September 2001

MACSI-net

A European Network of Excellence
To further the interaction of mathematics and industry in Europe

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EDITORIAL

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HOW TO JOIN MACSI-NET

Background

In October 2000 the EC formally approved the funding of MACSI-net. At that time 20 academic nodes and some 80 industrial partners joined efforts to increase the interaction between industry and academia with the purpose to

- help European industry (in particular SME) with advanced mathematical and computational tools
- increase awareness of academia of industrial needs.

These starting points have been worked out in a number of documents. More specifically the following objectives have been formulated:

- MACSI-net aims at a fifty-fifty participation of industries and academia.
- MACSInet is multidisciplinary, with applied mathematics, computing and engineering as constitutive disciplines.
- The main objective of MACSI-net is to provide mathematical tools for research, development and design in industrial problems.
- MACSI-net aims at collaboration of academia with both large companies and SME in a systematic way and Europe-wide.
- Innovative methodologies and their computational implementations will be assessed in workshops.
- MACSI-net is planned as a horizontal Network, but through its very actions it will provide a useful breeding ground for developing plans for Thematic Networks.
- MACSI-net has defined 7 areas which will receive particular emphasis, viz. aeronautics, material processes, chemistry, environment, bioengineering and medicine, telecommunication and energy.
- Industries are strongly invited to bring challenging (potentially multidisciplinary) problems.

Means

Thus far the network has become truly multidisciplinary, combining the power of applied mathematics, scientific computing and engineering, for modelling and simulation. To repeat briefly the means to achieve these goals we may mention the following actions

- Strategic meetings with industries about well specified topics
- Summer courses
- Workshops
- Visits of experts
- Industrial days

As it turns out the activities (to be called “events”) are best channelled through the establishment of Working Groups (WG). A Working Group can either be devoted to a single application (with a multidisciplinary composition) or to a discipline oriented subject with a variety of application areas. The above mentioned events are then the major activity of such a particular Working Group. MACSI is subsidising these events to some extent.

Invitation to join in activities

Persons from academic or industrial organisations who are working in or interested in industrial mathematics are cordially invited to participate in the various kinds of activities. To this end they should contact the MACSI-net secretariat (for address see first page). The benefits will be regular updates of MACSI-net activities as well as free copies of the newsletter.

Anyone living in the EU and interested in either setting up a new WG or in organising an event (as indicated above) is strongly advised to submit a proposal to this end. If the proposal is approved by the executive committee he will be notified and receive further instructions. Also persons from institutions, not yet included as nodes, may submit proposals.

Working Groups

The Working Groups are important means to achieve the goals of MACSI-net. Below we give an overview of various aspects related to establishing and running a Working Group (WG).

- A WG is focussing on a theme that is relevant for MACSI-net. It can be application oriented (vertical structure) or method based (horizontal structure).
- A proposal to found a WG can be sent in any time to the co-ordinator. The decision about approval is taken by the Executive Committee.
- A WG proposal should address at least the following points:
  - It should identify a proper theme
  - It identifies a group of experts.
  - There is a list of potential activities ("events").
  - There is a moderator (name and address), who is responsible for reporting.
- The WG will organise meetings, workshops etc, to be called "events" which are eligible for funding by MACSI-net, up to a certain amount (see web page). For each event a small proposal has to be submitted to the co-ordinator up for approval by the executive committee)
- For an event payments can only be made to an organiser who is member of MACSI-net (i.e. who has signed a membership agreement). Prospective organisers who are not yet a member, need to reckon with some administrative work (and delays accordingly) in their planning.
- Further details can be found at the website, www.macsinet.org

Should one like to have more information about the network or any other aspect of MACSI-net, he/she most cordially is invited to contact the secretariat.

Bob Mattheij, co-ordinator of MACSI-net

JACQUES- LOUIS LIONS (1928-2001)

Honoring the founder of the french Applied Mathematical School

Jacques Louis Lions, 73, a world recognized applied mathematician passed away on May 17, 2001 after a long illness.

Jacques Louis Lions was born in Grasse, France on May 2, 1928. He was Professor at the University of Nancy from 1954-1962, at the University of Paris 6, from 1962-1973; at the Ecole Polytechnique, from 1966-1986; and at the College de France from 1973-1998.

He talentuously taught modern mathematics, supervized many doctoral students from France and other countries and anticipated the profound impact that parallel computers would have on applied mathematics to solve challenging applications of industry and society.

