, mnohasetletý vývoj. S určitou nadsázkou je možné říci, že z tohoto hlediska se možná opět ocitáme na důležité křižovatce, kdy samozřejmost a výlučnost užívání rovnoměrné temperatury končí a rozhoduje se, co bude dále, zda-li v hudbě, která je provozována i nově komponována, se něco změní. Přichází doba „multitemperaturní“?

Tyto skutečnosti v kontextu domácího odborného povědomí téměř nenacházíme. Přežívá řada omylů, kde nejzatvrzelejší je stále opakovaná informace, že rovnoměrnou temperaturu prosazoval Andreas Werckmeister[2] a prakticky uzákonil Johann Sebastian Bach[3], a že od té doby se stále používá. Teprve kritické ověřování ukáže, že je tomu trochu jinak, než se mluví, myslí a píše.

Vydejme se nyní touto cestou se snahou vyvracet mnohaleté nepřesnosti či omyly kolem rovnoměrné temperatury. Lze už předem konstatovat, že domácí literatura ze 70.–90. let minulého století je překonaná, ale to je běžný a správný vývoj. Specialisté to už dnes vědí – proto jsem přesvědčen, že kdyby např. autor známé knihy o evropském hudebním ladění Luděk Zenkl psal svou studii[4] dnes, výsledek by byl zcela jiný.

Pro odpovídající pochopení je vhodné začít shrnutím teoretických základů, tentokrát v krátkém historickém přehledu.

Už od středověku hudební teoretikové chápali a popisovali hudbu pomocí jejích číselných proporcí a symetrie. V tom shledávali krásu, souměřitelnou se samotnou harmonií vesmíru. Např. Marchetto da Padova ve svém Lucidariu (ca 1315) uvádí: „Inter caeteras arboret admirabilis musica est, cuius rami sunt pulcre proportionati per numeros.“[5] A právě na základě těchto „krásných proporcí“ vznikají konsonance a „sladké harmonie“[6]. Dokonalost proporcí byla nutná i pro samotné ladění – proto tehdy používali ladění pythagorejské, vycházející z kvintových a oktávových kroků. To však představuje jen jeden typ tzv. přirozeného (nebo-li čistého) ladění,

[2] ČERNUŠÁK, GRACIAN *Dějiny evropské hudby*. Praha: 1972, s. 151.

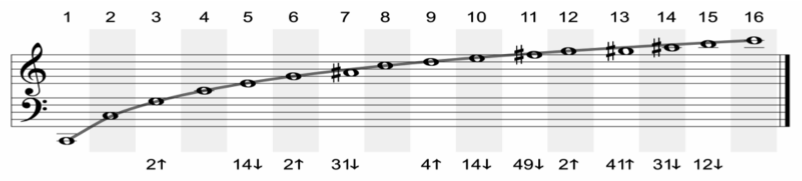
[3] VYSLOUŽIL, JIŘÍ *Hudební slovník pro každého*. I. díl, Vizovice: 1995, s. 295.

[4] ZENKL, LUDĚK *Temperované a čisté ladění v evropské hudbě 19. a 20. století*. Praha: 1971.

[5] *Scriptores ecclesiastici de musica sacra potissimum*. Ed. Martin Gerbert, Tomus III, St. Blasien 1784, s. 66.

[6] Tamtéž.

založeného, jak dnes víme, na poměrech tzv. vyšších harmonických tónů (alikvotů). Podíváme–li se na jejich tónovou řadu, může se nám zdát, že jakákoliv symetrie zde chybí:



Jako by šlo o omyl přírody či, chcete-li, Stvořitele. Jenže tady se skrývá hlubší zákonitost: poměr frekvencí těchto alikvotů tvoří celá čísla. Díky tomu durové či mollové akordy, sestavené z takovýchto tónů znějí skutečně čistě, tj. bez rázů. A to je ideál, ke kterému vždy směřovala většina dřívějších teoretiků i praktiků od počátku polyfonie až do poloviny 19. století. Teprve pak nastává definitivní zlom, kdy je tento ideální cíl vědomě odmítnut jako nedosažitelný a pro současnou praxi dokonce nepotřebný. A v praxi 20. století nadlouho upadne do zapomnění.

Jenže pokud bychom měli při souzvuku dvou a více tónů dodržovat pravidlo o vyloučení rázů, pak bychom mohli jen zpívat a hrát na smyčcové či dechové nástroje, a to ještě bez harmonických modulací. Na „normální" klaviaturu klávesových nástrojů se taková řada (půl)tónů prostě nevejde. Při aplikaci čistého ladění vznikají známé problémy:

1) Dvanáct čistých, následně stoupajících kvint vede v sedmé oktávě zpět k základnímu tónu.
   Ten však je vyšší o pythagorejské komma – 23,5 c.
2) Tři čisté, následně stoupající (velké) tercie vedou k oktávě, která je nižší o malou diesis – 41 c.
3) Čtyři čisté, následně stoupající kvinty vytvoří v druhé oktávě (velkou) tercii k základnímu tónu, která je o syntonické komma – 21,5 c – větší než čistá tercie. Proto při ladění jsou tercie a kvinty vzájemně provázané.

