EUROMECH
European Mechanics Society

Newsletter 18
April 2001

President's Introduction

The year 2000 has been very successful for EUROMECH *with our three big conferences, the* EUROMECH *Solid Mechanics, Fluid Mechanics and Turbulence conferences all held in the same year, with record numbers of participants. In addition there were twelve* EUROMECH *colloquia. On behalf of the* EUROMECH *Council I would like to thank the organisers for the time and trouble they have taken in preparing and running these important meetings.*

Elections for half the membership of the EUROMECH *Council were held in December 2000 and from among the distinguished candidates the following were elected*: I.D.Abrahams (*UK, Fluids*); A.Benallal (*France, Solids*); I.G.Goryacheva (*Russia, Solids*); E.J.Hopfinger (*France, Fluids*) *and* P.Huerre (*France, Fluids*). We wish them all the best of luck – and success.

The officers for 2001 are: H-H.Fernholz (*President*); M.Okrouhlík (*Secretary*) *and* E.J.Hopfinger (*Treasurer*).

I am glad to report that Cambridge University has established the G.K.Batchelor Fund *and the* D.G.Crighton Fund *in memory of these two eminent scientists, for the support of experimental work in fluid mechanics and to provide support for young scientists in Crighton's area of research.*

It is with great regret that I have to inform you that our former treasurer, E.A.Müller, *died in Göttingen on February 24th 2001, at the age of 75. As a founding member of the first* EUROMECH *Council he was a prime mover in the establishment of the Society. We must also remember gratefully the work that he did in keeping* EUROMECH *running, his generosity and his wisdom, without which the Society could not have attained its present standing.*

Hans-Hermann Fernholz
President, EUROMECH

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The European Journal of Mechanics

A letter addressed by the Editors to members of the advisory board

Dear Colleague,

You are a member of the Advisory Board of the European Journal of Mechanics B/Fluids. We have to confess that some of you have not heard from us for some time. We would like to give you some news of the Journal, since we recently had a meeting of the Editors-in-Chief and Associated Editors during the 4th Euromech Fluid Mechanics Conference held in Eindhoven.

As you have probably noticed the quality of the Journal is constantly improving. This has implied a rise in the impact factor over the last three years. We believe that our Journal must be considered as a serious alternative publication to our bigger competitors. Indeed, we offer rapid publication, and the individual impact factors show that good articles are cited as often when published in the EJMB as when published in other well-known journals.

Time has come for our community to consider the European Journal of Mechanics B/Fluids as one of the favourite media for publication. As a member of the Advisory Board you are an ambassador for the Journal. We are confident that you feel that this is so. This is the reason why we would like you to strengthen your efforts to advertise the Journal around you. When you are attending a conference, for example, or giving an oral presentation, you may mention that your work has been, or will be, published in this Journal. The Journal should now sound International, and not only European. The increasing number of contributions coming from the United States tells us that we are on the right track!

Full texts of all articles from EJMB are accessible through Science Direct. If your library subscribes to this we are convinced you have already noticed this. This increases the visibility of our Journal, and will in the near future increase again the number of citations of the articles published there. You can also access the table of contents and the abstracts free of charge at http://www.elsevier.fr or http://www.elsevier.nl .

Please do not hesitate to contact us should you have any questions. Whilst expressing our thanks to you for being the ambassador of this Journal, we wish a more fruitful and closer co-operation with you in the future.

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EUROMECH members are reminded that they can receive EJMB at a greatly reduced subscription.

ELECTIONS TO THE COUNCIL

At the end of 2000, five seats on the EUROMECH Council became vacant. After consultation with the advisory board, the affiliated organizations and suggestions made by EUROMECH members, the following EUROMECH members stood for election to the Council:

Time of office	slot no.	Name	Name
3 years	1	E.J. Hopfinger (F)	
6 years	2	P. Huerre (F)	
6 years	3	I.G. Goryacheva (S)	S.V. Sorokin (S)
6 years	4	I.D. Abrahams (F)	I.P. Castro (F)
6 years	5	A. Benallal (S)	F. Darve (S)

Generally, two candidates stand for one seat and this was the case for seats 3 to 5. This rule is not an obligation, imposed by the statutes, and when there are good reasons this unwritten rule needs not be applied. This was the case for seats 1 and 2. Seat 1 will be occupied only for three years to continue the work of the Treasurer and no opponent could be put up. Seat two had initially an opponent who finally declined and it was thought not necessary to search for a candidate in the last moment.

In October 2000 the ballots were sent to 1077 EUROMECH members and had to be returned to the Treasurer's Office on December 15 at the latest. A total of 361 ballots were returned by this deadline which is just slightly more than 1/3 of the ballots sent out and required by the statutes for the election to be valid. Some ballots, 9 up to now, arrived after this deadline and could not be taken into account.

The tallying was performed by two EUROMECH members (J.-L. Auriault, J.-L. Achard and the assistant to the Treasurer, G. Chavand. The results are as follows:

Slot n°				
1	E.J. Hopfinger	322		
2	P. Huerre	310		
3	I.G. Goryacheva	210	S.V. Sorokin	98
4	I.D. Abrahams	163	I.P. Castro	151
5	A.Benallal	170	F. Darve	133

Invalid ballots : 27

E.J. Hopfinger (France), **P. Huerre** (France), **I.G. Goryacheva** (Russia), **I.D. Abrahams** (UK) and **A. Benallal** (France) are, therefore, elected to the EUROMECH Council. France will be strongly represented on the Council but will come back to normal again in three years. The composition of the new Council is given in this Newsletter.

