EUROMECH
European Mechanics Society

Newsletter 16
June 2000

President's Introduction

It is with deepest sadness that I inform you of the peaceful death of Professor G.K. Batchelor on the evening of March 30th and of Professor D.G. Crighton a few days later in the early afternoon of April 12, 2000.

George Batchelor was one of the founders of the European Mechanics Colloquia, and the founding Chairman of the European Mechanics Committee a post in which he served from 1964 until his retirement in 1987. His energy, knowledge of the field and wide connections helped to establish these small research conferences as a very successful series of colloquia with specialised, timely and interesting topics connected to fluid or solid mechanics. He and his committee guaranteed high standards, well chosen chairpersons and, in general, informality. EUROMECH Colloquia brought together researchers from Western and Eastern European countries and furthered understanding within the mechanics community. 231 colloquia and the first European Turbulence Conference in 1986 were held during his Chairmanship. We shall miss his vision, his clear guidance and great knowledge.

David G. Crighton joined the EUROMECH Committee in 1984 and took over the Chairmanship from G.K. Batchelor in 1988. He won the sympathy, the respect and the support of the committee and the mechanics community in Europe at large in a very short time. This was due to his wide knowledge of the field, his great enthusiasm, his enormous energy, his diplomatic skill on the European stage and his human warmth, documented in his many letters and conversations. David G. Crighton led the discussions which resulted in the extension of the activities of the European Mechanics Council and effected its transformation into the European Mechanics Society in 1993. He served as the first President of this Society until 1997 and continued to serve as Vice-President. The EUROMECH Society has lost a great promoter and adviser and all of us an invaluable friend.

Hans-Hermann Fernholz
President, EUROMECH

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performs an oscillatory rotation about its centre, where the flow is continuously perturbed by boundary-layer formation and detachment.

Laboratory experiments will be carried out in a rectangular/square container mounted on a turntable that rotates with a harmonically modulated angular velocity and with the modulation amplitude and frequency, respectively. The overall background rotation guarantees that the flow is 2D. A sophisticated digital image analysis technique will be applied to measure the evolution of the vorticity distribution. In addition, the (chaotic) transport properties of the forced flow will be determined by both dye visualisation and particle tracking.

Numerical flow simulations will be carried out with the available spectral code. These simulations are complementary to the experiments, and will provide information about flow properties that can not be measured in the laboratory (like integral quantities, statistical properties, spectra etc.).

This post-doc project will substantiate our current work on 2D turbulence and coherent vortex structures. Given the fact that the required experimental and numerical infrastructure is available, it is expected that important results will be obtained and that the project can be completed successfully in two years time.

Scientific importance and relation to other fields

Apart from being scientifically challenging topic, selforganisation and advection characteristics of forced or decaying 2D turbulence is of great importance to a variety of flow simulations, ranging from tokamak-confined plasmas to geophysical flow systems. In the latter category, the dispersion of tracer pollutants in the atmosphere, the ocean and in estuaries is a crucial problem that can only be understood when the underlying advection properties of the flow systems are known.

If you are interested in this position, please contact GertJan van Heijst or Herman Clercx, who will be pleased to provide further details. For more information about the research activities of the Fluid Dynamics Laboratory, see http://www.fluid.tue.nl/.

In all cases send detailed resume and names/addresses of three professional references to

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GEORGE BATCHELOR FRS

G.K. Batchelor, FRS, Emeritus Professor of Applied Mathematics at the University of Cambridge, and Fellow of Trinity College, Cambridge, was born on 8th March 1920. He died on 30 March, aged 80.

As Founder Editor of the Journal of Fluid Mechanics, a position that he held for more than 40 years, George Batchelor exerted a prolonged and profound influence on a subject of central importance for both Applied Mathematics and Engineering Science. In his own research, first into the phenomenon of turbulence, a subject described by Einstein as the most challenging unsolved problem of classical physics, and subsequently into the field that became known under his leadership as 'microhydrodynamics', Batchelor wrote with exceptional precision and lucidity; and both by his example, and by the firm yet kind control that he imposed in his Editorial capacity, he played a crucial role in establishing the standards by which the best work world-wide in the broad field of Fluid Mechanics is now judged.

His influence during his long career within the University of Cambridge has been equally profound. As Founder Head of the Department of Applied Mathematics and Theoretical Physics (DAMTP), a post that he held from 1959 till 1983, he established an environment in which research in all applications of mathematics flourished, and in which many generations of research students were encouraged to develop their creative skills. Under Batchelor's leadership, the Department became a Mecca for senior visitors from all over the world who came to participate for extended periods in the exhilaration of fundamental research; a worldwide network of continuing research collaboration, in which DAMTP was the focus, developed from these origins.

George Keith Batchelor was born and educated in Melbourne, Australia. He studied Physics and Mathematics at the University of Melbourne, and then, at the start of the War, undertook research in a range of practical problems in Aerodynamics related to the war effort. During this period, he recognised turbulence as the greatest challenge in aerodynamics, and resolved to devote his energies to this great problem as soon as the war ended. He wrote to G.I.Taylor, the legendary British authority on turbulence at that time, offering his services; Taylor agreed to supervise his research, and in January 1945, together with his wife Wilma, also of Melbourne, Batchelor embarked on a marathon ten-week voyage via New Zealand, the Panama Canal and New York, and finally in a convoy of 80 ships across the Atlantic, and so to Cambridge, where the spring flowers and trees were in bloom, and where he and Wilma were destined to spend the rest of their lives.