Právě tento problém provází západoevropskou hudbu už od vzniku polyfonie. Cesta k jeho řešení je možná pouze dvěma směry: 1) větším počtem kláves v rámci oktávy, 2) temperováním (úpravou velikosti) půltónů v rámci oktávy.

Rozšiřování počtu kláves vedlo k zavádění tzv. subsemitonií, kdy počet kláves v rámci oktávy byl větší než 12. První praktické výsledky nacházíme u varhan[7] a vzápětí i u cembal, kde vznikají např. známá renesanční arcicembala[8]. Jenže technicky i hráčsky bylo toto řešení velmi obtížné a nepraktické, takže se udrželo jen do konce 17. století. Na našem území o něm zatím nemáme žádné přímé zprávy, jeho ozvěnou jsou pouze tzv. lomené oktávy u barokních varhan.

Druhým řešením jsou hudební temperatury. Z praktického hlediska jde o kompromis, kdy je prolomeno teoretické pravidlo o celočíselných poměrech tónových výšek. Dochází tak ke zvětšování či zmenšování (temperování) jednotlivých intervalů s cílem nalézt řešení, které je uživatelsky i posluchačsky přijatelné – opuštění přirozené čistoty souzvuků s sebou přináší nežádoucí rázy (zázněje). Příhodně to vyjadřuje dobová definice temperatury z pera německého teoretika Friedricha Wilhelma Marpurga z roku 1757: „Einem Intervalle etwas zusetzen oder abnehmen, heisst man ein Intervall schwebend zu machen, dass das Ohr nicht darunger leidet, heisst eine Temperatur"[9]. Stejnou definici (kde o rovnoměrnosti není zmínka) znovu použil ještě roku 1776[10], tedy dlouho po Bachově smrti. Jakkoliv Marpurg straní rovnoměrné temperatuře, je natolik objektivním znalcem, že popisuje i převažující používání jiných systémů ladění a dokonce sám jich několik navrhuje. Jeho definice už jasně ukazuje, že tehdejší problematika hudebního ladění nebyla jen záležitostí hudební teorie, ale vždy se přenášela do oblasti hudební psychologie a hudební estetiky. To přesně vystihuje Kerala Snyder, když hovoří o tom, jak ladící systémy výtečně reflektují dobové hudebně estetické názory[11].

Každé stylové období si vyžádalo svou temperaturu, aby výsledný zvuk dobové hudby byl co nejčistší. Vždy bylo třeba některé intervaly obětovat, aby se mohlo lépe harmonicky modulovat a hrát i na nástroje s pevným laděním; přitom některé tercie či kvinty vždy zůstávaly čisté. Až v posledním období (po roce 1860) se naše hudební kultura úplně vzdala uvedené čistoty ladění. Dodnes tak naprostá většina artificiální i non-artificiální hudby zaznívá bez jakýchkoliv přirozeně čistých intervalů – všechny bez

[7] ORTGIES, IBO *Die Praxis der Orgelstimmung in Norddeutschland inm 17. und 18. Jahrhundert*. Disertační práce. Göteborgs Universitet 2004, s. 147–179
[8] KOTTICK, EDWARD *A History of the Harpsichord.* Bloomington: 2003, s. 89 ad.
[9] MARPURG, FRIEDRICH WILHELM *Anfangsgründe der theoretischen Musik*. Leipzig: 1757, s. 117.
[10] MARPURG, FRIEDRICH WILHELM *Versuch über die musikalische Temperatur*. Breslau: 1776, s. 92.
[11] SNYDER, KERALA Organs as historical and aesthetic mirrors. In: The Organ as a Mirror of its Time. Oxford: 2002, s. 16 ad.

výjimky (zejména tercie a sexty) jsou rozladěné. Stručné shrnutí přináší následující přehled:

Období	Charakter hudby	Typ ladění	Charakter ladění
14.–15. století	převaha kvint a kvart	pythagorejské ladění celočíselné poměry kvint	čisté kvinty, rozladěné tercie, neexistující kvintový cyklus
16.–17. století	převaha tercií	středotónové temperatury distribuce dílů syntonického komma (1/3, 1/4, 1/5, 2/7)	většina čistých tercií rozladěné kvinty otevřený kvintový cyklus s vlčí kvintou
18. století	potřeba modulací v kvintovém kruhu	středotónové temperatury 18. století distribuce dílů pythagorejského komma (nejčastěji 1/6)	otevřený kvintový kruh, minimalizace vlčí kvinty
18–19. století	potřeba modulací v kvintovém kruhu	nerovnoměrné temperatury (wohltemperierte Stimmung apod.) distribuce dílů pythagorejského komma	některé čisté kvinty a minimum čistých tercií cyklický (uzavřený) kvintový kruh
19.–20. století	chromatické modulace novodobá enharmonika	rovnoměrná temperatura	všechny intervaly nečisté, hlavně tercie

Tento přehled je ryze schematický; v praxi, jak už dnes víme, byl až asi do roku 1880 souběžný výskyt různých temperatur normálním jevem. Ještě v průběhu 19. století se vedle rovnoměrné temperatury používal\ i středotónová a nerovnoměrná ladění[12].