Thank you for your support and collaboration.

Grenoble, January 19, 2001

E.J. Hopfinger, Treasurer

EUROMECH Presentation Prizes

Awarded to "Young Scientists"
at the fourth EUROMECH Fluid Mechanics Conference
Eindhoven, November 2000

Prize for the best oral presentation:

Nicola Parini (Politecnico di Milano)

with

The first Hopf bifurcation in a singular driven cavity flow

For the best poster presentation:

Astrid Manders (Netherlands Institute for Sea Research)

with

Spatial behaviour of inertial waves
in a rectangular basin with a sloping boundary

Mr Parini is currently working for a Ph.D. in the Department of Mathematics at Pennsylvania State University. His current interests lie in numerical investigation of fluid-dynamic systems, related to his work in Italy as reported at EMFC-4.

When not engrossed in his work, he is an enthusiastic traveller, whether by train, bicycle or "shank's pony" (hiking). His literary interests lie mostly in History, while he has an active appreciation of good jazz and folk music. In exile he misses good Italian wine (he proposes to maintain his Italian cooking skills) and in particular, living close to his girlfriend.

Mrs Manders studied seismology and geophysics (mantle dynamics) at the University of Utrecht before moving on in 1998 to work for a Ph.D. in oceanography at the Institute, a sample of her work being the subject of her poster. She has just embarked on an oceanographic research cruise.

Outside Fluid Mechanics, she follows classical music (playing the organ and recorder), literature, ballet and walking.

Editor's Piece

One of the principal functions of the Newsletter is to provide a general record of the Society's activities. Apart from administrative matters, this means reports on Colloquia and Conferences. The raw material for this has consisted of Chairpersons' reports as received by the Secretary General.

This material varies widely in both information content and literary quality. The editor will continue to feel that he should, where possible, adjust language to allow for the vagaries of non-native (*and* native) English speakers. He does not however propose to continue cutting reports significantly, aiming unsuccessfully to fit them into half a page.

The reports in this issue are virtually given in full, and are on the whole of an appropriate length. It was originally my intention to try to have one issue each year devoted to reports and one to proposals. With more extended reports, there will probably be two issues largely made up of reports. Proposals would remain fairly short, and might in any case be edited to provide the meat of a third issue.

Could Chairpersons bear this in mind, and, since in nearly every case the reports are now prepared on a word-processor, could they keep a copy on file for me so that I do not have to retype all the material. I would then ask you to send me an attachment by e-mail after the report had been received by the Secretary General.

Likewise, could the proposals to the Council, where possible, be kept filed in electronic form. I would then request an attachment after approval by the Council.

All this is not to cancel my perennial request for material suitable to form a 'feature article'.

PJF

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solitary waves in solids and the ultrasonic characterisation of material structure and properties. The session provoked extensive discussion between theoreticians and experimentalists.

The third and last session concentrated on problems related to acoustic emission (AE) treatment. Particular interest now applies to AE source identification and recognition. Discussion showed that advanced signal processing methods, including wavelet transform and the application of artificial neural networks can contribute substantially to this field.

At the end of the meeting a tour of the AE and ultrasonic laboratories of the Institute was arranged. The modern laboratory equipment, including ultrasonic scanners, the scanning acoustic microscope and DSP-based AE analysers gave rise to much discussion and exchange of specific experience between participants.

In conclusion, this non-traditional colloquium fulfilled its aim, initiating new collaborations between European laboratories. The limited scale of the colloquium and extensive common and personal discussions in specific fields were of great value. The presentations were relatively informal but of high scientific level, introducing problems of practical interest, as yet not completely solved. All participants remarked on the effectiveness of the meeting and expressed the hope that there would be a similar occasion in the near future.

The social programme involved "a panel discussion in the old town palace, a concert of baroque music and a closing ceremony on a steamboat passing Prague".

4th EUROMECH Fluid Mechanics Conference

Chairman: L.van Wijngaarden (Enschede)
Local Chairman: G.J.F.van Heijst (Eindhoven)

The 4th EUROMECH Fluid Mechanics Conference (EFMC-4) was held at Eindhoven University of Technology on November 19th – 23rd 2000. The meeting brought together more than 300 fluid dynamics experts from 31 different countries, mostly European, but also with representatives from North America, Asia and Australia.

At the opening of EFMC-4 memorial addresses in honour of the former EUROMECH Presidents Professors G.K.Batchelor and David G.Crighton were given by Professors Hans Fernholz (President of EUROMECH), Keith Moffat and Tim Pedley.

