Newsletter of the VKI Alumni Association

ISSUE 20, SEPTEMBER 2016

In This Issue:

From the Editors

by HANS-PETER DICKMANN, DC 1987
AND EDITOR, EUROPE
AND JOHN WENDT, FORMER DIRECTOR OF THE VKI
AND EDITOR, NORTH AMERICA

We start this issue of the Alumni Association's 20th Newsletter by informing our readers of the sudden death of Professor Jean-Pierre Contzen, Chairman of the VKI Board of Directors. Most of you never had the opportunity to meet him, but we can assure you that his service to the VKI was of the highest degree. Director Jean Muylaert writes a tribute to Professor Contzen and also announces the Board's recent election of Jean-Jacques Dordain, former director of the European Space Agency, as the next Chairman of the VKI Board. The remainder of NL20 continues the tradition of recounting the activities of former students, current doctoral candidates, technical developments at VKI and more fascinating details on the life of Theodore von Karman. Also, we take pleasure in announcing that Dr. John D. Anderson has been made an Honorary Member of the VKI Alumni Association; an interview of Dr. Anderson was conducted by Mickey Greenblatt (DC 1963). And we are sad to announce the death of Greg Holbrook (DC 1980). We close this issue with a reminder of the upcoming 60th Anniversary of the VKI and a description of the many activities planned on the occasion of this milestone. Hope to see you in Rhode-Saint-Genese/Sint-Genesius-Rode!

VKI 60th Anniversary

CELEBRATION ON
FRIDAY OCTOBER 14, 2016

Mark this date on your calendar now!

SEE THE LAST PAGE FOR DETAILS

The Passing of the Chairman of the VKI Board of Directors and the Appointment of a New Chairman

by JEAN MUYLAERT, VKI DIRECTOR

On October 27, 2015 Professor Jean-Pierre Contzen, Chairman of the VKI Board of Directors, passed away suddenly in St. Petersburg, Russia

while on active duty as chairman of the NIERSC foundation.

Jean-Pierre Contzen was the fourth Chairman of the Board of Directors. The first was Theodore von Karman, the founder of the Institute who was also chairman of the board from 1956 until his death in 1963 and it was after his death that the "Training Center for Experimental Aerodynamics" was renamed "von Karman Institute for Fluid Dynamics". The successor of Theodore von Karman was Professor Alec Young, Head of the Department of Aeronautical Engineering, then Professor Emeritus of Queen Mary College, London, who chaired the board for the unusual length of 30 years. He was followed by Baron André Jaumotte, Professor, Recteur Honoraire, Brusssels University, for the period 1993-2004. His successor was Jean-Pierre Contzen who was already since 1995 member of the board of directors.

J.P. Contzen joined in 1969 the European Space Organisation ESRO where he developed the programmes for satellite applications. In 1974 he started a 25 years' association with the European Commission occupying successively the positions of Director of Programmes of the Joint Research Centre (JRC), Director for Science & Technology Policy, Director General of the JRC and Special Adviser to the Commissioner in charge of External Relations. During this period, he was also a member of the Standing Committee of START (Global Change System for Analysis, Research and Training) (1992-1997) and member of the Management Board of the European Environmental Agency (1993-1997). Later he became Special Adviser to the Minister for Science & Technology of Portugal.

J.P. Contzen was also Chairman of the Institute for Advanced Studies of the United Nations University and Invited Chair Professor at the Instituto Superior Técnico in Lisbon and at the Eurasian National University of Kazakhstan. He also dealt with environmental issues through his chairmanship of the Board of Guardians of the Russian Scientific NIERSC Foundation (Nansen International Environmental and Remote Sensing Centre) in Saint -Petersburg and as member of the Scientific Committee of the Institut Royal pour la Gestion Durable des Ressources Naturelles et la Promotion des Technologies Propres (IRGT) in Brussels. He was also a member of the Committee of Applied Sciences of the Royal Belgian Academy.

The sudden death of J.P. Contzen left a vacancy on the VKI Board for several months during which the deputy chairman of the board, Herve Consigny (DC 1976), Directeur Technique Generale, ONERA, acted as chairman ad interim. On March 10, 2016 the von Karman Institute organized a Scientific Session dedicated to the memory of Jean-Pierre Contzen. Professor Manuel Heitor, Minister of Science and Technology of Portugal, Professor Jean-Jacque Dordain, former Director General of ESA, and Professor Ola Johannessen. Leader of the Nansen Group, revisited the achievements of the rich career of Jean-Pierre Contzen and emphasized in particular his visionary mind.

J.P. Contzen looked always forwards trying to imagine what the future would bring and evaluating the chances of realizing long term goals. Along these lines, on the VKI graduation day in 2012, he delivered the address to the students entitled "A Vision of the Future of VKI"

J.P. Contzen delivering his address to the students in 2012

At the occasion of an extraordinary board meeting on 20th April 2016 the board elected Prof. Jean-Jacques Dordain as the new Chairman of the Board of Directors. Jean-Jacques Dordain was the sixth Director General of ESA, serving from 2003 to 2015.

When he joined ESA in 1986, he was appointed Head of the newly established Department for the Promotion and Utilisation of the International Space Station. In 1993, he became Associate Director for Strategy Planning and International Policy, then in 1999 he took the position of Director of Strategy and Technical Assessment. In 2001, he became Director of Launchers, and was appointed Director General in July 2003.

Mr. Dordain was born in Lille in 1946. He graduated in engineering from the Ecole Centrale de Paris in 1969 (the year Neil Armstrong walked on the Moon), and began his scientific career in 1970 in the field of propulsion and rocket boosters at the French National Office for Aerospace Studies and Research (ONERA). From 1976 to 1983, he was the Coordinator of Space Activities at ONERA until he was appointed Director of Fundamental Physics. During this period he was among the first five French astronaut candidates to be selected by CNES for the ESA Spacelab 1 programme.

Throughout his career Mr. Dordain has taught in several prestigious positions. He was Professor of Fluid Mechanics at the Ecole Centrale de Paris, 1972–78, and also Professor of Rocket Propulsion at the Ecole Nationale Supérieure de l'Aéronautique et de l'Espace (sup'Aero) in Toulouse, 1972–82. From 1977 to 1993, he was Associate Professor in Mechanical Engineering at the Ecole Polytechnique and, from 1975 to 1995,

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he was Professor of Fluid Mechanics at the Ecole Nationale Supérieure des Techniques Avancées (ENSTA). Since 2003, he has been lecturer at La Sapienza University in Rome and Honorary Professor at the University of Technology, Graz, Austria, and at the University of Liège, Belgium.

In 1997, he was invited to be the Executive Secretary of the Evaluation Committee of the Japanese space agency NASDA.

J.J. Dordain

Mr. Dordain was awarded the honours of Officer of the French Légion d'Honneur and the Ordre National du Mérite. He was awarded the Order of Friendship by the Russian Federation, the title of Grand Officer in the Order of Merit of the Italian Republic and the Officer's Cross (Verdienstkreuz I. Klasse) in the Order of Merit of the Federal Republic of Germany and the title of Commander in the Order of Orange-Nassau of the Netherlands. He was recently awarded the honours of Grand Officer of the Order of the Crown of Belgium.

Mr. Dordain is a Member of the French Académie des Technologies, an Associate Member of the Belgian Académie Royale des Sciences, des Lettres et des Beaux Arts. He is also a Member of the Air and Space Academy (France); the International Academy of Astronautics and the Association Aéronautique et Astronautique de France. He has honorary functions as Vice President of the International Astronautical Federation and Chancellor of the International Space University.

The von Karman Institute is convinced that Prof. Dordain, thanks to his unique relations with both the aerospace and the aeronautics communities will strengthen the Institute during the years to come.

Updated Statistics NL1-NL20

by HANS-PETER DICKMANN, DC 1987
AND EDITOR, EUROPE

1. VKI-AA NEWSLETTER ITEMS

ITEM	ISSUE
President's Word	1
Kick-Off Belgian Chapter	1
VKI-AA Lapel Pins	6
VKI Alumni Day 2011	7
M. Greenblatt's speech to the alumni on the occasion of the VKI Alumni Day 2011	7
VKI-AA Research Travel Grants	10
NEW	
The Who's Who of the VKI-AA Board	14
Six Years After	15
A few words from the President of the VKI AA	16
A Network for Helping Recent VKI Graduates a new VKI-AA support action	19
The VKI-AA 2016 Research Travel Grants	19

2. RESEARCH TRAVEL GRANTS

ISSUE	WHO	Where
11	Jorge Sousa	Simulation Center (SCART) DLR in Göttingen
12	Imre Tamás Horváth	Particle Characterization Workgroup University of Bremen
13	Gennaro Serino	NASA Ames Research Center Moffett Field California
14	Sara Ruiz-Gonzalez	CORIA laboratory Rouen
15	Alessia Simonini	Pprime Institute Poitiers
16	Clara García Sánchez	Stanford UQ (Uncertainty Quantification) laboratory
18	Giulia Dell'Era	Compressor Aerodynamics École Centrale de Lyon
19	Alejandro Alvarez Laguna	NASA Ames Research Center Moffett Field California
10	Gian Luca Gori	Combustion & Gas Dynamics Reactive Fluids University Duisburg-Essen
20	M.A. Mendez	ICI Nantes

3. VKI ACTIVITIES

TOPIC	ISSUE
4 new faculty members	2
15 years of Aeroacoustic Research	3
Air Transport Partnership with Russia	3
Collaboration MYRRHA / Nuclear Research	4
Educational Activities & Tools for Aeronautics	5
Everlasting Search for Office Space	3
From DC to Research Master (MaM)	4
Nano-Technology Research	10
Recent News	3
QB 50 Project	7
Plasmatron Facility	3
Showcase: Prof. Smolderen's airplanes	10
Supersonic Wind Tunnel to Turbine Cascade	4
VKI Doctoral Program	1
VKI Graduation Day 2009	1