Batchelor was fiercely ambitious and totally committed to research, and made very rapid progress. Remarkably, he was the first western scientist to recognise the significance of the theory published by the great Russian mathematician Kolmogorov in 1941; Batchelor presented a critique of this theory at the sixth International Congress for Applied Mechanics, held in Paris in 1946, an achievement that immediately marked him as a rising star in the field of turbulence research.

Over the next 15 years, Batchelor published a succession of increasingly detailed studies exposing the intensely difficult nature of the turbulence problem -- a difficulty matched only by its central scientific importance in many fields -- not only in aerodynamics, but increasingly in chemical engineering, in the dynamics of ocean and atmosphere, and in the magnetohydrodynamics of interstellar gas clouds -- all areas in which Batchelor made fundamental contributions during these years. His research monograph 'Homogeneous Turbulence' published in 1953, virtually defined the subject; at the age of 33, Batchelor had created a new field which was to offer an extreme challenge to succeeding generations of mathematicians, physicists and engineers.

It was in 1956 that Batchelor founded the Journal of Fluid Mechanics, and in 1959 that, largely under his impetus, the Department of Applied Mathematics and Theoretical Physics was established in Cambridge. The administrative effort was enormous, and this, coupled with a growing recognition of the extreme intractability of the turbulence problem, deflected Batchelor's energies from research throughout the 60's; he did however publish in 1967 his definitive 'Introduction to Fluid Dynamics', a textbook of characteristic thoroughness emerging from his teaching of the subject in Cambridge, and now widely used for University courses, more appreciated, it must be said, by the teachers than by the normal students of such courses.

In the course of writing this book, Batchelor recognised that the techniques familiar to him from turbulence theory could equally be applied to problems involving the dynamics of fluids in which small particles or bubbles are in suspension. He developed these ideas in a powerful sequence of papers published in the early 1970s. He attracted a new cohort of talented research students to work in this field; and thus was the subject of microhydrodynamics born.

With far-sighted vision, Batchelor perceived the need for greater interaction at the European level in scientific research, and in 1964 was instrumental in establishing the European Mechanics Committee (now the European Society for Mechanics); he governed this body as Chairman till 1987. The function of the Committee was to promote and organise symposia on all aspects of Mechanics, both Fluid and Solid, at the European level, and it did so, under Batchelor's guidance, with spectacular success. Batchelor was also for many years a member of the Congress Committee

PhD position on two-dimensional turbulence

A PhD position is available for research on self-organisation and chaotic advection in two-dimensional (2D) turbulence. In contrast to three-dimensional turbulence, 2D turbulence is characterised by an inverse energy cascade, i.e. a spectral flux of kinetic energy from smaller towards larger scales of motion. As a result, 2D turbulent flows show selforganisation, visible in the emergence of large-scale vortex structures.

The present work on 2D turbulence is aimed at a better understanding of the effects of lateral walls (finite domain size) on the self-organisation process. In a companion project, the emphasis lies on an experimental study of 2D turbulent flows generated in a stratified electrolyte solution by applying electromagnetic forcing. Sophisticated visualisation and image analysis techniques are used to quantify the transport characteristics of the 2D turbulence. The vacant position concerns a high-resolution numerical study of the selforganisation process and the advection properties in 2D turbulent flows on a finite domain. For this purpose a pseudospectral code is available, which allows accurate calculation of the flow field. In order to determine the dispersion characteristics of the 2D flow, a Langrangian technique will be applied, allowing for tracking of passive tracers.

The numerical simulation project and the experimental project are complementary.

If you are interested in this position, please contact GertJan van Heijst or Herman Clercx, who will be pleased to provide further details. For more information about the research activities of the Fluid Dynamics Laboratory, see http://www.fluid.tue.nl/.

Send detailed resume and names/addresses of three professional references to Professor GertJan van Heijst. The address is below.

Post-doc position on continuously forced 2D turbulence

In the group Vortex Dynamics of the Physics Department at Eindhoven University of Technology (The Netherlands) a fundamental research program is focused on the properties of quasi-2D flows. Present research efforts, consisting of laboratory experiments, numerical simulations and theoretical modelling, are primarily aimed at investigating the dynamics of coherent vortices in stratified and rotating fluids, self-organisation and chaotic advection in 2D turbulence, and 3D viscous mixing.

Objectives post-doc project

The post-doc project concerns a combined numerical-experimental study of continuously forced 2D turbulence on a finite domain with realistic (no-slip) boundaries. Attention will be focused on a rectangular (or square) domain that

For this PhD project a master's degree in (theoretical) physics or mathematics and a good background in fluid dynamics are required. For a PhD position, the conditions are approximately as follows: As a PhD student you will receive a gross salary that increases during your 4 year contract. It is Dfl. 2843/month in the first year and increases to Dfl. 3841/month in the fourth year.

Further information on this PhD projects can be obtained from GertJan van Heijst or Herman Clercx. For more information about the research activities of the Fluid Dynamics Laboratory see http://www.fluid.tue.nl/.

Send detailed resume and names/addresses of three professional references to Professor GertJan van Heijst. The address is bellow.