His research activities were focused on Partial Differential Equations, Analysis and Control of Systems, Scientific Computing with applications to Environment, Aerospace Engineering, Energy, Production, Telecommunications.

All along his outstanding career, J.L. Lions played a very important role in promoting mathematics with their applications to industry. He founded and led a french school of mathematics famous in the world and inspired a new generation of applied mathematicians who in turn widened the influence of his school.

He was a member of the French Academy of Science at the early age of 45, then President elected of it from 1996 to 1998 and as chairman of the Comité 2000 coordinated a report of assessment of scientific issues facing the 21st century Society at the request from the President of the French Republic. J.L. Lions was also a member of many foreign academies, namely National Academy of the US, Royal Society, Russian Academy of Sciences, Academia Sinica and Académie Pontificale. He was also Doctor Honoris Causa of many universities and a founding member of Academia Europae and recently of Académie des Technologies.

Author of many books (the landmark work on control theory being his 1968 book on *Contrôle Optimal des Systèmes Gouvernés par des Equations aux Dérivées Partielles*), he received for his outstanding contribution to Applied Mathematics numerous prizes, including the John von Neuman Prize in 1986, the Japan Prize and the Harvey Prize in 1991 and the Lagrange Prize in 1999.

Among his numerous responsibilities he was from 1980 to 1984 the first President of INRIA promoting scientific computation through the French National Institute for Research in Computer Science and Automation and President of Centre National d'Etudes Spatial from 1984 to 1992 during which critical decisions were made with the european ARIANE 5 rocket, the HERMES Space Vehicle and the TOPEX POSEIDON satellite.

In the last period of his life he held very active high level scientific advisory positions in industry with Dassault Aviation and Elf.

To illustrate his clear cut position in modern Sciences and Technologies, J.L. Lions co-chaired in 1999 with H. P. Estola, NOKIA Vice President, the Strategic Board Committee of a prospective European Network of Excellence on the interactive role of Applied Mathematics and Engeneering for solving new multidisciplinary challenges, MACSInet (Mathematics, Simulation and Computation for Industry), a kernel assembled from two existing european associations, European Computational Methods for Applied Sciences (ECCOMAS) and European Consortium for Mathematics for Industry (ECMI); his last introductory lecture at the kick-off meeting of MACSInet in Amsterdam on November 23, 2000 was entitled: "APPLIED MATHEMATICS WORKING AT INTERFACES" and started as follows:

"Alan Turing is reported as saying that PDE's are made by God, the Boundary Conditions by the Devil!

The situation has changed, Devil has changed places….

We can say that the main challenges are in the INTERFACES with Devil not far away from them…"

He is is survived by his wife Andrée and his son Pierre- Louis who, as a distinguished mathematician, won a Fields Medal in 1994 , – a great happyness for him -.

Many colleagues and friends will remember J.L. Lions as an exceptional human being, modest, competent, warm and extraordinary human.

Jacques Periaux, Dassault-Aviation
Direction de la Prospective
MACSInet Executive Committee Co-coordinator

July 2001

Jacques Périaux
DASSAULT AVIATION
Direction de la Prospective
Directeur du Pôle Scientifique

Olivier Pironneau
University Pierre et Marie Curie
Directeur du Laboratoire
d'Analyse Numérique

Laboratoire d'Analyse Numérique

The Laboratory is a centre of Research, a training centre and a University / Industry exchange centre. It has been created by J.-L. Lions in 1969.

Themes of Research
The Research activities of the Laboratory are essentially centred on study of partial differential equations - PDE -, numerical analysis and scientific computing. The study the existence, uniqueness, regularity, qualitative properties of solutions and of the simulation methods leads to the understanding of problems of Physics, computer sciences engineering, and high technology industries.

DEA, DESS and thesis
The numerical analysis DEA is one of the most important in France concerning Applied Mathematics. Its success is due to the quality of the staff, to the contacts with industry (training) and to the participation of the Grandes Ecoles.

Industrial relations
The Laboratory takes part of the Research within the industrial environment through Research contracts with companies or state organisation, the Ministère de l'Education, de la Recherche et de la Technologie (MENRT), large national organizations (Commissariat à l'Energie Atomique - CEA, ...) or also through participation with large European programmes.