4. INTERVIEWS

NAME	DC/RM/PHD/PROF/DIR.	ISSUE
Andrew, P.	1988	8
Arnet, C. K.	1980	9
Bieler, H.	1983	8
Calta, C.	1986	7
Carbonaro, M.	1967	2
Consigny, H.	1976	10
Couston, M.	1972	1
Dolling, D.	1974	3, 8
Dowgwillo, R.	1973	8
Drtina, P.	1986	9
Arik, E.	1981	10
Giachi, M.	1987	10
Griepentrog, H.	1967	4
Gross, T.	1966	4
Martinozzi, G.	1967	6
McCroskey, J.	1963	2
Müller, B.	1981	9
Muylaert, J.	1980	2
Ottolia, D.	1999	9
Sanchez, C.	2012	9
Sauvan, S.	-	6
Tracy, R.	1960	10
v. Duitshuizen, H.	1963	5
Vankeirsbilck, P.	1988	10
Vetrano, M. R.	2002	8
Zawacki, T.	2010	9
NEW		
Eldem, C.	1983	11
Manfirani, L.	1981	11
Greenblatt, M.	1963	12
Soumoy, V.	1987	12
Congiu, F.	1995	13
Charbonnier, J.-M.	1991-1999	13
Agostini, F.	2004	14
Zambrano. T.	1978	14
Cakan, M.	1994	15
Mathioudakis, C.	1981	15
Marchal, P.	1977	15
Colpin, J.	1974	16
Donohue, J.	1987	16
Tinari, P.	1986	16
Algar Ruiz, M.	2002	16
Huang, L.	1987	17
Tirty, S.	2009	17
Paniagua, G,	1997	17
Greenblatt, M.	1963	17
Key, N.	2003	17
Michelassi, V.	1986	18
Michler, C.	2000	18
Falatyn, P.	1987	19
Johnson, G.	1975	19
Kirsch, P.	1969	20
Dobeš, J.	2002	20

5. TVK BIOGRAPHY

ISSUE	TITLE
8	Contribution to Rotorcraft
9	Contribution to Rocketry
10	German Aeronautical Research in 1945
11	Contribution to Solid Mechanics
14	Years at RWTH Aachen
15	1929 – 1941
16	1941 – 1945
16	In Spain
17	Espionage Part 1
18	Espionage Part 2
19	Supersonic Fighters and the Learjet – Post War Switzerland
20	Swiss Property Owner

Renovation of R-4 Compressor Facility

by CLAUS SIEVERDING
VKI HONORARY PROFESSOR

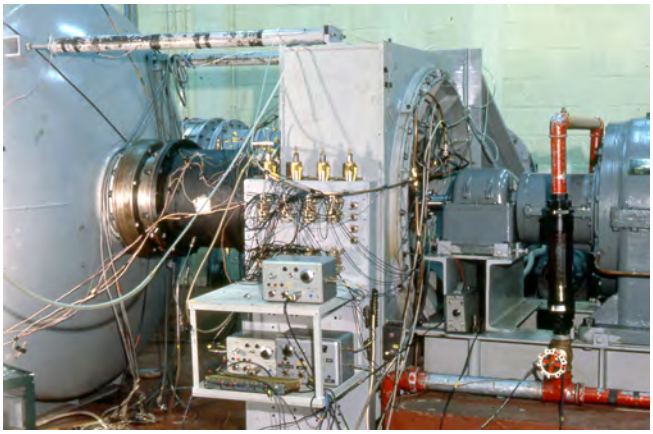
Brief review of early compressor research in the R-4 facility

Among the initial equipment of the Turbomachinery (TU) Department figured a closed-loop high-speed axial compressor test rig, received from NACA in 1960. This so-called R-2 facility, driven up to 10000 RPM by a 185 kW motor, enabled operating below atmospheric pressure and testing in gases different from air, e.g. Freon, allowing rotor testing with maximum tip Mach numbers of up to 1.5.

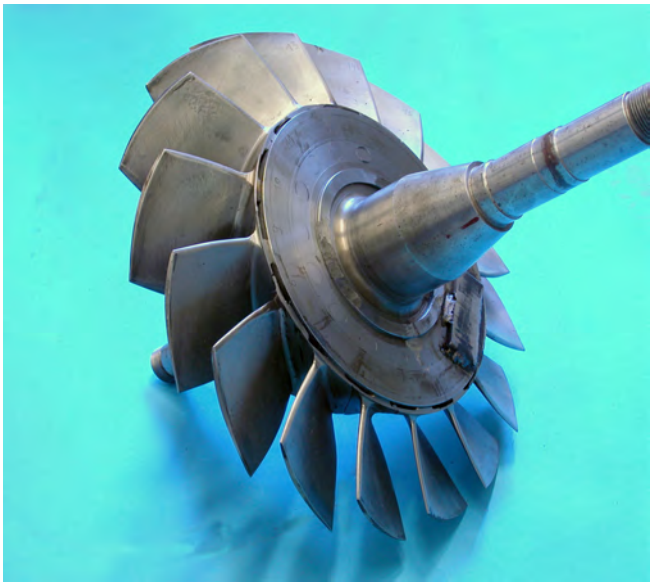
Prof. Jacques Chauvin and his assistant Frans Breugelmans developed in the period 1962 to 1967 a series of high hub-to-tip ratio supersonic axial compressors

based on the so-called “Blunt Trailing Edge Rotor Concept” (characterized by very long narrow blade channels) sponsored by the American Air Force. In parallel to this research the facility was used intensively for the testing of transonic rotors for a French company.

The limitations of the R-2 test rig, relatively low power and RPM, led in 1967 to the design and construction of a new, bigger high-speed closed loop test rig with a power supply of 750 kW and maximum shaft speeds up to 25,000 RPM. The test section was preceded by a large 1.8 m diameter settling chamber with heat exchanger and throttle valve. For compatibility reasons the test section diameter was selected to be the same as for the R-2 test rig, i.e. 400 mm. This facility was designed to enable testing of two-stage axial compressors and single stage radial compressors.



R-4 Compressor test rig 1967.



Mach 2 Compressor.

Prof. Frans Breugelmans pursued the development of supersonic compressors in this new facility in the years 1968 to 1973 with the design and testing of a low hub-to-tip ratio Mach 2 compressor. The final step was the development of a compressor with axial supersonic inlet velocity generated by an inflatable hub forming a convergent-divergent inlet duct. The supersonic compressor research was followed in the mid-seventies by inlet distortion tests as part of a general programme on rotating stall.

As regards radial compressor research in the R-4 facility, Prof. Rene Van den Braembussche, headed two important programmes. The first programme started in 1968 in close collaboration with the Belgian company FN (Fabrique Nationale) for the development of a small single stage high-pressure-ratio radial compressor to be used for helicopter engines or large trucks. This programme came to an end around 1976.

The second radial compressor programme started in 1976 in the frame of the development of an industrial 7.5 MW gas turbine by a Dutch company. VKI was in charge of the aero-design of the entire gas turbine. A radial compressor stage of this gas turbine was built and tested successfully in the early 1980’s.

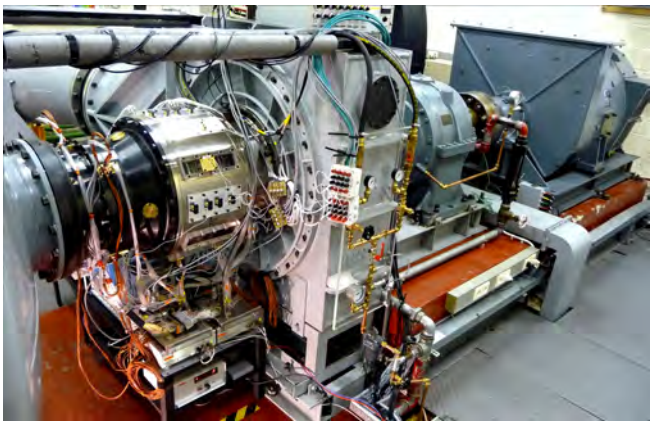
The activities on the R-4 test rig ceased then entirely for more than 20 years, mainly due to the fact that the new legislation related to the depletion of the earth’s ozone layer by the use of chlorofluorocarbons forbid the use of Freon as a test medium.

The renovation of the R-4 facility

A revival for the R-4 facility came about in late 2003 with a proposition from the Belgian company Techspace Aero to participate in a European Research programme, VITAL (Environment Friendly Aero Engines), for testing advanced LP compressor stage designs. The request from Techspace Aero was motivated by the fact that the company had decided to become a leader in the design and building of LP compressors for aero engines and needed urgently a compressor facility to verify their design methods. The objective was the design of highly loaded boosters for reduced weight and cost through a reduction in the number of blades as well as increased tip speed.

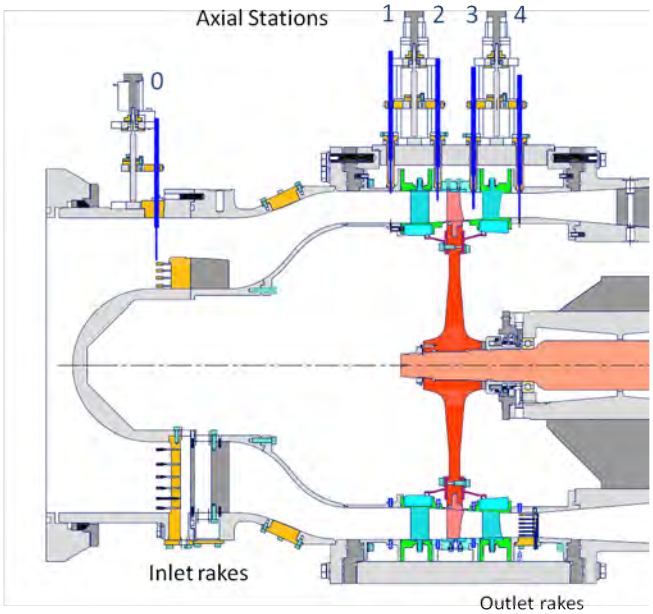
After careful consideration of the possibilities and the need to restore and modernize the R-4 test rig in terms of human and financial resources, the Turbomachinery Department under the heading of Prof. Tony Arts accepted the challenge.