PhD position on free-surface turbulence

Deep inside a fluid, turbulence takes on another form than on the surface of the fluid. Inside, vortices are stretched and give way to ever smaller vortices, until they hit the scales where viscosity reigns. At the surface of the fluid, these vortices are left alone, and there may even be a tendency towards large-scale structures.

You can actually see this if you look onto the surface of a flowing stream. Where vortices end at the surface, it shows a characteristic dimple. Therefore there is an intimate relation between the statistics of turbulence under the surface and the statistical properties of the free surface. It is our aim to precisely quantify these statistical relationships. As you may gather from our pages, 3D turbulence has exciting statistical properties, and it is a great challenge to link them to the statistics of the wrinkles on the free surface.

We will do that primarily through experiments on a turbulent flow through a water channel. You will work with modern field measurement techniques, such as Particle Image Velocimetry, and use it to get the vorticity. Other laser techniques will be used to measure the surface deformation. Apart form that, this exciting problem will be attacked using analytical and numerical studies.

The Fluid Dynamics Laboratory of Eindhoven University of Technology offers an excellent infrastructure of flow devices and instrumentation. You will become member of a group of enthusiastic people who do research on turbulence, pattern formation and laser spectroscopy for fluid dynamics.

If you are interested in this position, please contact Willem van de Water, GertJan van Heijst or Herman Clercx who will be pleased to provide further details. For more information about the research activities of the Fluid Dynamics Laboratory see http://www.fluid.tue.nl/.

of the International Union of Theoretical and Applied Mechanics, with responsibility for the major Congresses held in Stresa (1960), Munich (1964), Stanford, California (1968) and Moscow(1972). He was particularly active during the long years of the Cold War, in maintaining scientific links with Soviet and East European colleagues, often through the biennial meetings on fluid mechanics that were held in Poland throughout that era.

Batchelor knew G.I.(Sir Geoffrey) Taylor better than anyone else and had the greatest admiration for him. He edited the 4 volumes of G.I's collected papers, and in the 1980s spearheaded a successful fund-raising campaign to endow the G.I.Taylor Professorship of Fluid Mechanics in the University of Cambridge. He published in 1996 a biography "The Life and Legacy of G.I.Taylor", a fitting tribute to one of the greatest scientists of the 20th century.

Batchelor was elected a Fellow of Trinity College, Cambridge in 1947, and a Fellow of the Royal Society in 1957. He was elected to the new Professorship of Applied Mathematics at Cambridge in 1964. He received many honours including the Royal Medal of the Royal Society in 1988; and he was elected to a number of foreign Academies of Science in recognition of his great distinction (Sweden 1972, Poland 1975, France 1984, USA 1994). His election as Associate Member of the Australian Academy of Sciences in 1994 perhaps gave him greatest satisfaction; despite his long sojourn in Cambridge, his roots remained in Australia. He returned there regularly throughout his life, and attracted many talented students from Australia to follow in his footsteps in Cambridge.

Many of these research students will remember the warm hospitality offered by George and Wilma over many years at "Cobbers" in Cambridge, a house that George was proud to have designed himself on strict scientific principles; an early paper on the optimal spacing of the two sheets of glass in double-glazed windows (to provide maximal insulation) resulted from this phase of domestic activity. Sadly, Wilma died at Cobbers in 1997. Batchelor's health was already in severe decline with the onset of Parkinson's disease. He survived just long enough to celebrate his 80th birthday in his rooms in Trinity College on 8th March this year.

He is survived by three daughters.

H.K.Moffat

DAVID CRIGHTON, FRS

*David Crighton, FRS, Professor of Applied Mathematics at the University of Cambridge, and Master of Jesus College, Cambridge, was born in 1942. He died on April 12th, aged **.*

David Crighton, head of the Department of Applied Mathematics and Theoretical Physics (DAMTP) in Cambridge and Master of Jesus College, was for the last decade the undisputed leader of the applied mathematics community in Britain. He was a major figure in the theory of aeroacoustics (aircraft and engine noise and how to control it), linear and nonlinear waves, and structural vibrations; he pioneered Research Council initiatives for the funding of research in applied nonlinear mathematics; he was instrumental in bringing together all the mathematical organisations in the country so that they could speak with one voice; he initiated a campaign with mathematical educationalists to improve the image of mathematics in schools (the highlight was the `Pop Maths Roadshow'); and he led his department and College with immense energy and vision. Yet despite his ever-increasing activities and, recently, his developing illness, he invariably had time for all who wanted to see him, and everyone left feeling valued and strengthened.

David George Crighton was born in 1942 at Llandudno, where his parents, George and Violet Crighton, had been moved to escape the bombing of London. His education, at Watford Grammar School, took a remarkable change of direction in the lower sixth when a master observed `whatever else, he will never be any good at mathematics'. Never fearful of a challenge, he abandoned A-levels in Classics for double mathematics and physics. He entered St John's College, Cambridge, in 1961 and went down in 1964 with Firsts in Parts I and II of the Mathematical Tripos. He then made the conscious decision not to stay on for Part III but to teach mathematics at the Woolwich Polytechnic (now the University of Greenwich). There he taught a broad spectrum of mathematics for up to twenty-three hours a week and learned the techniques of crowd control (the evening class on subsidiary mathematics for engineering included several leather-clad `mature students' bearing knives).