Eleven invited lectures were given in plenary sessions:

H.I.Andersson: *Effects of rotation on wall-bounded flows.*
G.I.Barenblatt: *Fluid mechanics in the 20th century*
D.Barthés-Biesel: *Cell and capsule mechanics*
A.Dillman: *On the internal structure of steady cylindrical supersonic free jets*
L.Kleiser: *Direct and large-eddy simulation of wall-bounded turbulent flows*
A.Linan: *The role of fluid dynamics on combustion in unpremixed systems*
P.Luchini: *Excitation mechanisms of boundary layer instabilities*
J.Magnaudet: *Some recent advances in the understanding of bubbly flows*
F.T.M.Nieuwstadt: *Experiments and simulations in turbulence research*
D.H.Peregrine: *Water waves at sea walls*
A.Provenzale: *Dispersion in quasi-geostrophic flows*

More than 200 contributed presentations were delivered in six parallel sessions. The session topics were:

Turbulence	Boundary layers
Stability	Waves
Bubbles, drops and particles	Multiphase flows
Rotating flows and vortex dynamics	Buoyancy-driven flows
Simulation and numerical methods	Mixing and dispersion

In addition the programme included three 'mini-symposia' each of which was organised in the form of a number of parallel sessions:

Non-Newtonian fluid mechanics. Convenor: B.H.A.A. van den Brule
Biological fluid mechanics. Convenor: T.J.Pedley
Environmental fluid mechanics. Convenors: J.C.R.Hunt and F.Tampieri

In addition, more than 100 posters were presented during the poster exhibition.

The aim of the EFMC – to provide a platform for discussion and exchange of expertise between fluid dynamicists – was reached convincingly. Generally, the quality of the oral poster presentations was high, probably due to the strict selection of the papers chosen for presentation.

More than 96 participants (> 35%) were younger than 33 (i.e. born in 1968 or later). These young scientists were in principle candidates for the two EUROMECH Prizes, for the best lecture and the best poster. The winners were Mr Nicola Parolini (Politecnico di Milano, Italy) with his lecture on "*The first Hopf bifurcation in singular driven cavity flow*" and Mrs Astrid Manders (Netherlands Institute for Sea Research) with her poster on "*Spatial behaviour of inertial waves in a rectangular basin with a sloping boundary*". The winners received an official prize certificate – and an envelope containing 500 Euro. (See page 3)

In addition to providing a scientific setting, EFMC-4 provided a relaxed social ambience, with the social programme including trips to Belgium for a visit to Antwerp and the conference dinner in Oud-Turnhout.

The next meeting – EFMC5 – will take place in Toulouse (France) in 2003.

EFMC-4 Local Organising Committee	EUROMECH Fluid Mechanics Conference Committee	
G.J.F. van Heijst (*chairman*)	P. Blondeaux	(*Genoa*)
H.J.H. Clercx (*scientific secretary*)	D.G.Crighton (*deceased 12/4/2000*)	(*Cambridge*),
M.E.H. van Dongen	H.H. Fernholz	(*Berlin*)
C.C.M. Rindt (*treasurer*)	G.J.F. van Heijst	(*Eindhoven*)
A.A. van Steenhoven	E.J. Hopfinger	(*Grenoble*)
A.M.E.H. Peters (*conference office*)	P.A. Monkewitz	(*Lausanne*)
M.C.J. Tielemans (*conference office*)	T.J. Pedley	(*Cambridge*)
C. Damsma (*University conference office*)	L. van Wijngaarden (*chairman*)	(*Enschede*)

EUROMECH Colloquium 419
Elastic Waves in Non-destructive Testing

Chairpersons: Dr.Z.Prevorovsky (Institute of Thermomechanics, Prague)
Prof. P.P.Delsanto (Politecnico di Milano)

EUROMECH 419 took place at the Institute of Thermomechanics, of the Academy of Sciences, Prague, on 3rd – 5th October, 2000. There were 40 participants, including one from Israel.

The aim of the Colloquium was to bring together researchers in the apparently diverse fields of elastodynamics and acousto-ultrasonic non-destructive diagnostics, evaluation and testing of materials and structures. There are few contact points common to the two groups, which solve common problems from differing points of view. It is evident that the latest advances in numerical modelling with 2D and 3D computer simulations of elastic wave propagation in both isotropic and anisotropic mediums can help explain experimental observations and enhance the reliability of ultrasonic and acoustic emission testing.

The programme was divided into three principal sessions by topic:

- Elastic wave modelling and numerical simulations (11 papers)
- Nonlinear effects and non-destructive evaluation techniques (12 papers)
- Acoustic emission treatment (7 papers, 2 authors *in absentia*)

An opening lecture entitled *The necessity of elastic wave modelling in ultrasonic NDT applications* pointed out the role of theoretical solutions and simulations in ultrasonic signal waveform analysis and deconvolution. This holds in many diagnostic applications and in material research as well. In particular, problems arising from nonlinearity, dispersion and attenuation cause trouble in signal interpretation. The only way to truly quantitative NDE would seem to be by comparing experimental data to analytical solutions or numerical simulations.

Various aspects of advanced numerical wave propagation modelling by FEM, finite differences (LISA code) and finite integration techniques were the themes of the first session. The discussion ranged over the problems of computational schemes automatically generated by computer algebra, grid dispersion effects, questions concerning different computer simulation codes, results modelling guided waves or elastic wave propagation in pre-stressed media. In conclusion, the need for large 3D modelling was stated.

In the second session experimental NDE/NDT techniques and interesting measurements were mentioned. Particular attention was paid to a new nonlinear acoustic diagnostics technique, based on the spectral analysis of high order vibration modes at different excitation amplitudes, now the subject of an ESF project called NATEMIS. Interest also attached to laser-induced ultrasonic waves, generation of

EUROMECH Colloquium 417
Numerical Modelling in Damage Mechanics

Chairpersons: Prof. J.L.Chaboche (ONERA), Prof. K.Saanouni (Troyes), Prof. P.Steinmann (Kaiserslautern).