The complete renovation of the facility was carried out in two phases. The first phase, supervised by the then retired Prof. Claus Sieverding, comprised the redesign of the test section by the VKI drawing office, featuring a rotor in overhang configuration with inlet and outlet guide vanes, an increase of the test section diameter from 400 to 500 mm and a new diffuser. During phase 1 of the renovation it was unfortunately not possible to adapt the outlet diameter of the settling chamber to that of the new test section. The upstream duct featured therefore a conical transition between the settling chamber and the test section.



R-4 after Phase 1 Renovation, 2005.

The aero design of the first compressor stage for the VITAL project was carried out internally by Dr. Jean-Francois Brouckaert. A second major aspect for the renewal of the test rig was the design and installation of an entirely new operating and control system by the responsible engineer of the turbomachinery laboratory, Mr. Julien Desset, allowing direct on-line display of all steady state data. It is worthwhile noting that these works were entirely borne by the VKI and had to be carried out before the signature of the VITAL project contract. Prof. Remy Denos took then the leadership of the VKI VITAL project and worked out a detailed research programme for the investigation of casing treatment on the effect of rotating stall. The first experimental programme started in 2005. The successful performance of the experimental programme required of course the development of miniaturized steady state and fast response pressure and temperature probes as well as the development of unsteady data processing techniques.

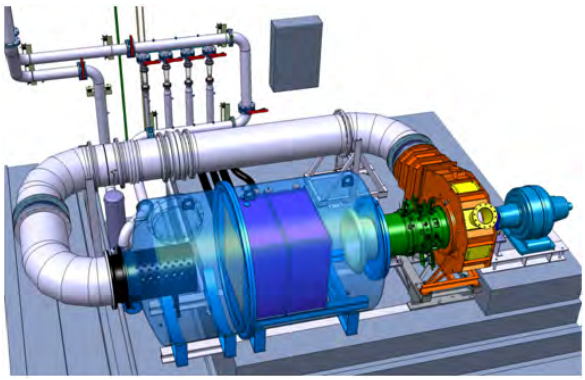


Test section.

After the departure of Prof. Denos end of 2006, to accept the position of Research Programme Officer for European Aero Engines at the European Commission, the VKI compressor research was headed by Dr. Brouckaert, freshly nominated Assistant Professor, who completed successfully the VITAL project in 2008. This programme was followed by a second European project, DREAM (vali**d**ation of **R**adical **E**ngine **A**rchitecture syste**M**s), in which VKI was again in charge of testing a new LP compressor as a partner of Techspace Aero. Parallel to the European programmes VKI performed also industry-funded research programmes.

In 2014 it was the turn of Prof. Brouckaert to leave VKI to become Project Officer for the European CLEAN-SKY Engines IDT. But before leaving he initiated the second phase of the renovation of the R-4 facility with the following particular aspects:

- Complete revision of the electric 750 kW motor (in fact limited to 500 kW since the late 1970's)
- Acquisition of a second gear box allowing an increase in the rotational speed from 10,000 to 16,000 RPM
- Replacement of the old heat exchanger in the settling chamber by a double stage heat exchanger with separate coolant supply for both units and a new control system
- The replacement of the old coolant water buffer tank by a new cooling tower with a fan driven by an 18 kW motor and a 15 kW main water pump allowing to maintain a constant compressor inlet temperature
- Increase of the settling chamber exit flange from 400 to 550 mm diameter allowing the design of a constant diameter upstream duct preceding the test section. Particular feature: extension of the upstream duct into the settling chamber with an appropriately designed inlet contraction
- Replacement of the old exhaust hood by a more rigid structure



Three-dimensional view of R-4, 2016.

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These changes were made under the entire responsibility of Julien Desset who was recently promoted to Research Engineer. The first tests have given entire satisfaction. The road for the VKI compressor research for the coming years is well paved. To start, VKI, as partner in a new European LEMCOTEC (**L**ow **Em**issions **Co**re-Engines **Tec**hnologies) programme, will carry out over the next two years an extensive test programme on the last stage of very advanced HP core compressors (instead of the previous LP compressor stage tests).

At present the compressor research is headed by Dr. Fabrizio Fontaneto who was nominated in 2015 as Assistant Professor.

The decision in 2003 to engage in a new domain of compressor research related to the aero engine LP compressors was most beneficial for the TU department. The R-4 renovated facility proved to be again an excellent research vehicle. The facility plays an important role for the education of our Research Master and PhD students. The involvement in large European projects contributes to an increased visibility of VKI compressor research and favours the relationship with other research institutions as, e.g., a close collaboration with the Ecole Centrale de Lyon. Besides the scientific aspects one has also to mention the important impact of both European projects and funded industrial projects on the TU research budget.

Shear Will: Sin I Cheng and the Analytical Theory of Turbulence

by SYLVAIN RAYNES
VKI DC 1980

Cheng, Sin I (1921-2011)

Sin I Cheng, 2010
Note: See the Appendix below for an English translation.

Dear Fellow VKI Alumnus or Alumna,

After more than 35 years of absence, it seems like I left Rhode Saint Genese only yesterday. Without a doubt, my VKI-days were some of the most intense I have ever experienced, not only because of the lasting friendships I forged in the cauldron of academic competition, but more importantly, for the sense of purpose and meaning that attended my two-year stay at the Institute, a place that has always stood for honor and excellence within the scientific world.

Back in 1980, I was both immature and foolish. Today, although I'm still foolish I have no regrets, and would do it again in a heartbeat. Yes, I probably drank too many pilsners at Montana Mike's and certainly ordered too many buckets of "moules et frites" Chez Leon, but be that as it may, it was worth every minute of the long nights and weekends I spent duking it out with the VAX downstairs. Some of those reading this will also remember my youthful indiscretions, and will hopefully have forgiven me by now.

As things turned out, a strange twist of fate kept me away from the lifelong engagement with aerodynamics I was looking for, the kind of career I truly believed was within my grasp. God knows I did whatever I could to avoid ending up on Wall Street as I did, a place where "turbulence" carries a much different connotation, one that too many of you have regrettably come to know firsthand, for better and for worse.

My purpose today is not about the past though, but the future. I want to tell you a story without a proper ending in the hope that one of you will see it fit to provide one. And I'm not looking for a Hollywood ending, unless it is first and foremost a truthful one. Besides, this is not a story about me and my American elucubrations, but about an unfinished symphony started long ago by my Princeton advisor, Professor Sin I Cheng. He himself was the first Ph.D. in Princeton's aerospace engineering

department, as well as its youngest professor. None others than Theodore von Karman and John von Neumann, two European giants of theoretical aerodynamics, sat on his Ph.D. review committee, not to mention his own advisor Prof. Luigi Crocco.

But I'm getting ahead of myself already. Professor Cheng would have hated that. The story truly begins at the dawn of one of modern China's most turbulent and revolutionary periods. Therefore, this too is where I have to start.

The Early Days and Princeton

Sin I Cheng was born in December 1921 in the village of Changhou near Shanghai, China. In 1943, he graduated from Chaio-Tung University, Shanghai with a Bachelor's degree in mechanical engineering. Five years later, he was one of only two mechanical engineers to be awarded a Chinese government (KMT) scholarship in the turbulent year 1948 to study aerodynamics abroad. Because he was first in his class, his classmates always referred to him as "Number One" [第一].

Shortly after arriving in the United States, he chose to attend the University of Michigan where, in 1949, he received a Master's Degree in Aerodynamics. He then left Ann Arbor for Princeton as a Jet Propulsion Fellow under the auspices of the Guggenheim Foundation. It is during his tenure at Princeton that he formulated his analytical theory of turbulence, a Platonic synthesis of more than 70 years of painstaking and unrequited research on the topic, eventually crystallizing into a coherent framework over the past ten years.

I was his last graduate student at Princeton in the early 1980's, right after leaving VKI[1]. In truth, I have nothing special to contribute to this unique achievement by a first-rate thinker save my experience as a Ph.D. student under his mentorship. Despite what I may have to say about him to all of you, he remains, to me at least, both an enigmatic figure and an unknown ideal, someone I remember mainly as aloof, too humble and out of reach. Only in recent times was I ever able to get to know him as a friend and confidante. In the end, I will never know what he really thought of me.

In many ways, Professor Cheng was the father I never had. I now realize that I was still too young to fully appreciate what he was trying to teach me about how one ought to conduct one's life. He said he had always hoped I would someday come back to him. Eventually, I did but with great apprehension and only at the insistence of my wife Ann. My only regret is that I did so much too late. If you care to know, it was because I was ashamed to admit that, despite the soaring intellectual heights to which I was exposed as his protégé, I had ended up in the mercenary and superficial world of modern finance.

Although, as I was about to leave Princeton, we did get together for brief conversations on various topics, even on current affairs, fluid mechanics was decidedly the perennial subject. It is a sad fact of life that it was, and to a large extent still is, politically incorrect to say that standard fluid mechanical theory is insufficiently grounded. This is because science, like the Church and Wall Street, is orthodoxy with a Praetorian Guard of enforcers. It was only later in life that he started to trust me enough to confess both his prior misgivings and what he intended to do about it.

The Basic Problem of Turbulence

Although this is neither the time nor the place to engage in a full discussion of the technical issues involved, drawing a rough sketch of the fundamental concepts is nevertheless instructive.

That a solution to the problem of turbulence has escaped generations of first-rate scientists for ca. 150 years is mainly due to the non-linearity of the three-dimensional equations of fluid motion, i.e. the Navier-Stokes [N-S] system derived from Newton's second law of motion in combination with the shear-stress or deformation tensor. In turn, such non-linearity leads to instability, the emergence of points of discontinuity and ultimately, to a staggering multiplicity of solutions. All prior attempts at a solution have focused on the entire N-S system and on finding reductions thereof. For instance, it is well known that a two-dimensional problem can, under certain conditions, be reduced to a one-dimensional problem and solved analytically that way. However, in three dimensions all such tricks eventually fail, and one ultimately ends up with just another three-dimensional problem with new variables. As a result, the only fruitful avenue was to abandon the latter, global approach and to re-conceptualize the very notion of a fluid particle, hopefully leading to a new insight into the way instability arises from an originally laminar, i.e. stable state. Now, the focus has to shift from the macro- to the micro-level and to control theory i.e. to cybernetics.