Then, by chance, he met John Ffowcs Williams, Reader in Mathematics at Imperial College and an expert in aeroacoustics, and became his research assistant at less than a quarter of the salary of a Senior Lecturer at Woolwich Polytechnic. His PhD at Imperial College followed in 1969 and he remained there until 1974 when he was appointed a Research Associate in the Department of Engineering in Cambridge. He visited the Engineering Department only once however, as he was immediately, apparently out of the blue, though in fact at the instigation of Sir James Lighthill, the founder of aeroacoustics, appointed Professor of Applied Mathematics at the University of Leeds at the age of 32. This was in succession to T G Cowling, a great scientist but one not good at encouraging younger staff. David immediately

Vacant PhD and post-doc positions at Eindhoven University of Technology

PhD position on small-scale structures of chaotic mixing

In the group Vortex Dynamics of the Physics Department at Eindhoven University of Technology (The Netherlands) a fundamental research program is focused on the properties of quasi-2D flows. Present research efforts, consisting of laboratory experiments, numerical simulations and theoretical modelling, are primarily aimed at investigating the dynamics of coherent vortices in stratified or rotating fluids, self-organisation and chaotic advection in 2D turbulence, and 3D viscous mixing. Applications for a PhD position are invited in the area of chaotic advection in quasi-2D flows.

Mixing of passive tracers in simple flows is predominantly determined by chaotic advection, which produces steep gradients in tracer concentration due to stretching and folding of material lines. Diffusion, active at small scales, tends to decrease these gradients. Mixing is found in many laminar flows, which are largely determined by viscous effects, and in advection dominated flows as arrays of counter-rotating vortices (e.g., Rayleigh-Benard convection). Despite the simplicity of such flow fields, the transport of tracers is extremely complex and generates many small-scale structures because in practical applications diffusion of tracer is some orders of magnitude smaller than the diffusion of momentum. Central questions in mixing studies are now: What is the role of advection in the mixing process? How will diffusion, which smoothes concentration gradients, counterbalance stretching? How can mixing be quantified?

In order to study these aspects of mixing we propose a novel approach for numerical studies of transport of passive tracers in simple 2D flows: the Spectral-Lattice Boltzmann method (SLB). The method consists of a spectral computation of the flow field, and a Lattice Boltzmann method for the simulation of passive tracer transport. It is planned to extend the applicability of the SLB method towards 2D turbulent flows.

An SLB method has several advantages. Firstly, it decouples the simulation procedure for the flow dynamics, which is much smoother than the tracer dynamics, from the details of tracer transport. Secondly, LB methods make massively parallel simulations of tracer dynamics possible, as for Lagrangian techniques, but without the additional statistical noise. Finally, statistics of data to obtain a quantitative measure of mixing is more efficient when lattice sites instead of moving tracers are used. The objectives of the present proposal are: (1) development of an SLB method suitable for massively parallel simulations, (2) investigation of dynamics of passive tracers in simple flows, (3) quantification of mixing on basis of the SLB-scheme and (4) application of the SLB-scheme to 2D turbulent flows.

The method that we apply is based on the modelling of a contact by three constraints (two constraints in 2-dimensional problems), which are activated or deleted from the system of equations depending on a contact law. This contact law invloves two parameters:

→ *Poisson's coefficient of restitution* which allows one to model energy dissipation during a shock
→ *Coulomb's friction coefficient*

When a contact is defined in one of our mechanisms, these two coefficients are either measured or taken from the literature.
The results that we obtain this way are satisfying, however they are based on the following assumptions:

→ The relative mass and the geometry of the contacting bodies are not taken into account.
→ The restitution coefficient is given, from experiments, for a central impact (the normal direction at the contact point passes through the gravity centers of the contacting bodies), though noncentral impacts occur.
→ In the case of multiple contacts, the relationships between the various restitution coefficients are not taken into account, which implies for instance that there are no impulsion propagations in the system.

Taking into account these strong assumptions, it seems important to improve our knowledge of the physical phenomena which come into play during a shock between two solids, in order to enable us to simulate in a more efficient and accurate way our mechanisms.
The goal is to obtain an analytical law that enables us to get an estimation of Poisson's restitution coefficient, incorporating the following parameters:
→ Iron or plastic materiels
→ Materials properties (Young's modulus, Poisson's coefficient, hardness...)
→ Relative mass of the contacting bodies
→ Geometry of t he contacting bodies
→ Impact velocity

Firstly, this law will be determined for a central shock without friction. It will be then extended towards non-central shocks with or without friction (12 months). A third part will be dedicated to the multiple impacts problems (12 months). At each step, the laws will be validated by simple experiments and FEM simulations (ANSYS).

Supervisors

Dr Bernard Brogliato, Chargé de Recherche CNRS, Laboratoire d'Automatique de Grenoble. (brogli@lag.ensieg.inpg.fr).
Dr Michel Abadie, Responsable Simulation de Mécanismes, Direction des Recherches, Schneider Electric Michel_Abadie@mail.schneider.fr).

made a difference, motivating his colleagues, many of them older than himself, to become active in research, to raise research funds and to take on students. He himself had fifteen research students in his time at Leeds. When he had been there only about a year, a new research student asked if they could fix a time for a regular weekly meeting. David looked at his diary and said "How about Monday at 7 o'clock?" The student asked "a.m. or p.m.?" to which the reply was "whichever you prefer". By the time David left in 1986, the applied mathematics department at Leeds had risen to be one of the top three or four in the country, a position it retains to this day. David's spells as Head of Department, Chairman of the School of Mathematics and Chairman of the Science Board (effectively Dean) left indelible marks of his imagination, energy and effectiveness.