EUROMECH 417 took place at the Université de Technologie de Troyes on October 2nd – 4th 2000. The meeting was attended by 51 scientists from 12 countries, including two participants from the USA. There were 32 presentations covering numerical aspects of damage in:

- Non-local and Gradient Damage Formulations
- Application to metal forming processes
- Application to metallic materials
- Application to concrete, rocks and soil
- Application to composite materials

The lectures and discussions confirmed that Damage Mechanics has now attained a high degree of maturity and is currently used in a variety of domains. The numerical applications considered extreme degradation, with complete material/ structural damage-induced softening. They are used to describe damage coupling effects, localisations, crack initiation and even crack growth and failure, for both brittle and ductile materials.

The difficulties associated with damage mechanics in structural analysis, especially localisation, loss of uniqueness and mesh dependency, were reviewed and discussed in detail from a theoretical point of view, in practical application and in relation to numerical tool developments. It appears that a variety of recently proposed gradient/non-local approaches can be helpful in rendering current numerical modelling methods more reliable and efficient.

Application to practical situations was reported for a range of situations. These include the brittle materials that are encountered in concrete structures or rock mechanics, damage development in metallic structural components including ductile crack growth simulation. Also covered were sheet metal forming and other forming methods (cutting, deep-drawing of complex shape components, hydroforming, forging ....). Some multiscale analyses of composite structures were also discussed in relation to the use of damage mechanics or cohesive zone models in interfacial or interlaminar cracking simulations.

Though the Conference Room was large and impressive, the informal atmosphere and the limited number of participants promoted a high level of lively debate. Eighteen papers have been prepared and reviewed for a Special Issue of the *European Journal of Finite Elements* (Hermes, France). Last, but not least, although *Glass Bottle Forming* was not a specific technical subject of the meeting, selected contents were much appreciated, this being deemed an obligation in one of the renowned Champagne capitals.

EUROMECH Colloquium 393

Crack Initiation after Extensive Multiaxial Plastic Flow

Chairpersons: Prof. A.G.Atkins (Reading), Dr. O.Kolednik (Leoben)

EUROMECH 393 met in conjunction with three Technical Committees (1, 8 & 12) of the European Structural Integrity Society at the University of Reading on 21st – 23rd March 2000. There were 25 participants including one from the USA. Twenty oral presentations were supplemented by discussion and an experiment on a large biaxial testing machine in the engineering department.

While evermore powerful large deformation, large rotation and rezoning computer codes enable the distortion of structures in crashes to be predicted quite accurately, there is uncertainty about when and where cracks will initiate and propogate in such biaxial and triaxial stress fields, and hence alter the "crashworthiness" of the structure. Some large deformation computer codes have no means of dealing with ductile fracture; some have criteria which are wrong given existing knowledge of hole growth mechanics in triaxial stress fields (e.g. a criterion of critical von Mises strain at fracture); and some users of these codes have been known to enquire why they can't simply use the %-reduction in area from a tension test as the fracture criterion. It is clear that there is a great need for proper fracture criteria in the sort of computer codes employed for crashworthiness analysis.

On the other hand, in the metal forming literature going back some forty years, there have been systematic attempts to predict the formation of defects after extensive plastic flow in processes such as extrusion, forging and so on. Indeed, Kudo investigated cavity formation using upper bound methods as early as 1960, and Oyane used porous plasticity, with crack initiation defined by a critical volume fraction of voids a decade before Le Rousselier-Gurson methods began to be employed for crack initiation in 'fracture mechanics' using pre-cracked bodies. (This topic is reviewed by Adams in a paper in *Fracture Research in Retrospect* - G.R.Irwin Festschrift pp327-350 – ed. H.P.Rossmanith, Rotterdam, Balkema 1997.) The meeting learnt that there are many empirical criteria for cracking in metal forming. A feature of many is that they work well for the process for which they were determined, but may be hopelessly wrong when applied to a different process having an entirely different loading history. A 'good' criterion should be capable of predicting failure under *any* loading history, having been calibrated under any arbitrary loading history.

The most successful of the empirical criteria (i.e. applicable over widely differing loading paths) appear to be versions of what are McClintock/Rice-Tracey type effective stress – effective strain relations. The meeting observed that the metal forming requirement for a fracture criterion is in some ways more stringent than that for ductile fracture from a pre-existing crack since: (1) the site of fracture is not known *ab initio*, (2) many isolated cracks may be initiated, (3) there may be significant rotations of microstructure with respect to principal stress axes before

fracture, (4) the inclusion spacing and orientation is altered by the plasticity preceding fracture, (5) anisotropy may be marked, (6) the range of hydrostatic stress is great, and (7) necking may precede fracture, which alters rates of damage accumulation.

Uncertainties about calibration of damage models were found to be common to all participants, whether their interests lay in structural integrity or metal forming. For example, does metallurgical damage begin immediately loading commences? Or should there be a lower strain limit to damage integrals which recognises that some deformation is required before de-cohesion of particle/matrix interfaces begins? Is such a lower limit dependent on the local hydrostatic stress state? Can metallurgical damage simply be added as loading paths change up to fracture? What happens when necking precedes fracture? All these features will affect predictions of fracture under different loading paths from those under which a damage model is calibrated. Furthermore, the more disposable parameters in the damage model, the more calibration tests are required and the greater the possibility of erroneous predictions for widely differing loading paths. All of this could be very important, yet not be picked up from calibration tests on one type, or a limited number of types, of testpiece.