Plné prosazení rovnoměrné temperatury se tak stalo záležitostí až druhé poloviny 19. století. K tomu však vedla dlouhá cesta. K lepšímu pochopení a doložení tohoto vývoje nám poslouží citáty z dobové literatury.

Celé 18. století lze charakterizovat jako nedokončený zápas o prosazení rovnoměrné temperatury oproti jiným, rozšířenějším způsobům ladění. Nešlo o souboj starého a nového, jak by se mohlo zdát. Právě v tomto

[12] Srov. novou odbornou literaturu, zejména práce autorů jako Mark Lindley, Theodor Meister, Franz Joseph Ratte ad.

období vznikla řada nových a kvalitních nerovnoměrných temperatur (Neidhardt, Valotti, Kirnberger), které spolu se staršími (Werckmeister) rovnoměrnou temperaturu jasně porážely. V samotném varhanářství se vedle toho používaly zdokonalené typy středotónových temperatur. To platí i o slavném Gottfriedu Silbermannovi, jinak příteli J. S. Bacha, Silbermann rovnoměrnou temperaturu odmítal a tvrdě prosazoval svůj vlastní systém ladění[13]. Přitom právě jeho varhany se považují za „bachovské".

Situaci na konci počátku 19. století popisuje Henrich Christoph Koch takto: „Es sind sehr verschiedene Arten einer solchen Temperatur […] von welchen jedoch nur die beiden Hauptarten hier angezeigt werden können, die man mit den Namen gleichschwebende und ungleischwebende Temperatur bezeichnet, und über deren Vorzüge die Meinungen noch bis jetzt geteilt zu sein scheinen"[14] . Toto svědectví tak dokládá, že po roce 1800 stále panovala rozdílnost názorů na výhody rovnoměrné temperatury, tj. že jiné typy temperatur se dosud běžně užívaly.

Ve stejném roce (1802) vyšlo druhé vydání významného hudebně estetického spisu Über die musikalische Malerey od Johanna Jacoba Engela (1741–1802). Zde se dočteme: „Jede der zwölf Dur- und Molltonleitern unterscheidet sich von den übrigen durch verschiedene eigene Intervalle, und bekömmt dadurch einen eigenen Charakter.[15]" Z tohoto popisu vyplývá, že jeho autor popisuje uzavřený (cyklický) tóninový kruh, což předpokládá i uzavřenou temperaturu, avšak nerovnoměrnou – každá tónina má vlastní, od jiných tónin odlišné intervaly (tj. různě velké tercie apod.). Engel proto jednoznačně mluví o vlastním charakteru každé tóniny a jako příklad uvádí nemožnost transpozice z C dur do As dur. Je tak zřejmé, že v jeho hudební estetice nemá rovnoměrná temperatura vůbec žádné místo.

O vztahu Johanna Sebastiana Bacha k rovnoměrné temperatuře (kvůli jeho Dobře temperovanému klavíru) se v té době nijak zvlášť nemluvilo. Dokonce máme k dispozici svým způsobem opačné vyjádření německého kantora a skladatele Johanna Heinricha Zanga (1733–1811), podle něhož Bach a další velcí němečtí skladatele jako Telemann, Werckmeister

[13] WEGSCHEIDER, KRISTIAN − SCHÜTZ, HARTMUT *Orgeltemperatur – ein Beitrag zum Problem der Rekonstruktion historischer Stimmungsarten bei Orgelrestaurierungen*. Sonderbeitrag Heft 5, Michaelstein/Blankenburg 1988.
[14] KOCH, HEINRICH CHRISTOPH *Musikalisches Lexikon*. Frankfurt a. M.: 1802, heslo Temperatur, sl. 1499
[15] ENGEL, JOHANN JAKOB Über die musikalische Malerey. In: *J. J. Engel´s Schriften*. 4. Band. Berlin: 1802, s. 309.

a Matheson sice na jejím hledání pracovali, ale prvním, kdo rovnoměrnou temperaturu vynalezl, byl až Georg Andreas Sorge[16] – tedy nikoliv Bach.

V boji za uznání rovnoměrné temperatury pokračovali někteří zástupci mladší generace. Ladění bylo nadále tak důležitým a aktuálním tématem, že se jím tehdy zabývali nejen hudebníci, ale i významní myslitelé z jiných oborů. K nim patřil známý filosof a pedagog Johann Friedrich Herbart (1776 – 1841), který v roce 1811 používání rovnoměrné temperatury doporučuje[17].

V nástrojařské praxi se i nadále počítalo s oběma druhy ladění. Potvrzuje to učebnice houslařství Gustava Adolpha Wettengela z roku 1828, kde čteme: „Jeder diese Temperaturen hat ihren Werth. Bald wird bei Instrumenten diese bald jene angewendet, oder von den Tonwerkzeug-Erbauern verlangt. […] Daher müssen sie beide genau kennen.“[18] Wettengel tak uznává rovnocennost obou systémů, přičemž u nerovnoměrné temperatury má na mysli Kirnbergerovo ladění.