These attributes have been the hallmarks of David's activities since he left Leeds, though now on a national and international scale. In 1986 he succeeded the late G K Batchelor as Professor of Applied Mathematics in Cambridge, and he took over the headship of DAMTP in 1991. His tenure of this position was characterised by his fierce determination that the department should not only remain by far the strongest mathematical sciences department in Britain and Europe, but that it should rank at least equal with the much more generously funded departments in America. He persuaded the University to create new Chairs and attracted eminent scientists to fill them: by the summer of 1999, for example, the staff of the department included 15 Fellows of the Royal Society, more than any other department in any other subject anywhere (and that does not count retired staff). The expanded department was very crowded however, and David both had the vision of a new Centre for Mathematical Sciences, to house the whole Faculty of Mathematics, and implemented it. He and his colleagues have tirelessly raised almost all the necessary funds, mostly from private sources, the building is well under way, half the faculty has moved in already, and the move will be complete in 2002. All this activity was on top of David's work as Chairman of many national and international committees (he succeeded Batchelor as Chairman of the European Mechanics Committee and oversaw its transformation into a Society of which he was the first President); of his extensive editorial work (he succeeded Batchelor as editor-in-chief of the *Journal of Fluid Mechanics*, the premier journal in the field, and he was editor of the *Cambridge Texts in Applied Mathematics* from 1986); and, since 1997, of his Mastership of Jesus College, where he individually met all third-year undergraduates as well as staff and Fellows.

Moreover, David had a full scientific career of his own, with one book and well over 100 published papers in major journals. Highlights of his research career include: the creative coupling, with F G Leppington, of two sophisticated mathematical methods (the method of matched asymptotic expansions and the Wiener-Hopf technique) to analyse the scattering of sound waves by solid bodies; the study of how the vortices that arise in the flow behind jet engines interact with the solid boundaries to generate noise; the analysis of the modes of vibration of a fluid-loaded ribbed plate (Crighton was a powerful mathematician, but his theories were always deployed to solve real engineering problems); prediction of the noisemade by many-bladed propellers (as in the new generation of prop-fan engines); and a more general theory than previously available of the development of shock waves. He received many prizes and honours, including Fellowship of the Royal Society in 1993 and three honorary doctorates.

Outside his work and his family, David Crighton's passion was music, especially opera. He was an authority on Wagner and wrote for an international magazine. He attended the Bayreuth Festival annually from his first visit, when an undergraduate, in 1962 until the onset of his illness. He held firmly to the view that there was only one thing better than a good performance of a favourite opera and that was two good performances of that favourite opera or, as in the case of Pfitzner's Palestrina, which was performed at Covent Garden in 1997, all six good performances. A few weeks before his death he conducted his College orchestra in a performance of the Overture to Tannhäuser. Earlier, he acted as sponsor in the West for the eminent Russian pianist, Tatiana Nikolaeva, arranging for her to play at a concert in Cambridge to celebrate his own 50th birthday; once he could be heard giving a live Radio 3 interview about her, in the middle of a weekday afternoon.

What everyone remembers about David was his unique ability to combine tremendous hard work with wonderful warmth and good humour. While keeping all his parallel concerns clearly in his mind at the same time, and making hard decisions when necessary, he took a deep interest in every individual. He was widely admired and deeply loved and will be terribly missed.

In 1969 he married Mary West with whom he had two children. The marriage was dissolved in 1985 and in 1986 he married Johanna Hol. Johanna and his two children were with him when, on 12 April 2000, he lost the battle against cancer that he had been courageously fighting for over a year.

T.J.Pedley

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Schneider Electric

Direction Scientifique et Technique
Ingénierie Intégrée
Groupe Calcul Scientifique et Modélisation

le : Thursday, 15 June 2000
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object : Post-Doc, Collaboration Schneider Electric – Laboratoire d'Automatique de Grenoble

Conditions

→ PhD thesis passed one year before the beginning of the Post Doc (that should begin before December 2000)
→ Duration : 2 years
→ Salary 170 kFF per year (6 FF = 1 Euro)
→ No nationality constraints

Background :

Contact mechanics, Friction, mechanisms numerical simulation (rigid bodies), Materials.

Objectives

The study is centred around Mechanisms Simulation, i.e. rigid multibody mechanical systems with classical links or frictional contacts.

The mechanical systems developed by Schneider Electric possess the particular feature that they are generally made of few bodies, but a large number of contacts (7 bodies and 16 contacts for the circuit breaker BTT C60). Moreover, friction plays a fundamental role in the statics and dynamics of such systems. It is therefor necessary to have a reliable and easily usable friction model .

This project follows the studies led in a previous project called « Simulation de Mécanismes » (96/99). This project has allowed us to settle an approach of frictional contact based on the notion of unilateral constraints (or inequality constraints) which provides very promising results. We are now able to treat problems with frictional contact, that the other available softwares cannot treat.. Our main objective here is to continue in this direction of research in order to provide our engineers with a software as thorough and as performant as possible.