But once instability sets in, how precisely are gravitational forces capable of restoring the system to equilibrium as a renormalized, stable unit? If this intricate renormalization mechanism can be conceptualized however, the turbulent field's evolution can be computed *via* a sequence of renormalization problems. In fact, this is well-trodden ground. In the absence of fortuitous circumstances, it is already recognized that fully nonlinear problems can be solved numerically as Cauchy sequences of provisionally linear versions of the original problem. In other words, although turbulent flows cannot be solved, they can be resolved.

Therefore, the essential challenge that had to be overcome was the re-conceptualization of turbulent

[1] In passing, I would like to thank VKI, specifically then Director Ginoux, for recommending me to Princeton's MAE department. Without it, I doubt I would have been accepted.

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fields under a renormalization framework, thus achieving stable computation *via* a series of linearized eigenvalue problems. As long as renormalization can be accomplished within the diffusive (elliptic) and dispersive (hyperbolic) double-wave essence of turbulent flows, a resolution of the problem amounts to retracing the temporal evolution of renormalized sequences of linear-wave problems. The latter are known to be amenable to stable computation via standard numerical methods, but with the difference that now, truncation and discretization errors are no longer able to conspire in the creation of numerical turbulence inside computing machinery. Thus far, the latter phenomenon has been essentially responsible for destroying any hope of achieving more than a feasibility study in the realistic calculation of turbulent flows, *ipso facto* forcing us to give up the very possibility of meaningful analysis thereof.

It is widely acknowledged that the elaboration of an analytical framework generally applicable to fluid turbulence would be the greatest achievement in fluid dynamics in over a century, a great leap forward of Gaussian proportions, literally the “Holy Grail" of fluid mechanical research. Ever since G.I. Taylor’s momentous work on the statistical theory of turbulence at Cambridge, few if any meaningful theoretical advances have been made, and this regardless of the dwarfing height of the political, strategic and industrial stakes that would attend a credible resolution.

It is also clear that, whatever *tour de force* could one day do the trick, it could not arise via a purely logical process, i.e. whereby the equations of motion are merely accepted as beyond criticism. On the contrary, a real contribution could only emerge by retracing the steps that led to the original N-S synthesis in the hope of uncovering the point where that fateful decision was made, the one that later became normative and quasi-sacrosanct *vis-à-vis* all future research efforts. At the same time however, this is a decision that had to be held out as questionable, and ultimately rejected in favor of a more complete non-linear formalism. Only a consummate master of the art in complete control of the mathematical formalism relevant to fluid dynamical theory could even be in a position to undertake this journey with any hope of eventual success.

At the time of his death, Prof. Cheng and I were cooperating on the publication of *“Analytical Theory of Turbulence*", his *magnum opus*. Regrettably, he was not to live long enough to see it through as a self-contained and independent work available to future turbulence researchers. It is now up to us, the living, to allow this work to emerge as best it still can without the impetus and leadership he could have provided to the next generation. In fact, the manuscript was delayed simply because he felt American audiences would be put off by an appeal to complex mathematics. As a result, he insisted on rewriting the book from scratch without a single reference to complex analysis, which is how it was originally conceived. Unfortunately, this reconstruction added two years to the publication schedule, two years that, as things turned out, he could not afford.

Despite direct and frequent interaction with him over a period of many years and his challenging me to think more deeply than I ever dreamed possible, I fear I have neither the intellect nor the courage necessary to undertake the daunting task of creating the numerical algorithms that will be required to prove him either right or wrong. The book’s editor[2] and I share the forlorn hope that Cheng’s theoretical contribution is but the first step on a long, treacherous and winding road to a transcendental understanding of turbulent flows.

The Task Ahead

Undoubtedly, the prize awaiting those sufficiently courageous to tame the turbulent beast is nothing less than a radically new philosophical understanding of an entire branch of mathematics, not to mention one currently abandoned as hopeless and futile by too many practitioners and theoreticians. Also at stake is undisputed mastery of one of the last great scientific problems in a domain of the utmost strategic and commercial significance to first-rate powers. Surely, this is a goal worthy of the most assiduous, careful, knowledgeable and seasoned aerodynamicists, mathematicians and numerical analysts.

If statistics alone were sufficient to take us even a single fundamental step beyond the current one, G.I. Taylor would surely have taken us there. Taking the next step required a breathtaking effort of synthesis, but one that also mandated the incorporation of the achievements and insightful analyses of earlier thinkers, people like Stokes, Navier, Poincaré, von Neumann, Burgers, Riemann, von Karman and many other pioneers whose singular accomplishments are too numerous to recount. One cannot build a solid edifice without paying due homage to the foundations laid out by the giants who came before us and on whose shoulders we are now standing. Although he did not have to start from scratch, Cheng still had to weave 300 years of previous fluid-dynamical research into a seamless tapestry, being careful not to invalidate the brilliant past in search of a better future.

Although he did not live long enough to undertake the task of empirical verification, in considering whether or not to pursue his line of enquiry, we hope you will bear in mind that his cybernetic framework is not the result of some sudden flash of inspiration, but the painstaking product of more than seven decades of theoretical and empirical analysis by one of the great aerospace engineers of the 20th Century. It is now our turn to pick up the baton wherever it may lie and to forge ahead with numerical implementation in one, two

[2] Dr. Joachim Kruithof, Paris, France

or even three dimensions as a prelude to a comparison of a priori predictions to existing experimental results. Only then can his analytical work hope to achieve the status to which I believe it is already entitled as a monumental contribution to a deeper ontological understanding of fluid motion.

Sin I Cheng: In Memoriam

I would like to leave you with my own translation of the following excerpt from Volume 71 of Martin Heidegger's collected works[3] and drawn from the section entitled "Kritik". Although Heidegger was actually thinking of Parmenides and Heraclitus when he wrote the following passage, it applies equally well to Cheng's analytical work.

What Heidegger means here is that, ultimately, every great thinker thinks the same, although obviously not the same thing. Properly understood, originality is not complicated at all, but rather utterly simple. It is so difficult to achieve only because it requires of you the clear realization of what is staring you in the face all along and yet remains passed over. Essential truth cannot dawn upon you piecewise, statistically, but instead can only be grasped in a moment, stochastically. After this Augenblick, everything falls into place, like an encrypted message whose key was just handed to you. Until that instant, you were neither closer nor, of course, farther away from any resolution. The truth about the truth is that uniqueness and transcendence are the necessary and sufficient preconditions for its existence.

"To think a thinker critically means first to grasp what, in his thought, is essential and to grasp it in the original manner such thinking itself opens up. Every fundamental thinker stands under the sway of the essence of truth, i.e. of what we ourselves must encounter and with which we must remain engaged in order to correspond to its message in an equally original way. Sheer criticism, from whatever gratuitous standpoint, or the mere accounting of mistakes from a comfortable academic tower on the basis of a purportedly objective philosophy, is not simply disingenuous, but wholly adolescent."

In the hope that the numerical challenge looming ahead does not fall on deaf ears or a complacent academic establishment, I wish all of you the best of luck and an insatiable hunger for the truth.

Appendix

Translation of Poem by Sin I Cheng

Before any existence or beginning (渾沌), there was neither light nor shape,
No start and no end, with space neither empty nor filled.
Born from this chaos of nothing yet everything became Yin and Yang (陰 and 陽), the fundamental elements and forces from which all else derive.

Yin and Yang evolve (化) into heaven and earth, creating both the living and the inanimate,
Propelling all through perpetual changes, integrating and disintegrating, forming and transforming.
Chaos, continuously bifurcating, leads to individuals.

Under the sky, on this earth, the journey of life takes us through unexpected ups and downs, twists and turns (逆旅).
We endure hardships, nourished by happiness.
Overcoming obstacles, we relish our successes.

Space accommodates the travels of many.
Time tirelessly carves (誌) each traveler's memory and soul,
While marking and recording the observables

Those who think they understand all, really do not.
A wise man knows what he does not know.

When one understands the limit, one attains enlightenment (神哲).
What is unknown is for the realm of the divine.

[3] Gesamtausgabe

Theodore von Kármán as Swiss Property Owner

by KENT P. MISEGADES
VKI DC 1980

In my previous article, which appeared in NL19 (Supersonic Fighters and the Learjet – TvK in post-war Switzerland), I described TvK's involvement with an ambitious, but short-lived attempt by the Swiss to develop a supersonic fighter aircraft, the EFW N-20 Aiguillon, and how this lead to the development of the first Learjet. This article (which, to the delight of the Editor and perhaps some readers, will be brief) concerns von Kármán's participation in a small real estate investment company that helped to absorb some of the wealth he had accumulated during his long and illustrious career in the United States and Europe.

Past articles have described von Kármán's deep concern not only for the well-being of his favorite students, but also for his own wealth and preventing its erosion

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through taxation or confiscation by any government, Capitalist or Communist. One learns that he sought the release of his brother Miklós and his wife Margit from the Hungarian Communists, not out of brotherly love but so as to keep the remaining family wealth under his control. This included not only assets in Aerojet but literally the family jewels, which Miklós managed to smuggle to TvK in Switzerland in advance of his own release. TvK promptly hid these in one of two safes he maintained along with accounts in no less thank six banks across Switzerland. Swiss banks maintained strict client secrecy in the 1950s, making the country an ideal place for TvK to invest money, as well as his time through his long, friendly relationships held with leading Swiss scientists, foremost among these with Jakob Ackeret.

Unlike many foreign investors seeking only tax shelters in Switzerland, von Kármán desired to see his wealth grow even further, leading to the establishment in 1957 of a real estate company, the "Schönring AG" together with businessman Marcel Dreyfuss and TvK's trusted attorney and adviser, Horace Mastronardi, who played a key role in securing Miklós' release from Hungary and handling many other delicate tasks for the aging scientist. The starting capital for the Schönring AG was 50,000 Swiss Francs. Von Kármán invested another 350,000 Swiss Francs so the company could acquire its first property, a house on the 'Ostring' in Bern, today near the Paul Klee museum. In the following year the three partners purchased a second house at 93 Seftigenstrasse to the south of the University of Bern. Upon the death of Miklós in 1958, his wife Margit moved into one of the apartments in this house where she lived for the remainder of her life free of charge thanks to the trust established in the name of TvK's beloved sister Joséphine de Kármán, a trust that was to become the sole heir to the considerable fortune of TvK on his death in 1963.