Této problematiky si tehdy všímali i lékaři, jak nasvědčuje pojednání Carla Gustava Linckeho. Ve svém spisu o sluchovém orgánu uznává určité výhody rovnoměrné temperatury, avšak objektivně konstatuje, že dosud mezi hudebníky není rozhodnuto, který z druhů ladění si zaslouží přednost[19].

Také v jiných zemích v té době panovaly na rovnoměrnou temperaturu obdobné, spíše odmítavé názory. Jousseho anglický spis o temperatuře a ladění klavíru shledává u rovnoměrné temperatury jednu výhodu oproti třem nevýhodám, kdežto u nerovnoměrných temperatur nalézá výhody dvě; z nich hned první je ta, že se v praxi snadněji ladí než rovnoměrná temperatura[20]. Tento argument může dnešního čtenáře značně překvapit; odpovídá však pravdě a setkáme se s ním i u jiných dobových pisatelů. Jousse škodolibě poznamenává, že i když někdo rovnoměrnou temperaturu naladí, stejně to není bez chyb a výsledek je opět nerovnoměrný[21]. To byl

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[16] ZANG, JOHANN HEINRICH *Der vollkommene Orgelmacher*. Nürnberg 1804, s. 26.

[17] HERBART, JOHANN FRIEDRICH Psychologische Bemerkungen zur Tonlehre (1811). In: *J. F. HERBART´S kleinere philosophische Schriften und Abhandlungen*. 1. Band. Leipzig: 1842, s. 337.

[18] WETTENGEL, GUSTAV ADOLPH *Lehrbuch der Anfertigung und Reparatur der* […] Geigen. Ilmenau 1828, s. 40.

[19] LINCKE, GUSTAV ADOLPH *Das Gehörorgan*. Leipzig: 1837, s. 344–345.

[20] JOUSSE, J. *An Essay on Temperament*. London: 1833, s.29.

[21] Tamtéž

i jeden z důvodů, proč se rovnoměrná temperatura v praxi prosazovala jen pomalu a obtížně. V Británii se proto nadále ladilo nerovnoměrně, dokonce ve středotónových temperaturách. Potvrzuje to ještě 4. vydání Hamiltonova Katechismu varhan z roku 1865, které přepracoval Joseph Warren. Sám se zde přiznává, že v otázce vhodnosti rovnoměrné temperatury se ještě nerozhodl[22].

Novou metodu, jak rovnoměrnou temperaturu naladit, vymyslel krefeldský továrník a hudební samouk Johann Heinrich Scheibler (1777–1837). Pomocí speciálního metronomu se měřily rázy laděných tonů s cílem dosáhnout shody s tabulkou rázů pro jednotlivé, rovnoměrně temperované půltóny. Celou metodu zveřejnil v samostatném spisu. Hned první věta jeho předmluvy zní: „Die so genannte gleichschwebende Temperatur ist bei der Orgel nicht in Gebrauch…“[23] Toto jednoznačné vyjádření je nesporným dokladem, že i v tak hudebně pokročilé zemi jako bylo Německo se ještě k roku 1837 téměř celá praxe chrámové a varhanní hudby odehrávala v nerovnoměrných temperaturách.

U komorní a symfonické hudby už měla rovnoměrná temperatura více zastánců. Ve snaze dodat jí náležitou vážnost a důležitost však právě zde začíná řada dlouho tradovaných dezinformací. Najdeme je např. v učebnici harmonie Siegfrieda Wilhelma Dehna (1799–1858). Tento vzdělaný teoretik a učitel kompozice (a budoucí knihovník hudebního oddělení Královské knihovny v Berlíně) znal staré hudební traktáty, navíc byl obdivovatelem Bachova díla. Byl přesvědčen, že slavný Temperovaný klavír byl vzhledem k aplikaci všech 24 tónin vytvořen díky použití rovnoměrné temperatury. Samotný Bach však žádný doklad či názor o druhu ladění nezanechal, a tak Dehn hledá důkazy jinde. Nachází je v traktátu o generálbasu od Andrease Werckmeistera z roku 1698, jehož jeden odstavec je pro Dehna tak důležitý, že jej přesně cituje: „Man könnte auch in heutiger Composition mit zween modis auskommen; wann denn dieselben auf das temperirte (!) Clavier appliciret und auf einen jeden clavem, einen modum, so insgemein dur, und alsdann einen, so moll genennet wird, gerichtet werden, dann hat man 24 triades harmonicas und kann das Clavier durch den Circul durchgegan-

[22] WARREN, JOSEPH – HAMILTON, JAMES ALEXANDER *Hamilton´s Catechism of the Organ*. London: 1865, s. 327.