432. Spectral Methods and Time Schemes for Incompressible
Flows in Complex Geometries
Chairman: Prof. M. Azaiez
Institut de Mécanique des Fluides de Toulouse
UMR 5502 CNRS, Université P. Sabatier de Toulouse
Allées du Professor Camille Soula, F-31400 Toulouse, France
E-mail: azaiez@imft.fr
Co-chairman: Prof. A. Bergeon, Inst. of Mechanics of Fluids, Toulouse, France
Euromech contact person: Prof. Emil J. Hopfinger
Date and location: September 2001, Toulouse, France

433. Dynamics of Trailing Vortices
Chairman: Prof. Wolfgang Schröder
Aerodynamisches Institut, RWTH Aachen
Wüllnerstr. zw. 5 u. 7, D-52062 Aachen, Germany
E-mail: office@aia.rwth-aachen.de
Co-chairman: Prof. Dieter Jacob, RWTH, Aachen, Germany
Euromech contact person: Prof. Hans-H. Fernholz
Date and location: October 2001, Aachen, Germany

List of Colloquia in 2002

431. Direct Numerical Simulation of Moving Interfaces
Chairman: Prof. Jean-Paul Caltagirone
MASTER-ENSCPB, Avenue Pey-Berland BP 108
F-33402 Talence, France
E-mail: calta@lmaster.u-bordeaux.fr
Co-chairman: Prof. Eric Arquis, MASTER-ENSCPB, Talence, France
Euromech contact person: Prof. Emil J. Hopfinger
Date and location: May 2002, Talence, France

434. Contact Mechanics of Coated Bodies
Chairman: Prof. Viktor M. Alexandrov
Institute for Problems in Mechanics, Russian Academy of Sciences
Prospekt Vernadskogo 101, building 1, 117526 Moscow, Russia
E-mail: goryache@ipmnet.ru
Co-chairman: Prof. J. J. Kalker, Delft University of Technology, The Netherlands
Euromech contact person: Prof. Irina Goryacheva
Date and location: May 2002, Moscow, Russia

435. Simulation of Friction and Wear in Metal Forming
Chairman: Prof. Jérôme Oudin
Industrial and Human Automatic Control and Mechanical Engineering
Le Mont Houy, University of Valenciennes
F-59313 Valenciennes Cedex 9, France
E-mail: euromech435@univ-valenciennes.fr
Co-chairman: Prof. Serge Cescotto, University of Liege, Liege, France
Euromech contact person: Prof. Jean Lemaitre
Date and location: 18 - 20 June, 2002, Valenciennes, France

EUROMECH Colloquium 390

Instability, bifurcation and localisation in fracture of materials

Chairmen: G.Rousselier (EDF), A.Benallal (Cachan)

EUROMECH 390 took place at the École Normale Supérieure de Cachan on May 10^{th} – 12^{th} 1999. It was attended by 47 participants from 16 countries, of whom 5 came from outside Europe. The limited number of attendees promoted a high level of lively debate. The 31 presentations covered the topics:

- Gradient/non-local models, Cosserat theory (7)
- Instabilities and localised plastic deformations in various situations and materials (12)
- Discontinuities and bifurcation (5)
- Fracture mechanics of brittle and ductile materials (3)
- Coupled multi-physics problems: chemical diffusion, fluid flow in solids (3)
- Discrete dislocation plasticity (1)

A wide range of stability analyses were presented, from structures (tensile tests, metal forming) to various materials (metals, concrete, rocks, rubber) at several scales. The relationships between damage, softening, bifurcation and stability were discussed. Multi-physics and multi-scale problems offer new fields of research as far as localisation is concerned.

It is now widely recognised that non-locality can resolve localisation and avoid associated mesh-dependence in finite element modelling. However, problems arise with the boundary conditions and more physics should be incorporated in the theories, especially on the basis of micromechanics.

EUROMECH Colloquium 395

Coastal, estuarine and river forms

Chairmen: H.J.de Vriend (Enschede), P.Blondeaus (Genoa)

EUROMECH 395 took place at the University of Twente, Enschede, the Netherlands, on the 2nd – 4th June, 1999. There were 32 participants from 6 countries, including representatives from all leading research units in the field. The meeting was very informal; about twenty presentations were given, each succeeded by ample time (about half an hour) for discussion. This format worked out very well and led to lively and in-depth conversations.

The subject of the meeting was the analysis of rhythmic morphological features in mobile-bed natural surface water systems. The principal objective was to confront and exchange expertise in rivers, estuaries, coastal waters and shelf seas.

The colloquium definitely achieved its goals, viz:

- an exchange of knowledge and views between "freshwater" (rivers) and "saltwater" (estuaries etc.) reesearchers; the majority of the saltwater group have collaborated for a long time in various EU-MAST projects, but freshwater research in this field has always been scattered,
- an exchange between senior and junior researchers; about 60% of the attendants were junior researchers or post-docs.,
- a confrontation of techniques (linear and non-linear perturbation analyses, simulation techniques, numerical modelling, data analysis), and of theory and data, and
- development of new research-network links.

It was decided not to produce formal proceedings of the meeting since most of the work is finding its way into refereed scientific journals. However, all participants who gave presentations have submitted a brief summary, as a contribution to a review paper in a leading scientific journal. The chairpersons have agreed to produce this paper.