In 1960 the Schönring AG purchased a 3rd property, an apartment house on the Talbrünnliweg, further to the south of downtown Bern in the Köniz district. In only three years, the Schönring AG, with three large apartment houses in one of the wealthiest cities in Switzerland, was so profitable that the partnership only needed a mortgage of 75,000 Swiss Francs to purchase this new property for 750,000 Swiss Francs. TvK made the acquisition even more lucrative for the Schönring AG and the Joséphine de Kármán trust by personally funding all expenses related to the purchase.

Not mentioned here are other properties owned by TvK including his spacious house in Pasadena, California (mentioned in previous articles) as well as apartments he rented or owned in Göttingen, Aachen, Paris and Madrid during his lifetime.

Seftigenstrasse 93, the second property acquired by Schönring AG, where Margit von Kármán was provided a free apartment following the death of her husband, Miklós, in 1958.

With TvK's death in 1963, his shares of the Schönring became part of the Joséphine de Kármán trust, which remains a substantial source of financial aid for students at the University of Bern, von Kármán's intent. According to records the author has obtained, the Schönring AG was liquidated in 2000. The von Kármán family jewels however remain in a safe in the Bank of Ernst in Vaduz, Liechtenstein. They were bequeathed by Margit von Kármán to the Swiss Cancer League (Schweizer Krebsliga) upon her death on November 8th, 1980.

In my next article I plan to revisit Theodore von Kármán's research during WWI in Vienna concerning propellers, work that led to significant performance improvements and success for the Austrian aircraft industry, which remains substantial even today.

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Interview with Philippe Kirsch, DC 1969

by Claus Sieverding,
DC 1966, VKI Honorary Professor

Following our recent mailing for the invitation to the 60th anniversary I got from our computer center a short list entitled "Opted out", meaning bluntly "Do not bother me anymore!" To my surprise among the former graduates figured also the name of Philippe Kirsch. Surprise, because after his participation in the VKI 50th anniversary event, several attempts to contact him had failed. Somebody told me that he had left for South America. I just thought, give it a trial. And then the answer came back immediately: "I am retired in Panama!"

Philippe Kirsch, June 2016

Most foreigners remember Belgium for its beer and chocolate. Similarly, up to a couple of months, the simple mentioning of Panama would make remind me automatically of "Canal and Hats". But very recently, these two items lost their top ranking, giving place to "Panama Papers". Should I add now "Panama: VKI Graduates Retirement Resort"? Remembering vaguely that before attending the 60th anniversary Philippe had also been in Kazakhstan this sounded like an exciting biography. Upon my request Philippe sent me a short CV and this exceeded by far my expectations. Luckily Philippe agreed immediately to share his exciting professional career with the readers of our Newsletter.

Philippe receiving his Diploma on graduation day

Philippe, you graduated in 1969 in the Turbomachinery Department and only two years later a PhD on the flow in pumps under the supervision of Professor Jacques Chauvin. This must have been one of the quickest PhD degrees I can remember.

"I think Hartmut Griepentrog had been faster. The Institute helped me a lot, building a brand new pump test rig and sending me for three months to the National Engineering Laboratory of East Kilbride in Scotland to support my calculations. Last but not least, my wife making her PhD in biology at the ULB next door was also a precious support"

As part of your social life I remember you playing frequently on the tennis courts in the sport center, in particular with your wife Micheline, and I suppose that there must have been other non-professional activities with your class mates. Did you try to keep in contact with some of them?

"Being Belgians living in Brussels, we felt normal to care about expatriates like Byron Roberts, Ivar Skoe, Shuang Huo, Gianni Raffo and of course Ahmad Noorbakhsh, inviting us mutually for eating at our respective homes. We spent some holidays in Italy with Gianni and Gianna Raffo, just married; they had a baby but unhappily my address book was stolen and we never could contact them anymore. Ahmad visited us regularly in Belgium; I met him and his family several times in Iran between '77 and '87. The last time was in '97 when touring through Iran we spent a week with his family at the Caspian sea. Once ACEC, recording our VKI past, nicely asked me to care about a VIP guest: Professor Pierre Lubunga (VKI '71)during his visit at our hydro power system division."

You chose then to start an industrial career at ACEC (part of Westinghouse Group). Your solid turbomachinery background allowed you to soon take up responsible positions.

"Napoleon used to ask his officer before promoting him to Marshal: "Sir, are you lucky?" I did not chose really anything; I was just lucky: My experimental pump at the institute was a gift of ACEC; before the end of my thesis I was proposed to join its R&D Laboratories and Jacques Chauvin told me: "You, like me, are made to make people

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work, take the job, the industry is great for you." I was offered a very good salary and a fictitious experience of 4 years for my PhD with full freedom for organizing my work. This valuation of my work at VKI explains my very quick progression in the hierarchy of the company. After designing some new pump impellers, optimizing cooling fans for generators, profiling the air intake of the ACEC gas turbines, and calculating at Westinghouse in Philadelphia the first compressor stages of the 100 MW gas turbine (the largest in the world at that time), I joined the Gas Turbine System Division as Technical Project Manager for a turnkey high performance combined cycle power station. Three years later and two weeks before its inauguration, I was sent to Iran to rescue our 12 units gas turbine project already two years behind schedule. It was in Teheran that I got the news of my promotion as head of the Engineering department, replacing my boss who was appointed director of the division. After a very successful completion of what was the first "serious" power station in Dubai I restructured my engineering department, reallocating a part to the "Rational Use of Energy", a new activity to compensate the loss of business due to the oil crises. I then became head of the Marketing Department keeping the pre-engineering (tendering phase). In this context, I started a very close collaboration with some Japanese companies for large projects like the desalination plants, mainly focusing to the Emirates market."

While being at ACEC you earned also an MBA at INSEAD, Fontainbleau , France one of the world's leading graduate business schools.

"The luck again, as ACEC selected me with another 30 colleagues to follow the MBA courses for company staffs at the INSEAD, in preparation for General Management level responsibilities. I also got a budget to intensively study Japanese."

This indicates that you did not want to spend your whole life designing pumps and gas turbines but that you wanted to get into the marketing and sales business.

"My Career Profile defined by ACEC planned for me to pass through many different departments. When I was proposed for the position of Director of the newly created "Rational Use of Energy" division, I refused it, preferring to keep my Marketing Department with its pre-engineering which needed more and more my presence in Japan. Having worked mainly in the Middle East for Gas Turbine projects and as this region was targeted by my Japanese partners, I became quasi automatically Corporate Sales Director for North Africa and the Middle East – 23 countries when the place was left vacant.

"I arrived at the general management level at the end of my industrial career when the Vice President of Marketing took me as adviser for cooperation with Japanese companies. A bit later I left the company – I was 42."

You left ACEC in 1987 shortly before it closed down and worked for 20 years as consultant and expert in economies in transition, first for a company, then as private consultant, mostly under contract for governmental agencies.

"Yes, the luck again, an international management consultant in Brussels hired me immediately for projects everywhere in Europe. Just after the end of the Berlin wall I became resident project leader for restructuring the gigantic Polish Copper Combinat. Not easy, full of surprises, but very educative. Having rapidly reached the limits of the Western management tools, I was forced to imagine pragmatic solutions, and to retrieve my sensations of former industry leader. A great experience. . .

"As very few people in this time period had been exposed to the reality of socialist economies, I quickly got a reputation of "expert in economics in transition" and, contracted by international organizations, was active in Bulgaria, Egypt, Ukraine... After three years at the European Commission I became coordinator to assist private companies in Central Asia and Mongolia"

Ulan Bator Parliament: The minister of labour (lady in dark suit) gives an honorific distinction to Zorygt rewarding the expansion of his business with our help.

Mongolia: shoe company,inauguration of the new plant: Next to me: Zorygt, director and designer, his wife acting director, engineer.

Mongolia: participants to an electoral meeting in the steppe

Kazakhstan: last visit to LPG bottling company after total modernisation by Italian experts.

Restructuring implies always also social aspects. Have you been concerned by these?

"Concerned, definitively yes, as I was now sharing the life of these populations trying to survive in the chaotic post communist world, with a sudden huge unemployment, no more public social security and often a very high inflation. Happily the few enterprises still active did not need "bleeding" restructuring, the very low wages reducing the personnel costs to a minimum not worth optimizing."

You have been in so many countries. You met so many people with different cultural backgrounds. Is it a problem to be sufficiently open-minded to accept that there are "many ways to Rome" to solve a problem and that you have to take into account the different sensitivities of people from different horizons?

"The luck again: to have had parents taking me with them since my young age when traveling through Europe, to have been educated to be extremely curious about everything, to have enjoyed this very special atmosphere at the VKI, and to have been gifted to learn all types of languages. All that plus the experience of negotiations, work and cooperation, helped to cope with so different persons like Poles, Iranians, Balts, Turks, Japanese. Finally, is a Belgian not genetically open-minded?"

You have been traveling a lot in Asian countries. Can you share with us some particular highlights of your travels?

"Iran: "where you learn the infinite patience!"
Central Asia: Kazakhstan, Kyrgyzstan Uzbekistan, Tadjikistan: "In search of the lost tribes": a reference to my mission to help isolated communities nearly inaccessible and forgotten
Mongolia: Genghis Khan, 5 times the surface of France for one million nomads and their 20 million camels, yaks, horses, sheep (cashmere wool) – probably the last free persons of the planet, so proud, so friendly, a real democracy.
Japan: nothing to say. . . everyone knows and everyone is wrong!"

Central Asia: Tadijks.

Tadijk Hospitality.

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Kyrgyzstan: Governor of Talas province (left) with our team and his collaborators.

With such a rich professional experience it appears natural that you wished to share also your expertise with others and hence you were engaged as Professor of "Corporate Strategic Management" at the Boston University in Brussels.

"Again, thanks to my PhD, I was called to teach in business schools. My capstone course looked really made for me as my ACEC experience of Business Plans (a Westinghouse add-on) combined with my "Japanese business touch" enabled me to concentrate in one course all I had to share with last year students."