[23] SCHEIBLER, JOHANN HEINRICH *Über mathematische Stimmung*. Krefeld: 1837.

gen werden."[24]. Toto Werckmeisterovo vyjádření zní opravdu přesvědčivě, zejména s výrokem o temperovaném klavíru, kde se vztah k budoucímu Bachovu dílu přímo nabízí. Proto Dehn vyvozuje, že teprve po zavedení „použitelné temperatury" (což je pro něho rovnoměrná temperatura) mohl Bach napsat svůj proslulý „Le clavecin bien temperé" ve všech tóninách[25]. Pro jeho současníky to bylo jedním z natolik nesporných a přesvědčivých důkazů, že se povědomí o Werckmeisterově a Bachově podílu na zavedení rovnoměrné temperatury začalo šířit dále.

Pokud však Dehnem citovaný výrok kriticky vyhodnotíme v kontextu celého traktátu[26], dospějeme k jiným závěrům. V § 26 Werckmeister odmítá zavádění matoucích super- a subsemitonií a dále píše, že na klaviatuře lze dosáhnout (kvintového) kruhu jinak – skrze dobrou temperaturu, která v praxi přinese uspokojení. V originálu zde stojí výraz „gute Temperatur". V jiných svých spisech Werckmeister používá pro ladění termín „wohltemperierte", kde slovo „wohl" je vlastně synonymem pro „gut". Najdeme to i v titulu jeho Musikalische Temperatur[27]. To nám napovídá, že nešlo o rovnoměrnou temperaturu, ale o nerovnoměrné ladění, ovšem cyklické (s uzavřeným kvintovým kruhem), jaké vytvořil a prosazovat právě Werckmeister. Zvláště v tom byla převratná novost jeho přínosu; nejznámějším „wohltemperirete" laděním je jeho temperatura, dnes nazývaná Werckmeister III. Další nezvratný důkaz opět najdeme v Dehnem citované generálbasové škole. V jejím závěru totiž Werckmeister připojil konkrétní návod, jak onu dobrou temperaturu naladit. Zde výslovně uvádí, že podle tohoto návodu jsou všechny kvinty užší o 1/8 až 1/12 komma[28]. Je tak zřejmé, že se jejich velikost liší, takže se v žádném případě nejedná o rovnoměrnou temperaturu.

Další názor přináší skladatel a docent muzikologie na lipské universitě Gottfried Wilhelm Fink ve svém spisu o harmonii z roku 1842. Stručně

[24] DEHN, SIEGFRIED WILHELM *Theoretisch-praktische Harmonielehre*. Berlin: 1840, s. 57.
[25] Tamtéž, s. 58.
[26] WERCKMEISTER, ANDREAS *Die nothwendigsten Anmerckungen und Regeln wie der Bassus continuus oder General-Bass wol könne tractiret werden.* Aschersleben: 1698.
[27] WERCKMEISTER, ANDREAS *Musikalische Temperatur*. Frankfurt und Leipzig: 1691. Termín „wohltemperierte" v tomtéž smyslu později přejímá i Bach.
[28] WERCKMEISTER, ANDREAS *Die nothwendigsten Anmerckungen und Regeln wie der Bassus continuus oder General-Bass wol könne tractiret werden*. Aschersleben: 1698, s. 69.

shrnuje jiný, tentokrát hudebně estetický důvod, proč byla rovnoměrná temperatura stále v nelibosti: ruší charakteristické rozdíly u různých kvint, což nerovnoměrná temperatura nedělá, ani v durových, ani v mollových tóninách. To je podle Finka hlavní důvod, proč jsou názory na ladění dosud rozděleny[29].

Z našeho pohledu jsou cenná především svědectví o skutečné dobové praxi. K nim patří výroky Christiana Friedricha Gottlieba Thona v jedné z jeho universálních příruček, tentokrát o klávesových strunných nástrojích (z roku 1843). Thon nebyl specializovaným hudebním znalcem, ale o to více si všímá a zaznamenává dobové názory. Podle něho je rovnoměrná temperatura kvůli rozladěným terciím pocitově na obtíž. Při tomto ladění se z hudby vytrácí potřebná různorodost a charakter tónin. Není tak sporu, že nerovnoměrné temperatury mají přednost[30]. Kvůli tomu „[…] wird von den meisten guten Stimmern jetzt wieder die ungleichschwebende Temperatur zum Grunde gelegt“[31]. Opět tak může překvapit zjištění, že ještě k polovině 19. století se v Německu někteří (podle Thona dobří) ladiči klavírů opět vraceli k nerovnoměrným temperaturám.