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426. Swirling Flows
Chairman: Prof. Helge I. Andersson
Division of Applied Mechanics
Norwegian University of Science and Technology
N-7491 Trondheim, Norway
E-mail: helge.i.andersson@mtf.ntnu.no
Co-chairman: Prof. S. V. Alekseenko, Inst. of Thermophysics, Novosibirsk, Russia
Euromech contact person: Prof. Emil J. Hopfinger
Date and location: 16 - 20 September, 2001, Trondheim, Norway

427. Computational Techniques and Applications in Nonlinear Dynamics of Structures and Multibody Systems
Chairman: Prof. Adnan Ibrahimbegovic
ENS - Cachan, LMT/61, Avenue du Président Wilson
94235 Cachan, France
E-mail: ai@lmt.ens-cachan.fr
Co-chairman: Prof. Werner Schiehlen, Inst. B für Mechanik, Stuttgart, Germany
Euromech contact person: Prof. Werner Schiehlen
Date and location: 25 - 28 September, 2001, Paris, France

428. Transport by Coherent Structures in Environmental and Geophysical Flows
Chairman: Antonello Provenzale
Intituto di Cosmogeofisica del CNR, Corso Fiume 4
I-10133 Torino, Italy
E-mail: anto@icg.to.infn.it
Co-chairman: Andrew Hogg, University of Bristol, Bristol, U. K.
Euromech contact person: Prof. Paolo Blondeaux
Date and location: 26 - 29 September, 2001, Torino, Italy

429. Computational and Experimental Mechanics of Advanced Materials
Chairman: Prof. E. A. Werner
Lehrstuhl A für Mechanik und Christian-Doppler-Laboratorium für Moderne Mehrphasenstähle
Technische Universität München, Boltzmannstr. 15
D-85747 Garching b. München, Germany
E-mail: werner@lam.mw.tu-muenchen.de
Co-chairman: Prof. H. J. Böhm, TU Wien, Austria
Euromech contact person: Prof. Franz G. Rammerstorfer
Date and location: 18 - 20 September, 2001, München, Germany

430. Formulations and Constitutive Laws for Very Large Strains
Chairman: Dr. Jiri Plesek
Institute of Thermomechanics ASCR, Dolejskova 5
182 00 Prague 8, Czech Republic
E-mail: plesek@it.cas.cz
Co-chairman: Prof. Larsgunnar Nilsson, Linköping Universtity, Sweden
Euromech contact person: Prof. Miloslav Okrouhlik
Dåte and location: 12 - 14 September, 2001, Prague, Czech Republic

List of Colloquia in 2001

420. Mechanobiology of Cells and Tissues
Chairman: Prof. J. F. Stoltz
Angiohématologie-Hémorhéologie, LEMTA - UMR CNR 7563, Faculté de Médicine, 9 Avenue de la Foret de Haye, 54505 Vandoeuvre-les-Nancy, Cedex, France
E-mail: stoltz@hemato.u-nancy.fr
Co-chairman: Prof. Xiong Wang, CR CNRS, France
Euromech contact person: Prof. Emil J. Hopfinger
Date and location: 24 - 26 April, 2001, Nancy, France

421. Strongly-Coupled Dispersed Two-Phase Flows
Chairman: Prof. Alain Cartellier, CR CNRS, LEGI BP 53, 38041 Grenoble Cedex, France
E-mail: alain.cartellier@hmg.inpg.fr
Co-chairman: Prof. Jacques Leblond, ESPCI, Paris, France
Euromech contact person: Prof. Emil J. Hopfinger
Date and location: 3 - 5 September, 2001, Grenoble, France

422. Pattern Formation by Motile Micro-Organisms and Cells
Chairman: Dr. N. A. Hill
Department of Applied Mathematics, University of Leeds, LS2 9JT Leeds, U. K.
E-mail: n.a.hill@leeds.ac.uk
Co-chairman: Dr. M. A. Bees, University of Surrey, U. K.
Euromech contact person: Prof. Timothy J. Pedley
Date and location: 5 - 8 December, 2001, University of Leeds, U. K.

423. Boundary-Layer Transition in Aerodynamics
Chairman: Prof. Dr. - Ing. Siegfried Wagner
Universitaet Stuttgart, Pfaffenwaldring 21, D-70550 Stuttgart, Germany
E-mail: wagner@iag.uni-stuttgart.de
Co-chairman: Dr. - Ing. Markus Kloker, Universitaet of Stuttgart, Germany
Euromech contact person: Prof. Hans-H. Fernholz
Date and location: 2 – 4 April, 2001, Universitaet Stuttgart, Germany

424. Buckling Predictions of Imperfection-Sensitive Shells
Chairman: Prof. Dr. J. Arbocz
Delft Univ. of Technology, P. O. Box 5058, 2600 GB Delft, The Netherlands
E-mail: J.Arbocz@lr.tudelft.nl
Co-chairman: Prof. Dr. - Ing. W. Wunderlich, TU München, Germany
Euromech contact person: Prof. Dr. Erik Van der Giessen
Date and location: 2 - 5 September, 2001, Kerkrade, The Netherlands

425. Nonlinear Dynamics, Control and Condition Monitoring of Engineering Systems and Structures
Chairman: Dr. Marian Wiercigroch
Aberdeen University, Dept. of Eng., Kings College, AB24 3UE Aberdeen, Scotland, U. K.
E-mail: M.Wiercigroch@eng.abdn.ac.uk
Co-chairman: Prof. Albert A Rodger, Aberdeen University, U. K.
Euromech contact person: Prof. Werner Schiehlen
Date and location: August 2001, Aberdeen, Scotland, U.K.