DASSAULT AVIATION is involved in the design and production of the MIRAGE and RAFALE fighters, ATLANTIQUE 1, 2 and 3 maritime patrol aircraft and FALCON business jets which are manufactured in France. Through these activities the company is in charge of design, development and integration of systems that feature the major characteristics and techniques relevant to this project:

- Acoustics
- Aerodynamics
- Control
- Electromagnetics
- Fluid Dynamics
- Multi Disciplinary Design Optimisation
- Scientific computing

As an integrator, the company is responsible for all design and development phases and relies on simulation and testing techniques performed on its own facilities (simulators and test rigs), either in Saint Cloud or Istres.

KEYNODE

DASSAULT AVIATION / UPMC

Pôle Scientifique, St Cloud, France

Founded in 1998 by Dassault Aviation and the University of Pierre et Marie Curie

Goals

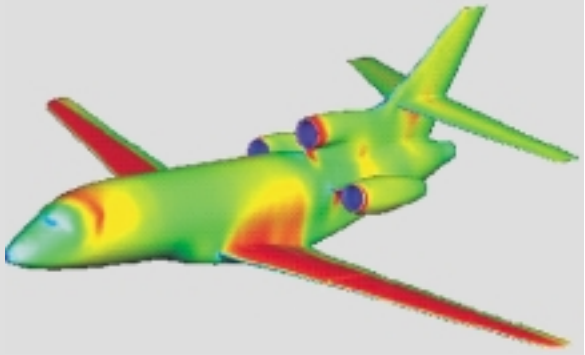
- Open Structure for visiting researchers
- Interactions between scientists and engineers
- Software feedback from research to aerospace industry

Actions

- Strong International Cooperations (more than 15 invited Prof. for 2000)
- International Seminar every 3 months
- Conference Support (Eurodays, NFD 2000, MACSI-net, ...)
- European IT networks
- Global Scientific Network.

Means

- Permanent staff
- Post-doctoral fellows
- Foreign PhD Students
- Post-grad students
- University Paris VI Local network
- Unix server
- Cluster of Linux PCs



INDUSTRIAL NODE

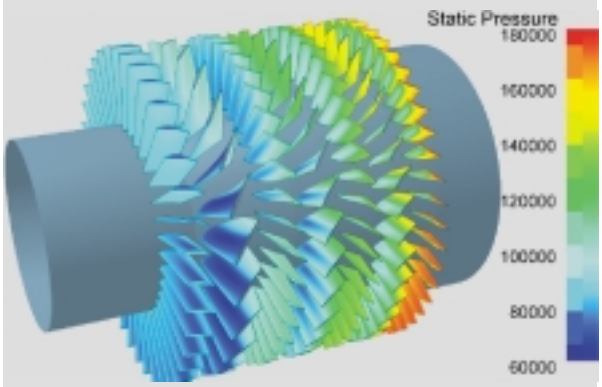
NUMECA INTERNATIONAL

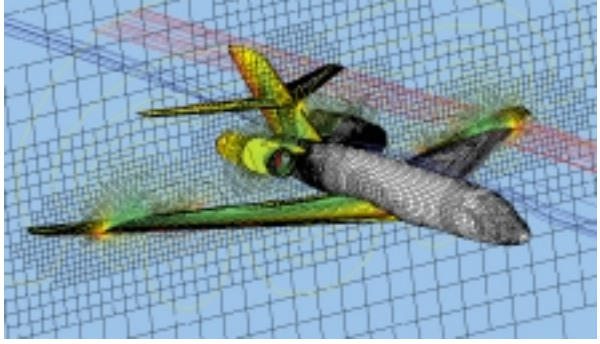
Brussels, Belgium

- Private company founded in 1992
- Computational Fluid Dynamics (CFD) and Optimization technologies
- 50% average growth rate since its creation
- 50 engineers and PhD's in CFD, Mathematics and fluid dynamics

NUMECA: OVERVIEW

- Created in 1992 as a result of research activities in the field of CFD systems, carried out at the department of Fluid Mechanics of the Vrije Universiteit Brussel, NUMECA has been growing steadily and gained progressively world-wide recognition. It has a strong market presence in Europe, the United States and Asia.
- The main strategy adopted by NUMECA is based on the development of highly integrated, fully automatic and customised software systems, following closely industry's requirements and needs. The collaboration with University Departments, research laboratories and major industrial partners, is an important part of NUMECA's strategy towards the improvements and development of creative and innovative products.
- NUMECA's most popular software suites FINE/Turbo and FINE/Design3D are being used by the most demanding industrial sectors: aircraft designers, aircraft and helicopter engines, power plant gas turbines, space vehicles and cabins, car and tyre manufacturers, etc. The speed, accuracy, user-friendliness and customisation of the FINE suite, allow the designers to improve a lot the aerodynamic performances of their machines in very short times.