The EPSRC-funded large biaxial testing rig, newly commissioned in the Department of Engineering at Reading, was demonstrated to the meeting. Differing in-plane biaxialities are achieved by hydraulically bulging test plates over different elliptical orifices. The metre-long major axis permits plates 25mm thick and greater to be loaded under membrane conditions. Principal advantages over cruciform test pieces are the simplified loading system and that fracture in uncracked plates is virtually guaranteed to occur at the pole of the dome. Pre-cracked plates are tested with a rubber patch so as to prevent loss of fluid. Fracture toughness is determined from measurement of pressure and bulge volume to give work done for the usual nlefin-Hencky analysis for J_c. Changes in J_c with different in-plane remote biaxialities are thereby investigated. A number of new features have to be considered in this method of testing. Whereas cracking under conditions of contained yielding and uncontained yielding have recognised meanings with standard test pieces used in ductile fracture mechanics (where parts of the test piece remain elastic), in this method the whole ductile test piece is plastic and yielding is completely 'uncontained'. Cracking is stable in the rig and, of great interest, it is possible to study the propagation of naturally-initiated cracks, i.e., cracks formed while loading an initially *uncracked* plate.

EUROMECH Colloquium407: Symbolical and geometric methods in multibody kinematics and dynamics has been cancelled

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EUROMECH Colloquium 416
Interaction of Strong Turbulence with Free Surfaces

Chairpersons: Dr. M.Brocchini (Genova); Prof. D.H.Peregrine (Bristol).

EUROMECH 416 was held at the University of Genova on September 17th – 20th 2000. There were 30 participants from 9 countries of whom 8 came from outside Europe. There were twenty high quality oral presentations arranged in nine 30 minute sessions, each concluded by a 30 minute discussion period. A significant proportion of the participants (~ 30%) were research students which we consider a significant contribution to the success of the meeting and a starting point for more collaborative research in this difficult area of fluid mehanics.

A major aim of the Colloquium was to enhance the interaction among the different communities of applied mathematicians, physicists and hydraulic engineers involved in aspects of research on the interaction of turbulence with an air-water interface.

A motivation for this meeting was to improve study of the dynamics of breaking water waves by including a wider range of topics with the same problems. The first morning of the meeting was on breaking waves, with a nice mixture of experiment, modelling and numerics, all of which succeeded in highlighting the difficulties associated with this subject matter. Further talks moved to more fundamental considerations of turbulence near a free surface and the level of discussion rose as people from different backgrounds gave their perspective on the problems.

The challenging topic of the Colloquium was explored and discussed in a friendly and informal atmosphere made especially lively by the presence of representatives of very different scientific communities (water waves, two-phase flow, turbulence). Overall there was a good balance between experimental reports, analytical models and numerical studies. In the end, however, there was general agreement that most presentations represented a first attempt at a challenging subject, or were studies of associated and somewhat simpler topics.

A book of abstracts with summaries of each contribution was produced. A review paper summarising the Colloquium as a whole may be prepared for submission to a leading scientific journal.

Soil Structure Interaction is a subject of great interest in the fields of Civil, Structural and Earthquake Engineering. Most of the structural collapses which occur in buildings and other civil or industrial facilities, under normal life conditions or severe earthquake excitation, are due to failures in the soil or in structural components caused by the effects of soil-structure interaction inadequately treated in the phases of analysis and design.

Popular numerical methods in the field of structural engineering such as the Finite Element Method or the Finite Difference Method are inadequate in soil-structure interaction because the soil, one of the two media involved in the analyses is unbounded. The Boundary Element Method offers obvious advantages in the field of soil-structure analysis because, by setting the problem on the boundary of the body under study, it clearly reduces the number of unknowns of the problem. The use of fundamental solutions available for the infinite or semi-infinite domain (full space or half space) removes the need for a full discretisation of the unbounded soil. Only the interface with the structure, or, in many cases, a finite part of the infinite boundary needs to be discretised.

There were seven technical sessions on the topics:

Foundations; Boundary Element/Finite Element Coupling; New Formulations; Stochastic Analysis; Galerkin Methods; Seismic Problems and Traffic Problems.

Generally sessions were introduced with a Review Presentation, followed by submitted papers and finishing with a period for open ended discussion either leading up to lunch or to the end of day. The state-of-the-art presentations described the work of a number of leading European researchers covering numerical techniques in dynamic soil-structure interaction, the semi-scaled boundary finite element method, boundary element formulation of non-local elasticity, boundary element analysis of soil-structure interaction problems in random media, the symmetric Galerkin boundary element method, the dual boundary element method in elastodynamics and soil-structure interaction in practice. Together with the contributed papers there was a wide coverage of topics, from the theoretical treatment of models not based on fundamental solutions, treatments involving power law variations in inhomogeneous soil, scattering of seismic waves by irregular topographies and buried valleys to mitigation of vibrations caused by moving trains on nearby buildings. All papers attracted discussion which was often lively and extended.