Philippe with his wife Patricia from Costa Rica.

What made you decide to leave Europe after your retirement in 2007 and what have you been up to since then?

"In 2007, being 63, I decided to retire. Europe that I had visited so many times did not attract me anymore. Looking just for a sunny place with new horizons, I hesitated between South East Asian and Central America. Finally it was Costa Rica during the first eight years and now I am in Panama. Here I relax, read a lot, follow the progress of fuel cells and artificial intelligence and write about my life. Panama does not deserve its current reputation – the documents just came from the Panama branch of an international law office specialized in offshore. But Panama now is the biggest financial hub of Latin America, a capital looking more and more like Singapore and dreaming to become a new Dubai. The "new" canal is impressive – well done the Belgian engineers – and the country relatively nice and very generous for retired people."

There is a final question for the interviews: Do you have any recommendations to our graduates for their future careers?

"Our world now is volatile. Getting various diplomas or certificates is nearly a must – they will all be useful but not always for what you think. Jump on any opportunity, build any kind of experience as this is as important as a diploma. Never stop learning... all your life. And, above all, always keep a real passion for what you do."

Interview with Jiri Dobeš, DC 2002

by TORSTEN KLEIN
DC 2002

Jirka and I, attended the VKI DC of 2001/2002. After the course we met several times in Prague, Cologne and Dresden. When he was at my place, I invited him to come with my friends to do the German version of bowling (Kegeln). He did not do that before but we never saw a person for the first time throwing the kegel ball with such a power and precision towards the pins, which looked for him rather to be a target than just pins. Well, he explained later that he could gather a lot of bowling experience during university times, however, the kegel ball is different and people are not used to it because there are no holes inside. But good for us, some beers compensated this advantage a bit later on.

Jiri receiving his Diploma on graduation day

Jirka, where did you work after your Diploma Course?

"I decided to stay at VKI for my PhD. The study was based on an ad-hoc agreement between rectors of the Czech Technical University and Université libre de Bruxelles. I continued the development of basic research on residual distribution schemes for advanced applications under the supervision of Prof. Herman Deconinck. Main topics concern aero-elasticity, moving meshes, laminar viscous flows, shallow water equations, wave propagation in elastic bodies, etc. In Prague I pushed for the application of the schemes for technical problems – mainly for transonic turbulent turbomachinery flows. It was a very nice period of my life. Nice friends at VKI, interesting work, results published in solid research journals and conferences. When the PhD work was completed, I returned to Prague. I have still enjoyed the work, but teaching duties of not-always-very-motivated-students and science work administration started to eat more and more of my time. At the same time I felt some slowdown of the work pace. After some time I have decided to leave science and try another career path."

Jirka with his wife Zuzka and his two children Max and Theodor.

What did you do after leaving. . .

"I joined a management consulting company, The Boston Consulting Group (BCG). We gave advice on all aspects of problems faced by companies today from strategic recommendations on the overall direction of the business, opening new business lines for new products, supporting mergers and acquisitions, advice on pricing, etc. I was working in Europe (Slovakia, Denmark) and on the east coast of USA. The work was very interesting and challenging. However, when our first kid, Max, was born, it was time to move to a more "settled" way of life and stop daily traveling for business.

"I've joined Doosan Škoda Power, a manufacturer of steam turbines. The new work offers a perfect match to my past experience: business experience from BCG with technical know-how on fluid dynamics from PhD times and general mechanical engineering from university and high school. I have changed job positions several times within the company. Now I am project manager and head of the project office. In the past I have helped to establish industrial marketing and corporate strategy departments. I really do enjoy my work."

What benefits could you take from your DC time at VKI for your professional career?

"Since I left University/VKI I did not work with CFD anymore. However, the company I work for is essentially designing and selling fluid dynamics machinery. Clearly, VKI background gives me an advantage as a turbomachinery professional. Perhaps even more important than technical knowledge are general problem solving skills and comfort in multicultural environment, what I gained at VKI."

Fixing stator winding of a blender.

Is there anything special you could tell us about your DC life at VKI and in Brussels in 2001/2002 . . . ?

"I really enjoyed the spirit of the DC, working hard and having fun. At the end of my DC, Herman Deconinck with Remi Abgrall and several other guys organized a workshop in Bordeaux for residual distribution schemes. We were 20 people in total, some of the senior guys I knew only as "names for numerical methods". I even did not try to imagine that they are still in business and active. After work, while going out for a drink, they shared stories on how they invented their numerical methods in the midst of the cold war. This was pretty amazing."

Are you still in contact with the colleagues of your DC?

"Beside every-new-year email with mutual invitation to Cologne/Prague with you, Torsten, I am in touch with several of our friends. We visited Johannes Baumgart in Dresden a couple of times, Johannes and his wife also went to Prague. We managed to return a visit to Karin Hald to Oslo, and we are in touch. I've got a call from Mario Ricchiuto that our paper on residual distribution schemes is finally out (after 8 years of reviewing?). We are in touch with a few more friends from VKI times, although with some of them only via Facebook."

Did you return to VKI for attending or contributing to Lecture Series or did you have any collaboration with

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VKI?

"Unfortunately, not. But I have recommended VKI Lecture series to some of my colleagues."

What were the most exotic types of fluid dynamics problems you had to work on in your professional life until today?

"I cannot share the nature of fluid dynamic problems what we face at work. However, to give you an idea about our day-to-day business: as I mentioned before, I work for Doosan Škoda Power. We have celebrated 111 years of steam turbine production last year. Interestingly, it is a much more difficult business than I have ever thought. There are only a few companies with original technology in the world, that can produce large steam turbines. It is a mature industry; the customers are often tough and well-established companies. The contract is over 1000 pages long, often written in some exotic language governed by an exotic law, with exotic local regulations and grid code. There are multiple parties each with a "good idea" on how the resulting power-station should look like. We are active on all continents (not on Antarctica), managing works on site. It is always a technically advanced solution, we use state of the art materials, manufacturing tolerances are often a few μm, etc. We have a big R&D dept, with a fully equipped lab including a 10 MW steam turbine. I have never ever heard about more interesting businesses – technically, commercially and in terms of people organization."

As a compensation for not sharing a nice exotic type of fluid dynamic problem: Jirka, what is the most twisted C coding you ever saw?

"My favorite is Ian Phillipps code winning The International Obfuscated C Code Contest 1988 and The Story of Mel. Search Google for both, it is funny and also very educational. I strongly recommend to read it."

And the most strange coding language you used?

"I write quite a lot in AWK. It is a language from good old times of UNIX for text manipulation. Actually, I still use it from time to time."

If I asked you: what kind of story you will not forget when you start to think about programming, what would you answer?

"During my university time (before the VKI DC) I already wrote a quite long FORTRAN 90 code for 2D compressible flow simulations on unstructured meshes. Although the code was OK, it started to be difficult to implement new features I wanted to work on for my PhD. I started to contemplate writing a new code from scratch, also switching from FORTRAN to C/C++ (mainly because of the larger community and better documentation compared to FORTRAN). It was by the end of my DC, one evening after having some drinks with DC friends – I went to bed, but still could not sleep dreaming about the new code. After some 30 minutes, I got up again, decided midnight to be a good time to start with the new code. As one of a few students I had a computer at home – laptops were virtually non-existent at that time – since some time before, I had borrowed from Ar pad Csik an outdated Pentium III which was a spare part in KU Leuven. I started coding with main() [C language, remark from the editors], and in the morning I had created a NACA0012 transonic test case running for 1st order upwind with Roe and LF flux on unstructured meshes. The computer was OK to compile the code and check whether it was running, but to get results, I had to go to VKI to run it on the Alpha station. At 9 a.m. it converged and I went back home to sleep. . . "

Jirka with his children and the Dog.

Finally – What do you do in your spare time?

"I have two kids, with whom I spend most of my time. I try to teach them a love and passion for engineering and science and awake in them general curiosity.

"In terms of personal hobbies, I try to run several times a week and I have started boxing to get in shape. I learned the Korean language already for a few years [Doosan is a Korean concern, remark from the editors]. I have started to play 5 string banjo last year. But it is very, very difficult to find free time for all of that."

Many thanks for answering the questions.

A day at the European cradle of aviation science and research, ONERA Lille

by Tamas Regert
DC 2004, Assistant Professor

This year the one day trip sponsored by the VKI-AA targeted one of the research centers of ONERA based in the city of Lille. The trip was fully organized by Prof. Mario Carbonaro and contrary to last year's trip to the Le Bourget airshow (see NL 18) the trip went very smoothly.

ONERA Lille.

We found ourselves in front of the ONERA main building with only a 10minute delay with respect to schedule. The inscription and "badging" process was very quick due to the pre-registration of the participants, so the program started just in time, without a minute lost. Our host was Alain Merlen, former scientific director of the fluid mechanics branch at ONERA Lille who was also a former member of the TAC (Technical Advisory Committee) of VKI.

First a general overview was given in the form of a presentation by the director of the Lille establishment of ONERA DAAP (Department of Applied Aerodynamics), M. Bruno Mialon. We were amazed to learn about the aviation-related activities that usually all aerodynamicists just dream about doing. The legendary and extremely highly precious status of ONERA on the world scene was clearly reflected from this presentation and justified the basic attraction and expectation of the participants. The Lille centre of ONERA is one of its oldest establishments, dating back to 1929. Their L1 wind tunnel thus existed already before the creation of ONERA itself and it is still in operation with a high scientific value. Beside this ancient, yet heavily used facility, four other major facilities were highlighted by the director: the model design and fabrication department, the free flight facility, the crash test facility and the vertical wind tunnel. We were informed that it was impossible to visit the vertical wind tunnel this time because a confidential test was being carried out in it, but this did not decrease the magical ambience of the visit.