Jenže hudební teorie, zejména v oblasti kompozice, už v té době brala v úvahu jen rovnoměrnou temperaturu. Vzniká tak rozpor mezi teorií a praxí, který výslovně konstatuje i Herbartův žák, matematik, psycholog a filosof Moritz Wilhelm Drobisch (1802–1896) ve svém významném spisu o ladění: „Die heutige theoretische Musik macht diese gleichschwebende Temperatur ausschliesslich zur Basis der Compositionslehre“. Důvodem je podle Drobische používání klavíru. U všech ostatních nástrojů „die praktische Musik dagegen weicht […] von dieser Temperatur wesentlich ab. Denn ist es Thatsache, dass auf den Streichinstrumenten und im Gesange *Cis* und *Des*, *Dis* und *Es* u.s.w. wirklich unterschieden werden“[32]. K tomuto konstatování Drobisch připojuje jednu vysoce zajímavou poznámku: „Es muss befremden, diese Thatsache nicht nur in den musikalischen Lehrbüchern, sondern selbst in praktischen Anleitungen gänzlich ignorirt, ja geradezu verleugnet zu sehen.[33]“ Drobisch tak upozorňuje na

[29] FINK, GOTTFIRED WILHELM *System der musikalischen Harmonielehre*. Leipzig: 1842, s. 58.

[30] THON, CHRISTIAN FRIEDRICH GOTTLIEB *Abhandlung der Klavier-Saiten-Instrumente*. Weimar: 1843, s.135.

[31] Tamtéž, s. 172.

[32] DROBISCH, MORITZ WILHELM *Über musikalische Tonbestimmung und Temperatur*. Leipzig: 1852, s. 66.

[33] Tamtéž, s. 66, poznámka pod textem.

překvapivou skutečnost, že jiná dobová hudebně teoretická literatura (jmenuje např. A. B. Marxe) dosavadní používání nerovnoměrných temperatur v praxi nejen neuvádí, ale snad dokonce záměrně zapírá. Toto svědectví vysvětluje, proč se i z pozdějšího pohledu mylně zdálo, že v té době už se nepoužívalo nic jiného než rovnoměrná temperatura.

Jenže její charakter stále vzbuzoval nelibost. Jak píše matematik a fyzik Friedrich Zamminer (1817–1858), rozličnost tercií, jakou poskytuje nerovnoměrná temperatura, je mocným hudebním prostředkem, takže přijetím rovnoměrné temperatury se této výhody navždy vzdáváme[34]. Podle Zamminera je velkou předností rovnoměrné temperatury stejná čistota pro všechny tóniny a čistota kvintových a kvartových intervalů; slabou stránkou jsou tercie a sexty, což se obzvláště projevuje při souhře klavíru s houslemi či violoncellem. Zde stojí za povšimnutí, že význam termínu „čistota" intervalů zde se skutečnou, tj. přirozenou čistotou ladění už nemá mnoho společného. Pro úplnost lze dodat, že podle Zamminera byla rovnoměrná temperatura vytvořena na konci 17. století a jejími obhájci proti útokům hudebníků a teoretiků byli d´Alembert a Lambert[35]. Zřejmě odsud tuto informaci převzal a téměř doslova znovu uveřejnil Arrey von Dommer v novém vydání (1865) Kochova hudebního slovníku. Navíc připojil poznámku, že rovnoměrnou temperaturu proslavil Bach svým Dobře temperovaným klavírem[36]. I toto (mylné) tvrzení už předtím najdeme např. ve Weitzmannových dějinách klavírní hry z roku 1863[37]. Ve skutečnosti ani tehdy pro to nebyly žádné přímé doklady, takže Oscar Paul tvrzení o vztahu Dobře temperovaného klavíru a rovnoměrné temperatury zakládá jen na Bachově kompoziční metodě[38]. Podobně, tj. na základě nepřímých indicií, uvažují i tehdejší uznávaní hudební teoretikové jako Moritz Hauptmann (1792–1868), jehož text o temperatuře vyšel v renomované Chrysanderově ročence Jahrbücher für musikalische Wissenschaft[39].

[34] ZAMMINER, FRIEDRICH *Die Musik und die musikalischen Instrumente*. Giessen: 1855, s. 139.
[35] Tamtéž, s. 138.
[36] DOMMER, ARREY VON − KOCH, HEINRICH CHRISTOPH *Musikalisches Lexicon*. Heidelberg: 1865, s. 828.
[37] WEITZMANN, CARL FRIEDRICH *Geschichte der Clavierspeils*. Stuttgart: 1863, s. XII–XIII.
[38] PAUL, OSCAR *Geschichte des Claviers*. Leipzig: 1868, s. 26.
[39] HAUPTMANN, MORITZ Temperatur. In: *Jahrbücher für musikalische Wissenschaft*. 1. svazek, Lepzig: 1863, s. 34.

To představovalo natolik vlivné názory, že nemohly zůstat bez následků – jsou jedním z důvodů, proč příznivci rovnoměrné temperatury začínají převládat. Toto ladění tak dostalo nálepku jediného vhodného základu pro moderní kompozici.

Ale i tehdy se proti tomuto silnému proudu ze strany „oficiálních" zástupců hudební kultury objevují opoziční názory. Sem náležel třeba významný teolog August Ebrard (1818–1888), který se zabýval i hudební akustikou. Ve svém spisku si nebere servítky: „Schaden genug hat übrigens diese „gleichschwebende Temperatur" doch gebracht. Sie war der Sündenfall der Musik." Podle Erbrarda tento „hudební prohřešek" nadělal tolik škody z nám už známých důvodů – nedokonalost v ladění a absolutní ztráta charakteru hudby. A opět čteme jeho přímé svědectví z tehdejší praxe: „Ein Glück ist, dass die Naturhörner und Trompeten ihre Quinten rein blasen müssen […] und dass die Streichinstrumente noch in reinen scharfen Quinten gestimmt werden. Dadurch kommt wenigstens beim Orchester noch einige Haltung in die allgemeine Verwaschenheit."[40] Podle těchto Erbrardových slov tak tehdejší německé orchestry ještě stále ladily nerovnoměrně.