A book of abstracts was prepared for the colloquium. A selection of reviewed papers will be published in a special issue of *Meccanica* and Kluwer Academic will publish the Review Presentations as a state-of-the-art book.

An opportunity for further exchanges in this area exists in a Mini-Symposium which will be part of the AIMETA congress to be held in Taormina, Sicily, in September 2001. This will be organised by Professors Hall and Oliveto.

Three younger researchers from Brazil, Germany and the Ukraine received EUROMECH Fellowships and substantial additional support.

EUROMECH Colloquium 408
Interactive Dynamics of Convection and Solidification

Chairpersons: Prof. D.S.Riley (Nottingham); Dr. P.Erhrard (Karlsruhe); Prof. P.H.Steen (Cornell)

EUROMECH 408 was held at Chamonix, France, on 18th – 22nd March, 2000. There were 38 participants of whom 16 came from the USA. There were 5 invited contributions and 29 other contributed presentations, organised in 5 sessions.

Crystal growth, casting, soldering, welding, high-energy surface treatment, nuclear safety systems and geophysical flows are just a few examples of examples where solidification and convection occur together. These processes are interactive on both micro- and macroscales: flow affects the distribution of heat and species and hence the freezing process, while solidification changes flow boundaries, as for example in crusting, may therefore radically alter the convection pattern. Mathematical modellers, experimentalists and applied scientists were invited to this colloquium with the aim of consolidating our understanding of such interactions, of identifying key outstanding issues and of developing new approaches in this important area of fundamental research.

The contributions divide roughly into three classes depending on the length scale of interest: (i) dendritic or micro- length scales, (ii) mushy or meso- length scales, (iii) overall or macro- length scales.

(i) On the micro-scale, several contributions concentrated on various aspects of directional solidification of binary alloys such as (localised) morphologies for various flow conditions and for rapid solidification. The morphological instability of pure melts, subject to convection, or the morphological instability of binary alloys with anisotropic kinetics were further foci. The growth of dendrites under diffusion-controlled conditions, as well as subject to forced or free convection, was another broad field, treated both experimentally and by phase-field methods. The final contribution concentrated on accurate experimental methods for the determination of liquid diffusion coefficients.

(ii) On the meso-scale, one focus lay on convection in mushy zones which are relevant in geophysical flows, often featuring chimneys. Other contributions treated meso-segregation within the granular phase during equi-axed solidification and derived models for macro-segregation through coarsening of dendrites in the mush. The deformation of steel in the mushy state and the complex solidification of ternary systems were also topics. Further contributions covered various aspects of solidifying water-salt systems, such as simultaneous melting and solidification, thermohaline convection and natural convection in the mush with forced convection in the liquid zone. A final contribution gave an overview of the phase-change behaviour of liquid crystalline elastomers.

(iii) On the macro-scale, various complex industrial casting processes, such as

vertical or horizontal continuous casting of steel, with and without magnetic stirring, strip casting and spin casting were investigated experimentally and/or modelled. Another class of problems considered was spreading flows, relevant to nuclear safety or geophysical flows. Models for top-crusting oxidic melts and for metallic melts featuring strongly temperature-sensitive viscosities were presented as well as experimental investigations of corium spreading and on axisymmetric spreading of metallic melts, both subject to simultaneous solidification. Further contributions concentrated on other problems, relevant for nuclear safety, such as freezing liquid-metal flow in tubes and the numerical treatment of solidified corium, subject to internal heat generation and subsequent internal re-melting. Finally, the overall simulation of Czochralski crystal growth, the reactive wetting of alloys on metal substrates, the solidification of sessile water droplets, the *in-situ* X-ray visualisation of concentration fields in metallic alloys, and the filament deposition technique, as a potential free-form manufacturing process, were presented.

Proceedings of the Colloquium, containing 28 contributions on about 300 pages, have been edited and will shortly be published by Kluwer Academic Publishers.

EUROMECH Colloquium 409

Dynamics and Long-Term Behaviour of Railway Vehicles, Track and Sub-Grade

Chairpersons: Prof. Dr Karl Popp (Hannover)
Prof. Dr. R.Bogacz (Warsaw) and Prof. Dr. H.True (Lyngby)

EUROMECH 409 was held at the University of Hannover, Germany, from March 6^{th} – 9^{th}, 2000. There were about 80 participants from 12 European countries, with representatives from Japan and South Africa. There were 31 lectures and 13 poster presentations. The meeting was opened impressively by the Vice-President of the University, the Dean of Engineering and the Chairman of the conference, followed by the opening lecture on "Rolling Contact" by J.J.Kalker.

The main objective was to combine short term dynamics and the long-term behaviour of the entire railway system consisting of vehicle, track and sub-grade. Here the most important dynamic phenomena occur in the intermediate frequency range between 50 and 500 Hz. The scientific programme was organised in the following sessions:

Semi-analytical contact models
Full track models
Train-track interaction coupled with long-term behaviour
Wave propagation in the subsoil
Contact methods based on Finite Elements

- Industrial applications

Selected papers will form the proceedings of the Colloquium to be published by Kluwer Academic Publishers, Dordrecht, in 2001

EUROMECH Colloquium 413

Stochastic Dynamics of Nonlinear Mechanical Systems

Chairpersons: Prof. Mario di Paola (Palermo)
Prof Rudolf Heuer, substituting for Prof. Franz Ziegler (Vienna)

EUROMECH 413 took place in Palermo on June 12^{th} – 14^{th} 2000. There were 36 participants, 8 coming from outside Europe.