EUROMECH Colloquium 402

Micro-mechanics of fracture processes

Chairmen: D.Gross (Darmstadt), F.D.Fischer (Leoben) and E van der Giessen (Delft)

The colloquium took place on October 25th – 27th 1999 at the Lufthansa Training Centre in Seeheim near Darmstadt. The meeting was attended by 71 scientists from 17 countries, including 5 participants from 3 non-European countries. There were 30 lectures and 13 poster presentations covering recent or current research from the theoretical, numerical and experimental point of view.

The micro-mechanical approach is of increasing significance because it offers a deeper insight into the nature of material failure and makes possible realistic modelling of complex material behaviour, providing a basis for the improvement of material properties relevant to failure.

The presentations showed significant progress in understanding failure processes on the micro-level and in their description by realistic models on different scales. Amongst others the main topics were: heterogeneous material structure, gradient effects, micro-morphological influences on the behaviour of crystals or two-phase materials, modelling of micro-defect evolution in brittle and ductile materials, continuum damage modelling, micro-macro interaction, discrete versus continuous models, general mathematical aspects of multiple failurein solids, and, last but not least, the numerical realisation of micro failure models. It would have been interesting to have had more contributions from the last two fields mentioned, which are of considerable importance for modelling discrete multi-failure of large systems.

In summary, the colloquium showed as a clear trend that micro-mechanics becomes more and more important in the understanding and the description of fracture processes. This also refers to the application of fracture mechanics to practical problems although the material data basis on the micro-level is often incomplete. This problem aside, it is a fact that consideration of micro-mechanical aspects goes hand in hand with the development of computer power and numerical methods.

The informal atmosphere, supported by the location and facilities of the conference site, led to interesting discussions and fruitful contacts between the participants. Post-colloquium reactions of the attendees were positive and suggest a repeat meeting on this topic within a few years.

An abstract volume has been prepared.

EUROMECH Colloquium 403

Turbulence in high speed compressible flows

Chairmen: J-P Bonnet (CEAT Poitiers), O.Leuchter (ONERA)

EUROMECH 403 took place on the "Futuroscope" site in Poitiers from November 2^{nd} – 4^{th}, 1999. There were 35 participants, predominately from France. The meeting was divided into six sessions, each introduced by an invited speaker.

1. *Theoretical approaches and modelling of turbulence in compressible flow.*
The opening lecture was followed by four presentations. Two were devoted to new strategies for the effcts of gradient density and thermo-chemical closure. There followed a new classification of gas flows and a theoretical study of the development of Görtler vortices. Turbulence modelling may seem to be in direct competition with DNS but remains a strategical field for progress. Indeed, for compressible flow, at present it remains the only practical approach available to industry.

2. *Experimental approaches to turbulence in high-speed compressible flow.*
An invited lecture on the effects of compressibility on laminar-turbulent transition gave a progress report on this delicate and crucial subject. The presentations described increased mixing in the free stream and the effects of roughness on the wakes of slender bodies. Experimental studies in supersonic flow are delicate, expensive and sometimes disappointing. Participants nevertheless showed how it was possible to extract information of both fundamental and industrial value.

3. *DNS and LES approaches to simulation of high speed compressible flows.*
The invited lecture gave an overview of turbulent supersonic channel flow. Presentations described 3D DNS and LES calculations for channel flows, mixing layers and boundary layers. The increase in available computer power has made possible simulations in increasingly less academic configurations, with DNS giving insight into the effects of compressibility on turbulence and LES at the threshold of industrial use.

4. *Flows with Shock/turbulence interactions.* Presentations concerned calculations of shock/mixing layer and boundary layer interactions, also the linear theory of shock/turbulence interaction. An unusual topic was the interaction in astrophysics. The topic is so complex and various that any approach, theoretical or experimental, can only touch on the problem. Nevertheless in industrial applications understanding and control of shock turbulence interactions remains of crucial importance.

5. *Rayleigh-Taylor instabilities.* There was a single presentation in this field. If the instability is generated by a shock, it becomes a crucial problem in dimensioning a nuclear weapon, or in controlling fusion by inertial confinement. In future research simulations may become possible using laser bombardment.

6. *New experimental diagnostics for high speed compressible flows.*
Two presentations described new optical methods making it possible to measure density fluctuations in compressible flow. These are of great potential value, giving access to the measurement of a quantity previously inaccessible to experiment, and providing a significant contribution to total knowledge.

EUROMECH Colloquium 404

Advances in computational multi-body dynamics

Chairmen: J.A.C.Ambrósio (Lisboa), W.O.Schiehlen (Stuttgart)

EUROMECH 404 took place at the Instituto Superior Téchnico, Lisboa, on 20^{th} – 23^{rd} September 1999. There were 64 participants, with 9 from outside Europe. There were 14 sessions, each consisting of 4 – 5 presentations.

Abstracts of the presentations may be found on the meeting's website at

www.dem.ist.utl.pt/~EUROMECH

Selected papers will be published in the journal *Multibody Systems Dynamics.*

At the time of writing, reports have not been received for EUROMECH 401 & 405