Laděním se zabýval i jeden z nejvýznamnějších myslitelů 19. století Hermann Helmholtz (1821–1894), zejména ve třetím vydání svého proslulého spisu Die Lehre von den Tonempfindungen. Jako zkušený vědec se opíral o původní zdroje informací, takže se v této problematice vracel ke starým traktátům. Cituje Mathesonův výrok z roku 1725, že tuto temperaturu vynalezl Werckmeister a Neidhardt. Také on zastává názor, že rovnoměrnou temperaturu používal už Johann Sebastian Bach. Na rozdíl od jiných pisatelů pro své tvrzení uvádí dva konkrétní důkazy: a) Kirnbergerovo svědectví citované Marpurgem, že když ladil Bachovi cembalo, musel všechny tercie naladit o něco výše, b) informaci, že Bachův syn Emanuel požaduje ve své učebnici klavírní hry rovnoměrnou temperaturu[41].

Podobně jako u předchozího Dehnova textu je žádoucí provést verifikaci této Helmholtzovy hypotézy. Nejdříve k vynálezu rovnoměrné temperatury: Mathesonovo vyjádření je pochopitelně nepřesné. Asi to sám zjistil, neboť později už Werckmeistera a Neidhardta pouze uvádí mezi těmi, kdo o rovnoměrné temperatuře psali[42]. A to už odpovídá skutečnosti.

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[40] EBRARD, AUGUST *System der musikalischen Akustik*. Erlangen: 1866, s. 39

[41] HELMHOLTZ, HERMANN *Die Lehre von den Tonempfindungen*. Braunschweig: 1870, s. 503.

[42] MATHESON, JOHANN *Der vollkommene Capellmeister*. Hamburg: 1739, s. 55.

Kirnbergerův postřeh, že pro Bacha ladil všechny tercie o něco výše (tj. nad jejich přirozenou výšku v hodnotě 386 centů), je skutečně pozoruhodný; avšak vyvozovat z toho, že jde o rovnoměrnou temperaturu, není v žádném případě možné. Tuto definici totiž splňují i jiná ladění, z nichž ke známějším patří středotónové ladění s dělením 1/5 komma nebo populární temperatura, dnes nazývaná Werckmeister III.

Mnohem častější argument o tom, že Bachův syn Carl Philip Emmanuel ve své učebnici požaduje rovnoměrnou temperaturu, je rovněž možné vyvrátit. V jejím textu označení rovnoměrná temperatura nikde nenajdeme. Je však třeba vzít v potaz jeho vyjádření, že klávesové nástroje musí být dobře laděny („gut temperirt" – stejný termín jako u Werckmeistera, viz výše), přičemž většině kvint („den meisten Quinten") se odebírá na jejich čistotě jen tolik, aby si toho sluch sotva všiml a mohlo se použít všech 24 tónin[43]. V námi zvýrazněném slově je jádro problému: pokud autor učebnice píše „jen" o většině kvint, nemůže se jednat o rovnoměrnou temperaturu, kde by se to muselo týkat bezvýhradně všech kvint. Proto se už dnes o Bachově nejmladším synovi v souvislosti se zaváděním rovnoměrné temperatury nedá mluvit.

Z těchto důvodů nelze výše uvedené Helmholtzovo tvrzení přijmout. Nicméně tento badatel byl snad první, kdo zřetelně definoval proměny hudby v důsledku přijímání rovnoměrné temperatury a jasnozřivě odhadl další vývoj. Z jeho vět lze vytušit, že k jejím stoupencům nijak zvlášť nepatřil a svým způsobem ji bral jako dobou vnucený kompromis. Ve svém spise věnoval celých dvanáct stran oddílu, nazvanému „Nevýhody temperovaného ladění". V podstatě zde shrnuje a z pozice akustiky a psychologie zdůvodňuje námitky, se kterými jsme se setkali již dříve. U diskuse o rovnoměrně temperovaných terciích si neodpustí svědectví, že umělci prvního řádu jako pan Joachim nadále potřebují přirozeně čisté tercie i u melodie[44]. V závěru Helmholtzových úvah o rovnoměrné temperatuře nacházíme důležité vyhodnocení: nesmíme podceňovat vliv rovnoměrné temperatury na kompoziční způsoby. Zpočátku dala skladatelům i hudebníků velkou lehkost, s níž se mohou pohybovat v nejrůznějších tóninách. Přinesla také velké bohatství modulací, jaké dříve neexistovalo. Na druhé straně nelze podcenit, že toto změněné ladění si tak velké množství modulací vynucuje.