The aim of EUROMECH 413 was to bring together people working in the field of nonlinear stochastic dynamic systems with emphasis on both the theoretical and practical aspects. This was achieved in that a wide spread of mathematicians and engineers, with well known scientists from Eastern Europe and the USA took part in the meeting.

There were two keynote lectures giving a deep insight on the current trends of stochastic dynamics: Professor Ludwig Arnold spoke on *Stochastic Dynamics*, while Professor Pol Spanos introduced *Simulation Methods*.

In the contributory sessions, topics covered included: stability, chaos, Itô calculus, numerical treatment of the Fokker-Planck equation, response of nonlinear systems to impulsive random processes and experimental studies of an elastic-plastic model under random excitation. Other relevant problems were deeply discussed.

EUROMECH Colloquium 414

Boundary Element Methods for Soil/Structure Interaction

Chairpersons: Prof. W.S.Hall (University of Teesside, UK);
Prof. G.Oliveto, (University of Catania, Italy).

EUROMECH 414 took place in the 'La Perla Ionica' conference centre, Acireale, Italy on 21^{st} – 23^{rd} June 2000. There were 37 participants from 10 countries, 2 from outside Europe. There were 7 Review Presentations given by subject leaders and 13 submitted papers. The intention was to bring together key workers in BEM and SSI so as to promote a greater awareness of BEM in this area of study. Most participants were already combining the two, but for others, the value lay in the dissemination of leading edge methods to a mixed audience.

The social programme included a tour of Rouen and a banquet.

A selection of original papers are to be published in *Measurement Science and Technology*, probably in March 2001.

EUROMECH Colloquium 412
LES of Complex Transitional and Turbulent Flows

Chairpersons: Prof. R.Friedrich (Munich), Prof. W.Rodi (Karlsruhe)

EUROMECH 412 took place at the Munich University of Technology, Garching, on October 4th – 6th 2000. There were 73 participants, with 4 from outside Europe. There were five invited speakers and thirty-three oral presentations.

The colloquium aimed at presenting and discussing recent advances in the field of large eddy simulation (LES) for transitional and turbulent flows where the complexity of the flow arises either from complex boundaries or physical mechanisms involved. Topics covered included: subgrid-scale modelling, LES on unstructured and Cartesian grids (to represent complex geometries), coupling strategies between LES and RANS computations and the DES approach. The complex phenomena treated with LES included magnetic field effects, turbulent combustion, flow separation and reattachment, and aircraft wake vortex motions.

The five invited lectures were:

Ten years of the dynamic model. Massimo Germano (Politecnico di Torino, Torino, Italy)

How can we make LES fulfil its promise. Bernard J.Geurts (University of Twente, Enschede, The Netherlands)

Subgrid combustion modelling for LES of reacting single and two-phase flow Suresh Menon (Georgia Institute of Technology, Atlanta, USA)

Detached eddy simulation, 1997-2000. Philippe Spalart (Boeing Commercial Airplanes, Seattle USA)

Towards LES of complex flows. Christer Fureby (FOA Defense Research Establishment, Stockholm, Sweden)

The thirty-three oral contributions were presented in nine sessions listed below:

- SGS modelling and Analysis
- Aircraft wake vortices
- Turbulent combustion (I & II)
- Numerical issues in LES
- Separating and reattaching flows
- RANS-LES coupling
- Unstructured/Cartesian grids for complex geometries (I & II)
- Compressible, hydromagnetic and shearless flows

Dynamics of bogies with elastic wheelsets
Dynamic analysis of track quality
Railway vehicle vibrations
Long-term behaviour of track
Modelling of certain track components
Wear in wheel-rail contact: modelling and experiments

All lectures were delivered as proposed in the programme and followed by a lively discussion. The posters were introduced in the lecture hall and discussed intensively later on. There will be no published Proceedings but abstracts and references can be found on http://www.ifm.uni-hannover.de/~EUROMECH.

The evening social programme included a Welcome Party, a Lord Mayor's Reception and the Conference Dinner. There was also an afternoon excursion to the Research and Test Centre of Deutsche Bahn AG in Minden.

Participants from Eastern European countries were sponsored by the Friends of the University of Hannover, while Deutsche Bahn AG offered a free rail ticket to Hannover to all Participants, who expressed their opinion that the Colloquium was extremely successful and well organised.

EUROMECH Colloquium 411

Application of PIV to turbulence measurements
Developments of 3 C Stereoscopic and Holographic Techniques

Chairpersons: Dr. M. Trinité (Rouen),
Dr. J. Kompenhans (Göttingen), Prof. M. Stanislas (Villeneuve d'Asq)

EUROMECH 411 was held at the University of Rouen on May 29th – 31st 2000. There were 50 participants, predominately from France with 4 from outside Europe.