NUMECA: ACTIVITIES

Software Development

NUMECA develops and maintains full-integrated software solutions for numerical industrial flow simulations. These solutions, integrated into a user-friendly and customised GUI (FINE), include:

- Automatic mesh generators, valid on any geometry imported from a CAD tool
- Flow solvers, based on the most recent technologies, able to simulate any type of flow problem (supersonic/subsonic/incompressible flows, steady/unsteady regimes, complex fluid properties, reacting flows, multi-phase flows, etc) with a high accuracy and speed. NUMECA's latest technology also adapts automatically the mesh during the calculation, to further improve the accuracy of the solution
- Interactive and Automatic Visualisation tools, providing all qualitative and quantitative tools for flow analysis, including the comparison with experimental data
- Optimization systems, based on inverse methods and artificial intelligence algorithms (genetic algorithm, gradient methods, ANN), allowing the automatic redesign and aerodynamic optimization of complex geometries, in strong coupling with the CFD methods

In addition, NUMECA couples its systems to external software systems, in order to allow multi-disciplinary simulations, such as aero-structure or aero-acoustic analyses.

The Software Development activity covers as well the development and maintenance of specific customer-oriented graphical user interfaces.

Consulting in Fluid Flow Engineering

Through a team of experts in fluid dynamics, NUMECA offers a complete set of consulting services, from geometry modeling to complex flow analysis and shape optimization. These services include on-site outsourcing of NUMECA experts, for a few days or several months.

VUB
VRIJE UNIVERSITEIT BRUSSEL

Brussels, Belgium

- founded in 1970
- 9000 registered students
- 1800 international students

Department of Fluid Mechanics

- Head: Prof. Dr. Charles HIRSCH
- 2 professors,
- 4 post-doctoral positions
- 14 researchers

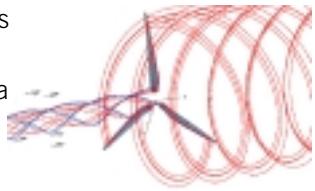
ACTIVITIES

Computational Fluid Dynamics

for Reynolds Averaged Navier-Stokes

Numerical algorithms on structured meshes

- Mesh adaptive Navier-Stokes solver
- Non-Newtonian flows
- Unsteady flows
- Flow in porous media
- Flow with moving interfaces



Numerical algorithms on unstructured meshes

- Mesh adaptive N-S solver on unstructured, hexahedral meshes

Large Eddy Simulation

The aim is to develop a LES code from the well-validated Reynolds Averaged Navier-Stokes (RANS) solver EURANUS (department code). The LES code will be applied to flows where the RANS models fail or give unsatisfactory results such as flows with combustion or multiphase flows.

Experimental Turbulence

- Study of transition in turbo-machinery flows
- Experimental study of complex flows

Turbomachinery

- Quasi-Steady Rotor-Stator Interaction
- 3D measurements and internal flows
- CFD simulation of turbo-machinery components
- Development of a test facility for pumps and water turbines

Environmental Flows

Wind Energy

Wind Engineering

Coordination of European projects

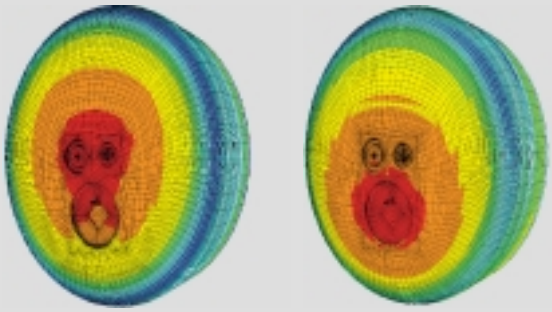
- QNET-CFD - A thematic network for quality and trust in the industrial application of Computational Fluid Dynamics, GROWTH, 5th framework Program
- ALICE - Quantitative Flow Field Visualisation – for unified treatment of EFD and CFD data, ESPRIT 4th Framework Program.

OVERVIEW

The Vrije Universiteit Brussel is a medium-sized university, with some 9000 registered students. About 1800 VUB-students are from outside Belgium, about 800 of them come from Asia, Africa and South America.