[43] BACH, CARL, PHILIP EMMANUEL *Versuch über die wahre Art das Clavier zu spielen*.1. díl. Leipzig: 1787, s. 7.

[44] HELMHOLTZ, HERMANN *Die Lehre von den Tonempfindungen*. Braunschweig: 1870, s. 407. Jednalo se o proslulého houslistu Josepha Joachima.

Protože libozvuk konsonantních akordů už není natolik čistý, aby skryl rozdíly mezi různými převraty těchto akordů, je k tomu zapotřebí silnějších prostředků, jakými jsou ostřejší disonance, použití neobvyklých modulací apod. Proto v novodobých skladbách jsou disonantní septakordy v převaze a konsonantní akordy jsou v menšině. Půjde-li to takto dále, pak hrozí, že cit pro tonalitu se úplně ztratí. To jsou nepříznivé symptomy pro další vývoj hudebního umění.

Asi není sporu, že v tomto ohledu Helmholtz přinesl přesnou prognózu dalšího vývoje směrem k atonalitě, dodekafonii apod. Dnes už se běžně uznává, že tyto směry by byly bez prosazení rovnoměrné temperatury nemožné[45].

Vítězství zastánců rovnoměrné temperatury se tak blížilo. Mocným prostředkem její propagace byla obliba klavíru, který se ze šlechtických paláců a koncertních sálů rozšířil do měšťanských domácností. Oblíbená čtyřruční hra tehdejších operních a tanečních novinek byla bez rovnoměrného ladění nemyslitelná. Proto aschaffenburgský profesor fyziky Cal Bohn v roce 1878 konstatuje, že kvůli rozšíření klavírní hudby čistá houslová hra a zpěv stejně jako čisté ladění pozvolna mizí[46].

Nadále se proti rovnoměrné temperatuře stavěli už jen dvě skupiny hudebníků – sbormistři a varhaníci, každá pochopitelně z jiných důvodů. Zástupcem prvé skupiny může být ředitel berlínské Singakademie Eduard Grell (1800 – 1886), když v roce 1887 prohlásil rovnoměrnou temperaturu za „disharmonierendes Surrogat der wirklichen Harmonie“[47].

Varhanáři a varhaníci až na výjimky vždy patřily k názorově konzervativnějším. Není se co divit, vždyť stavba varhan patří k nejnáročnějším úkolům, kde sebemenší změna může mít za následek jasně slyšitelné odlišnosti. V zemi, známé dodržováním tradic, jako je Anglie, proto nemůže překvapit, že u tamních varhan se středotónové ladění používalo ještě do 70. let 19. století[48]. Podobně tomu bylo ve Španělsku. O to překvapivější je zpráva, že nerovnoměrné temperatury se v Německu používaly až do začátku 20. století. Tento údaj uvádí hamburský ladič klavírů Th. Hollmann

[45] FLURY, CHRISTIAN *Die Terminologie der zwölftonmusik*. Diplomarbet. Universität Wien, 2009, s. 19 ad.

[46] BOHN, CARL *Ergebnisse physikalischer Forschung*. Leipzig: 1878, s. 223.

[47] CHRYSANDER, FRIEDRICH Eduard Grell als Gegner der Instrumentalmusik, der Orgel, der Temperatur und der Virtuosität. In: *Vierteljahresschrift für Musikwissenschaft*. 4, 1888, č, 1, s. 110.

[48] SCHOLES, PERCY A. Some Puzzles about Temperament. *The Musical Times,* roč. 76, č. 1111 (září 1935), s. 787–788.

ve své učebnici ladění klavíru z roku 1902. Podle jeho slov ve Španělsku tehdy ještě nevymřelo středotónové ladění (tj. s distribucí 1/4 komma) a u některých německých chrámových varhan se stále navrhuje např. silbermannovská temperatura („Silbermannsche Temperatur")[49]. Pro období po roce 1900 jde o značně překvapivou skutečnost. To však byly poslední případy dřívější praxe. Nastalo tak zhruba sedmdesátileté údobí téměř absolutní vlády rovnoměrné temperatury.

V tomto příspěvku jsem se vědomě zaměřil na informace zejména z německé literatury, tj. z hudebně vyspělé evropské země, kde se podle výše zmíněné české literatury rovnoměrná temperatura používala už od Bachova života. Předložený obraz se však od těchto běžně tradovaných názorů odlišuje. Snad tak přispěje k lepšímu pochopení a k odpovídající recepci starší hudby.

O dění na domácí půdě, tj. v českých historických zemích, toho zatím víme mnohem méně, ale tento výzkum dále pokračuje. Už teď však mohu uvést, že se zde rýsuje velmi podobná situace.

[49] HOLLMANN, TH. *Lehrbuch der Stimmkunst*. Hamburg: 1902, s. 54.

prof. PaedDr. Jiří Luska, CSc., (ed.)

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Výkonný redaktor Mgr. Emilie Petříková
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Vydala a vytiskla Univerzita Palackého v Olomouci
Křížkovského 8, 771 47 Olomouc
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