The principal topics of the meeting focused on three differing aspects:

- Advanced PIV techniques (2D2C, 2D3C or 3C) usable for the study of turbulent flows
- Accuracy and limitations of PIV treatments for measurement of turbulence properties
- Relevant post processing tools for PIV data to extract information on turbulent flows

Twenty-four papers were presented on these topics, distributed in five sessions:

- 3D Holographic PIV and others
- 2D-3C PIV Stereoscopy and others

- Turbulence and advanced PIV treatments
- Post processing of PIV maps (POD, wavelets ...)
- Time-resolved PIV and applications

Four keynote lectures were given by recognised specialists:

- Holography as a 3D PIV method (Dr. H.Royer, France)
- Multi-plane stereo PIV recording and evaluation methods (Dr. Kaehler, DLR Göttingen)
- Turbulence and PIV (Dr. P.Saarenrinne, Tampere, Finland)
- Eulerian and Lagrangian velocity measurements by means of image analysis (Prof. A.Cenedese, Rome University)

The keynote lectures were complemented by two 'round tables' – on "turbulence" (Prof. M.S.Stanislas, Lille) and "future aspects of PIV" (Prof. M.Riethmuller, VKI, Belgium).

If 3-C, 3-D (4-D with time), is the ultimate final aim of PIV developments; holography is the only practical way to extend sheet-orientated PIV to a measuring volume of significant depth from the 3-D point of view. However, a major problem is pollution by out of focus particles located at various depths, spoiling image quality by introducing noise. Light-in-flight holography allows considerable suppression of this noise (Geiger *et al.*).

Interesting results have been obtained for a localised flow such as a free jet. Digital holography (Cöetmellec *et al.*) using a 2-D wavelet algorithm is a very simple promising new method in spite of poor resolution. An alternative 3-D, 3-C approach is based on the measurement of the 3-D co-ordinates of individual particles by PTV from stereoscopic sequences (Burr *et al.*). This technique also permits a Lagrangian approach (Cenedese *et al.*). It allows high spatial resolution and temporal evolution of particle position but the velocity field is not resolved down to the small scales of turbulence due to the limited seeding density.

Stereoscopic PIV using two cameras viewing the flow field from different angles is one technique for measuring all three components in a fluid plane. For the reconstruction of the three-dimensional velocity field a calibration stage is necessary, since the imaging geometry introduces significant aberrations. A 3D vector is computed at a physical point in the object plane. The method is split into two steps: The first consists of computing two 2D vectors at the physical point from the two cameras. Two methods were discussed (warping and mapping – Coudert *et al.*). In the second step, the 3D vector is computed from the two 2D vectors by geometric reconstruction which is determinant for the accuracy of the results (Fei *et al.*).

We may now consider that Stereoscopic PIV is sufficiently operative for applications such as complex bubbly flows (Hassan) or combustion flows (Lecerf *et*

al.). However, quite often the distribution of the velocity in a single plane, captured at a single instant in time, does not yield the information required to answer fluid-mechanical questions, particularly for turbulent flow. The multiplane method (Kähler) is a promising alternative solution to holography.

If Hot Wire Anemometry (HWA) can be considered as the "reference" method for turbulence measurements *at one point*, the use of PIV for the same measurements *in one plane* seems very exciting. To date, however, certain limitations exist for the determination of some advanced parameters such as dissipation rate (Saarenrinne *et al.*). Spatial resolution is one of the limitations. Hybrid PIV-PTV methods, combining the advantages of the two approaches, can lead to a noticeable increase in spatial resolution (Stitou *et al.*). Noise embedded in the velocity vector values is another problem for spectral analysis. New advanced algorithms are needed for this purpose (Delence *et al.*). Various experimental studies using known flow fields such as grid turbulence or pipe flows have been used to try to show the ability of the PIV technique to extract the information from turbulent vector maps. These studies however always show that it is difficult to chose which technique is the more accurate for the measurement of a given flow. This is mainly due to an imprecise knowledge of the exact characteristics of the flows. One solution is to impose known flow properties on a synthetic image generated numerically (Lecordier *et al.*). A similar approach is now possible using data from Direct Numerical Simulations (DNS).

Another challenge for PIV lies in time resolution. For low speed pseudolaminar flows such as in water tunnels, recently developed standard cameras permit time-resolved investigation by PIV and animation of the vector fields (Lee *et al.*). In flow configurations at high Reynolds number and gas flows the use of high-speed cameras in combination with appropriate laser systems provides high temporal resolution between two consecutive velocity maps. It makes possible studies of turbulence development and flow structure evolution (Bauer *et al.*). Supersonic flow investigations also become possible with short pulse generation (Golyakov *et al.*).

If PIV has now evolved from an embryonic state to a reasonable maturity, we face a problem directly linked to the high spatial resolution and frequency of acquisition now possible with commercial CCD cameras. There is an overabundance of information which must be appropriately reduced if we are to draw conclusions from the data set. To this end two recently developed tools are used to resolve the problem of unsteady turbulent flows and to try to separate out the fluctuation intensity due to the overall unsteadiness and that due to the turbulence as such. These are Proper Orthogonal Decomposition (POD) and wavelet transform analysis. Promising results have been obtained in rotating flows (Graftieux *et al.*, Moreau *et al.*) and wake flows (Santa Cruz *et al.*). This tool, in combination with spatial correlation and pattern recognition, promises to assist in the evaluation of the contribution of coherent structures to the generation and self-sustention of wall turbulence in boundary layers. Applications of wavelet transformation can be used to analyse the temporal evolution of coherent structures and to characterise the leading vortex generated in a starting flow (Scham *et al.*).