The first station of the visit was the model design and fabrication department. M. F. Ternoy received us in the hall of the department where some special examples of their work are exposed. M. Ternoy described the activities of the workshop and the office and the extreme requirements concerning model precision and quality. The office also designs and produces models for cryogenic wind tunnels in cooperation with DLR, the German Aerospace Center. He emphasized some aspects of the special requirements of cryogenic models, mainly concerning humidity and thermal dilatation and thermal stress issues. Wing models equipped with MEMS (Micro Electromechanical Systems) actuators and synthetic jets were also visible. Such wing models are characterized by a high level of complexity in construction: the main structure of the wing was metal as it has high precision and good strength against flow-induced model deformation, MEMS are flush mounted on the wing surface and several of them are placed side by side in several rows (yet another technical challenge), downstream of the actuators there was a plastic type of flush-mounted insert characterized by high thermal emissivity for infrared thermography measurements of the effect of the MEMS actuators. All this was implemented in a wing of mean chord length 150 mm and maximum thickness of 20 mm... almost an artistic work rather than ordinary engineering. Some air-screw blades made of carbon fiber composite materials were also exhibited. The 3D printing technology has infiltrated as well at ONERA as a fast way of model production, but according to a comment from Alain Merlen, the precision of such models is lower than that of metallic models. The department also produces aerodynamic balances, out of which a special double sting balance system was exhibited for the visitors. This model was designed to measure the loads acting on a jet engine nacelle and on the embedded fan, separately. Thus the nacelle and the internal rotor unit were fixed on separate stings, leading to challenges at the wind tunnel interference correction activities.

The next station of the visit was the ancient L1 wind tunnel, dating back to 1929, a purely French production. The age of the wind tunnel does not reflect its performance; it is still a very worthy facility with high scientific potential. Currently, flow control basic research is carried out in its test section, in the frame of which a wing section is equipped with so-called sweeping jets as actuators. These actuators are meant to influence the boundary layer separation for high lift conditions. M. Mialon explained that they had a very interesting and successful cooperation with DLR on the application of synthetic jets on a wing model. The main challenge concerning synthetic jets is that the net mass flux of the jet has to be zero, although the net momentum flux can be different from zero. The realization of such a synthetic jet imposes technical problems for the accurate blowing and suction cycles. The input and extracted flow rates have to be accurately measured to ensure that the net mass flux is zero. M. Mialon explained that although blowing can be realized by a rather over-sized pressurized air system, the extraction of air is a more challenging problem.

During the discussion next to the L1 wind tunnel the usual flow control related question arose: when and how can these devices be applied on real cruise aircraft... the answer was clear: it is a multi-disciplinary

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problem, the first task is to demonstrate the feasibility, which is successfully done. The next is to evaluate the necessary equipment that is needed for providing the operation of the actuators. This equipment must not be bulky and heavy, nor should it require high energy input. The following issue is the certification for flight that implies a whole series of safety and operational security requirements in order to not endanger any phase of flight, including emergency situations. As a consequence, we learned that from the aerodynamic point of view, the existing flow control techniques have proven so far to be highly successful. The remaining large portion of the road to be done concerns the development of all the devices and infrastructure necessary for their operation.

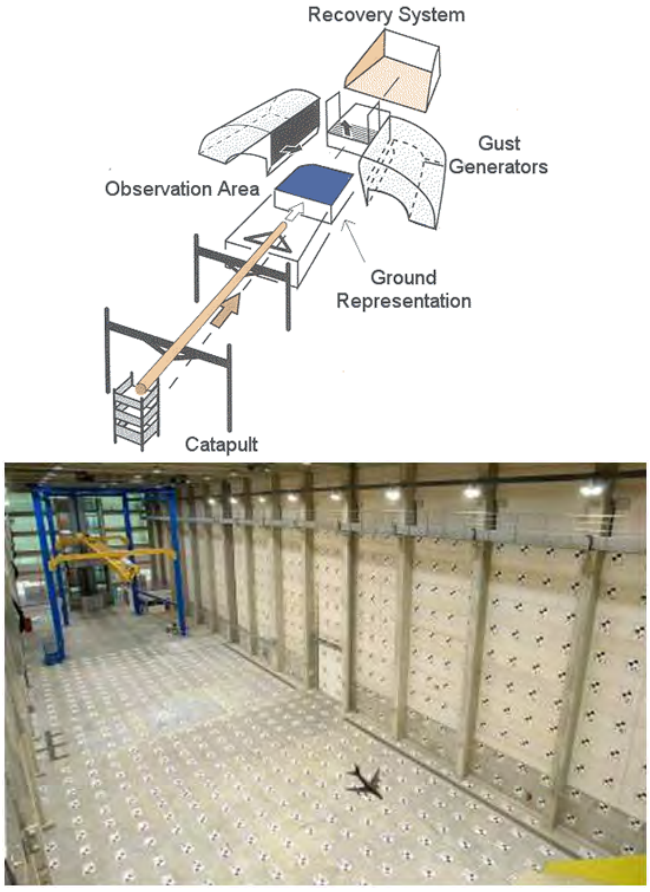
After the interesting discussion at the L1 test section the group walked to the crash tower facility where M. G. Portemont received us. It was an exceptional occasion for us as specialists of fluid mechanics, to visit such an installation where an extraordinary activity is carried out: the study of damage caused to an aircraft structure. M. Portemont started his presentation by comparing the crash tests of aircraft to that of cars. The main and most obvious difference is that while cars can be tested in 1:1 scale using their real structure for crash tests, large aircraft cannot be built for this purposeĚ it would be extremely expensive. The crash analysis engineers thus have to rely on similarity laws and numerical simulation of structure deformation and behavior during the crash landing events. For this reason aircraft crash analysis requires high validation data input in order to increase the reliability of their computations. For this reason the main task of the crash tower facility is to apply a series of well controlled impacts on aircraft structure samples and determine the manner and level of damage. The test section of the crash tower is limited to small samples, on the order of 0.7 m diameter in total, but yet it is possible to build smaller scale real aircraft airframe models to see how a complex structure would behave for impact in this section. Next to the massive and impressive 15m high crash (drop) tower facility we have seen an impact simulation ballistic gun which shoots simulated birds or other obstacles at aircraft parts. The impacts are recorded using high frame rate imaging systems with an impressive 100000 images/s camera system operating at 1 Mega-pixel resolution. The crash testing department is developing stereoscopic reconstruction techniques as well for the evaluation of the deformation of the structural elements. M. Portemont highlighted a recent problem with the newest aircraft technology: recently carbon fiber reinforced composites are very popular in aircraft construction technology due to their very high strength, specific rigidity and very low weight. However, during a crash it breaks in a rigid way, spreading very sharp chips of the fiber composite structure all around and the damaged parts can be extremely sharp. This characteristic puts these materials in a disadvantageous position with respect to conventional steel and aluminum structures. Aluminum just deforms and folds, and as such there are no sharp broken surfaces and razor blade sharp chips around.

Crash tower (image courtesy of ONERA).

From the crash tower facility the group walked to the amazing free flight facility. The so-called B20 hall is 20 m wide and 90 m long. Scaled models of airliners (approximately 1:30, 1:35 scale) can be launched by a catapult system and they can fly a 90 m trajectory. Along the way they pass through a 'test section' of an open section wind tunnel which can produce a flow perpendicular to the flight path in lateral direction to the model. In this way a sudden strong gust can be simulated and the behavior of the aircraft thus evaluated. This kind of testing of aircraft configurations experiencing wind gusts is not possible in conventional wind tunnels and justifies the utility of such a large and impressive installation as the B20 free flight facility. M. Mialon explained that the models are first tested in "conventional" wind tunnels in order to create their aerodynamic database for all different settings of the flaps, slats, trim, elevator and rudder positions. As a result, before the catapulting event the researchers know at what trajectory the aircraft model will fly in the absence of the simulated gust. At the end of the hall, the model "lands" in a cavity filled with foam and other shock-absorbing materials to minimize damage. Usually only the aircraft nose is damaged, but the

leading edges of the wings remain in good state. However, the main task of this testing is usually the investigation of model behavior in the presence of the lateral wind gust. Evidently as the gust effect is rather unpredictable and the aircraft models are not remotely controlled, it happens sometimes that the model with its on-board instrumentation deviates from the foam-filled cavity and encounters the less forgiving building wall at a velocity of 40 m/s . Recently this facility has been used for testing small drones as a new and popular area of aviation technology.

After finishing the visit of these facilities the group left the territory of ONERA and took a nice lunch at the Institut Pasteur. In the afternoon the University of Lille hosted us where two main institutes were visited: the LML (Laboratoire Mechanique Lille) and the IEMN (Institut d'électronique de microélectronique et de nanotechnologie). Due to the limited number of people allowed for the visit of IEMN, the group was divided into two sub-groups. While one group visited IEMN, the other group visited LML.



B20 free filght facility (images courtesy of ONERA).

At LML Jean-Marc Foucault was our host; he showed us the boundary layer wind tunnel on which they have already carried out much fundamental research on boundary layer turbulence and flow control. The 27 m long, fully transparent test section of this low speed wind tunnel allows complete optical access to any part of the boundary layer. The laboratory is exceptionally well equipped with optical measurement techniques, mainly with PIV (Particle Image Velocimetry). Many high resolution double shutter cameras were aimed at the part of the test section of interest showing that multiple fields of view are about to be measured by a stereoscopic PIV approach. The famous "2D bump" configuration, which served as a reference test case in the past decade for many European and worldwide studies on flow control, was examined in this wind tunnel by the research group to which Jean-Marc also belongs. Tamas Regert, one of the visitors in the group expressed his feelings, being very much touched by this experience, as he also used this bump configuration as a test case several years ago when working on the subject of flow control. M. Foucault explained that they have re-designed the bump experiment by introducing a new bump geometry where the location of boundary layer separation is fixed. The original bump was rather similar to an airfoil with a smooth surface, thus with undetermined and varying location of boundary layer separation. Currently a research group is trying to measure the wake of a fractal shaped geometry that echoes the old idea that turbulence might be related to fractal structures. . .