Department of Fluid Mechanics

The Department of Fluid Mechanics is part of the Faculty of Applied Sciences. The head of the department is Prof. Ch. Hirsch. The department has 2 professors, 2 assistants and 14 researchers with 4 of them having post-doctoral position. The research and development activities are conducted in the following fields:



a:Static pressure field over Huygens probe for an incidence angle of 0 degrees
b:Static pressure field over Huygens probe for an incidence angle of 15 degrees

Participation in European projects

- VISCEL Viscous and aeroelastic effects on wind turbine blades
- FLOWnet - Flow Library On the Web - is a Thematic Network in the 5th Framework Program.
- Implementation and further application of refined transition prediction methods for turbo- machinery and other aerodynamic flows

Belgium National projects

FWO, VLW, DWT,OZR

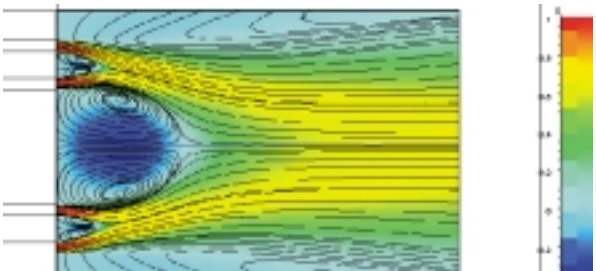


Fig: Streamwise velocity component and streamlines of the turbulent flow in a double annular burner geometry

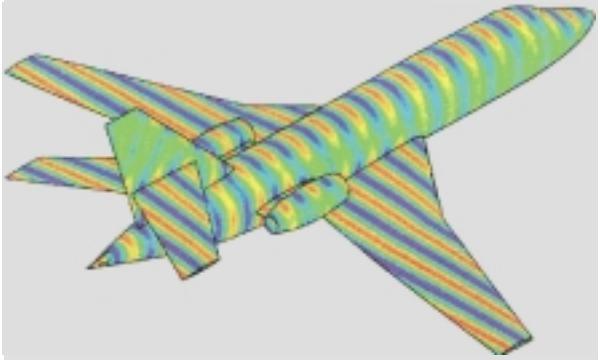
CIVIL ENGINEERING, SCHOOL OF ENGINEERING

University of Wales, Swansea, Wales, UK

- 14 academic staff
- 90 research staff
- Head: Professor N. P. Weatherill

OVERVIEW

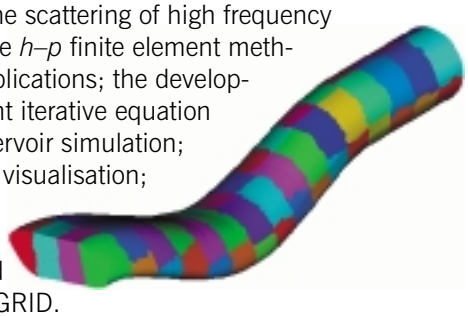
The School of Engineering at the University of Wales Swansea has a long tradition of excellence in the provision of both undergraduate and postgraduate courses in the areas of Chemical, Civil, Electrical and Electronic, Materials and Mechanical Engineering. Within Civil Engineering, for the past forty years the research activity has focused on the development and application of numerical methods for the solution of practical problems of engineering analysis and design. The new £3.5 million research centre, due for completion in 2002, will provide a unique environment for undertaking research in computational mechanics with its modern computer and visualisation facilities.



ACTIVITIES

Research

The main research groups operate within the areas of structural mechanics, geomechanics, fluid mechanics, electromagnetics and biomechanics. Current topics of interest include: discrete element and meshless methods; impact and fracture; the scattering of high frequency waves; adaptive *h*–*p* finite element methods; dental applications; the development of efficient iterative equation solvers; oil reservoir simulation; aerodynamics; visualisation; parallel processing techniques and the use of the GRID.



Graduate training

One year courses, involving advanced study and research, lead to the degrees of either MSc or MRes in the area of computational methods. These courses are supported by the UK Research Council (EPSRC). Students following the three year PhD programme, and post-doctoral research workers, are generally supported by external, industrially related, research contracts or by EPSRC research grants.

Service

The Welsh Development Agency has recently awarded financial support, and the Centre of Excellence designation, to the range of activities within the area of computational modelling. This Centre will employ staff with the specific intention of linking with industry to exploit the expertise in computational modelling.