The last station of the visit was the IEMN which is the key point of all the research done locally by ONERA and the University of Lille. This institute is the biggest one of a network of electronic and microelectronic establishments. Their specialty is the production of micro and nano-scale structures, devices like flow velocity and pressure sensors, and MEMS and synthetic or pulsed jet producing devices. The IEMN is well equipped with a clean room system and with machines able to assemble models on atomic levels. The institute consists of two large units: the production unit where the small devices are constructed, and a diagnostic unit, where all the characterization and quantification happens. The group visited only the production unit which was rather impressive. The extraordinary machines of production were behind the windows of the clean rooms and they looked like any other machine to the outsider such as our group was. However, the explanation given by our host was just amazing. Etching with electron beams and printing by short wavelength laser light, masking in nano-scale layers, gave an outstanding ambiance for the specialists of fluid mechanics. It was evident that research activities such as flow control cannot be carried out in an organization specializing in fluid mechanics without such a sophisticated institute within the group.

The visit was such a rich experience that it would be nice if similar future visits could be made part of the RM course with obligatory participation for all RM students.

The Elephant of Nantes

by MIGUEL ALFONSO MENDEZ
VKI PHD CANDIDATE
WINNER OF VKI-AA RESEARCH TRAVEL GRANT 2016

I'm Miguel Alfonso Mendez and I was awarded the VKI-AA Research Travel Grant 2016. Next October I'll start the 4th year of my Ph.D. in VKI on the dynamics of a gas jet impinging on vertical falling liquid films. Last April, thanks to the VKI-AA Travel Grant, I had the possibility to spend one month in Nantes, at the Institut de Calcul Intensif (ICI) at Nantes's Ecole Centrale (EC), under the supervision of Prof. Thierry Coupez.

To study the complex and coupled phenomena occurring in the interaction between an impinging jet and a falling liquid film, my research has focused on the analysis of simplified laboratory models. One of these consists of a jet impinging on a 2D membrane whose shape and motion are imposed and controlled remotely. In December 2015, while presenting my last experimental results to several partners in this research, I had the opportunity to meet Prof. Coupez, who has shown a great interest in my research. In particular, my configuration was of great interest to test the capabilities of the CFD code his group has been developing in the last ten years.

In fact, the large deformation featured in the configuration analyzed experimentally is a great challenge for standard CFD packages, but naturally modeled by the CFD code (ICItech) developed by Prof. Coupez's group. This code is the result of a long-standing expertise on computational methods of the ICI group, which combines several interesting ideas such as variational multiscale, anisotropic mesh adaptation and immersed framework. To start the VKI-ICI collaboration, it was of interest to spend some time in the ICI lab.

A few days later, the possibility to start this collaboration was opened by an email of Prof. Carbonaro recalling the opportunity offered by the VKI-AA travel grant for a research stay at a foreign laboratory. With no doubt, this was an opportunity to seize immediately, and the adventure started just a month after the VKI-AA Research Travel Grant was awarded.

The ICI lab welcomed me warmly and made me immediately feel right at home. It was clear since the very first day that this was going to be a fruitful collaboration for both teams: the ICI code proved quickly to be extremely powerful, and my experimental test case has been just the validation test case they were looking for. The workload, indeed, also proved to be very demanding as I had to learn many new ideas and a new programming language from scratch. Time passed quickly, but with the support of the ICI team, every day has been efficiently spent. Several interesting simulations have been carried out, and a remote connection from VKI to their super computer Liger has been established.

Besides the challenging and rewarding work experience, my stay has been wonderful. Nantes, the "cité des ducs", is considered as one of the most liveable cities in Europe. Easily accessible and with a good public transport system, Nantes is an important student city with a weather a lot sunnier than Paris and, no doubt, Brussels. The banks of the Loire river are always full of students and tourists enjoying the sun, particularly in the areas around the île de Nantes. Here, I had the pleasure to visit one of its main attractions: the famous warehouse hosting the "Machines de l'Île", an interesting artistic, touristic and cultural project aiming at promoting the city's image of a creative metropole. The warehouse hosts several monumental structures which combine the mechanical universe of Leonardo Da Vinci and the imaginary worlds of Jules Verne. Its most representative machine is a mechanical elephant 12 meters high, 8 meters wide, made from 45 tons of wood and steel, and taking about 50 passengers for a 45-minute walk.

A walk along the banks of the Loire on a 12m high mechanical elephant.

Moreover, like every other French city, Nantes boasts delightful gastronomy, famous for pork products like the Rillettes du Mans, and some tasty cheeses such as Port Salut, Saint Paulin and Curé Nantais.

I am deeply grateful to the ICI team and the full group of PhD students at the Ecole Centrale (EC) for making this experience so memorable, and for making me feel part of their wonderful family. The activities carried out with this collaboration, besides CFD coding sessions, include interesting... laser battles! Organized by the ACDC association of PhD Students, this battle has seen 3 teams of 10 people fighting until the last laser shot for defending their bases: a fun challenge that should definitely be exported to VKI PhD community!

PhD Students in Nantes in a Laser Game Challenge. Miguel is second from left in the front row.

Indeed, my collaboration with Prof. Coupez has been really rewarding and I strongly recommend such an experience to any VKI PhD Student. I believe that the possibility offered by this fellowship is of fundamental importance to VKI. Not only does it allow for setting up scientific collaboration with other institutions/universities, but it also allows PhD students to broaden their professional expertise, and maybe to bring back to VKI interesting ideas. Such as a laser battle at VKI, for example!

. . . We also shared some Belgian beers I brought to Duisburg. . .

by Gian-Luca Gori
VKI PhD Candidate
Winner of VKI-AA Research Travel Grant 2016

I am a PhD student at the Von Karman Institute and this year I have been awarded the VKI-AA Travel Grant. I investigate experimentally the behavior of cooling channels, specifically applied to turbomachinery. The idea is to provide additional information of the flow by measuring its temperature. It is important to do it non-intrusively and maintaining the test conditions as close as possible to the real case. For this reason, the visit to the Universität Duisburg-Essen was a great opportunity to acquire experience from the experts of LIF (Laser Induced Fluorescence) temperature measurements in gas-phase flows.

Prof. Kaiser allowed me to work with his research group in an optical IC engine. The latter, shown in the picture below, even if it is not visible, is composed by a quartz transparent optical part of the cylinder. This allows the optical accesses of the laser and both cameras. The technique is really sensitive to the level of signal recorded by two cameras. Indeed, the higher signal the lower influence of noise. However, it has been shown that a too high Intensifier Gain decreases the quality of the images. In this period we dealt with finding a good compromise. Some images were also taken with the running engine at different crank angle positions. In addition to the experience acquired in the laboratory, I had the opportunity to work on the post processing of already existing LIF images in order to retrieve the temperature distribution.

The experimental set-up in the optical IC engine.

Besides, during formal and informal meetings, I received specific suggestions for my PhD study. In particular, Prof. Kaiser suggested a one-color approach with toluene for its greater temperature dependence and high signal. Further increase of the signal might be obtained as well by using nitrogen as the working fluid instead of air. These inputs will be soon put in practice in the facility we designed at the VKI for the LIF temperature measurements in cooling channels.

The IVG (Institut für Verbrennung und Gasdynamik – Reaktive Fluide) is part of the Universität Duisburg-Essen and it is several years that it is a really important center for combustion and optical measurements in IC engines. In the laboratory 4 completely separated engine cells are present for research. Prof. Kaiser follows every day the progress done in the lab for the different projects and his competence and experience is transferred to all people working with him. It was nice to speak with them and know everything about their activities. The work environment has a nice atmosphere where people often take breaks together in the morning and for lunch in the University canteen. We also shared some beers I brought from Belgium when I realized that Prof. Kaiser likes Belgian beers.

There was also time to enjoy and visit the small city of Duisburg as well as the neighbor Düsseldorf.

Duisburg (left) and Düsseldorf (right)

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I want to show my enthusiasm for the great time I had in Germany. It is always important to exchange and acquire experience in a foreign laboratory and I want to gratefully acknowledge the VKI-AA for giving me this opportunity.

Obituary

GREGORY HOLBROOK

Gregory Holbbrook passed away on August 13 after a severe illness. Greg attended the VKI Diploma course in 1979-80 in the turbomachinery department under the supervision of Professor Frans Breugelmans. He graduated with honours and received the von Karman prize. Greg started then on an industrial career in the aeronautical sector. For the last 28 years he worked at Honeywell. He was an outstanding engineer who made many contributions to the field of turbomachinery and compressor design.

Greg (right) with Prof. Frans Bruegelmans in the 50th anniversary of VKI in 2006.

Greg kept strong links with the von Karman Institute. In 2008 he was co-founder of the VKI Alumni Association and was board member ever since. We lose a great engineer, a strong supporter of the Institute and a true friend.

On behalf of the Alumni Association
Claus Sieverding

Celebration of VKI 60th Anniversary

FINAL PROGRAM
FRIDAY OCTOBER 14TH, 2016

09:30	Registration
10:00	Alumni visit of the VKI laboratories
12:00	Sandwich Lunch
13:30	VKI-AA General Assembly
15:00	Break and welcoming of invited external guests

15:30 **ACADEMIC SESSION**
Chairman: *Mr. Jean-Jacques Dordain, Chairman of the VKI Board of Directors*

Welcome Address – Review of the research at VKI from 2006-2016
Dr. Jean Muylaert, Director, VKI, Belgium

ESA and IXV (Intermediate eXperimental Vehicle) Activities
Dr. Giorgio Tumino, Programme Manager, ESA, The Netherlands

Nuclear Reactor 4th edition
Prof. Hamid Aït Abderrahim, Adjoint Director, SCK•CEN, Belgium

CFD and High Performance Computing
Prof. Christian Cord-Rossow, Head of Institute, Braunschweig, DLR, Germany

European Cleansky project
Dr. Jean-François Brouckaert, Project Officer, CLEANSKY Engines ITD, Belgium

Impact of Nanotechnologies on Fluid Dynamics Research
Pierre Proulx, Full Professor, Université de Sherbrooke, Canada

18:00 Cocktail Party

19:30 **Alumni Dinner**
Kasteel Gravenhof
Alsembergsesteenweg 676, 1653 Dworp

OPEN DAY ON
SATURDAY OCTOBER 15TH, 2016

11:00–16:00	Visit of Laboratories
18:00 – . . .	Aperitif and BBQ for VKI Personnel, Students and Alumni

Kasteel Gravenhof