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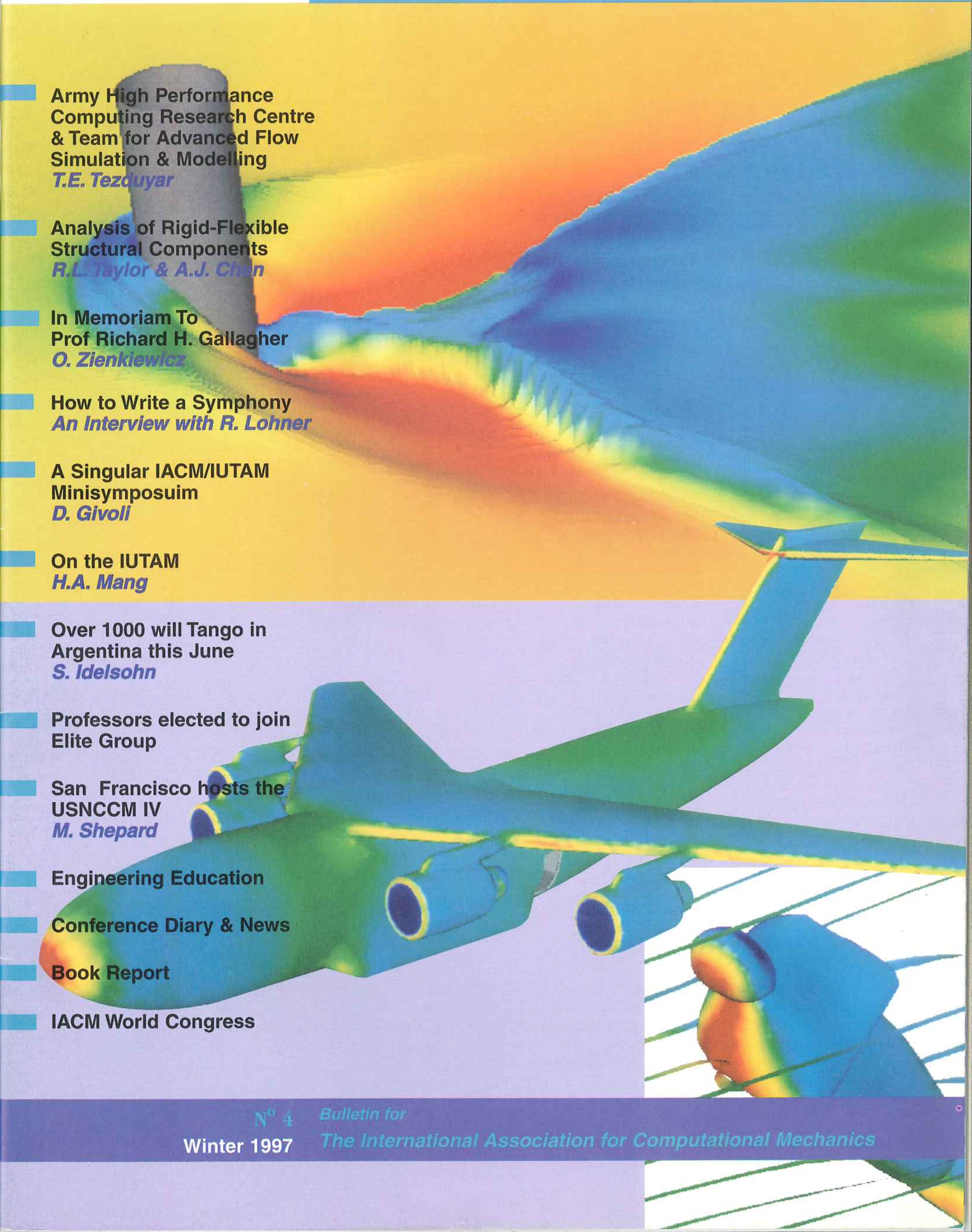

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The International Association for Computational Mechanics

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IACM Expressions

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Front Cover
Some analysis performed by the Army High Performance Computing Research Centre and Team for Advanced Flow Simulation and Modelling at the University of Minnesota, Pages 4 - 6, Figures 1 and 4

contents

editorial

Farewell to a great pioneer

The recent death of Prof R. Gallagher has shocked the IACM community. Dick was one of the great pioneers in the field and the leader of the group of scientists which formed IACM. These words and some of the articles in this issue are a small tribute to his memory and an opportunity to express, on behalf of IACM, our sincere sympathy to his wife Terry and the rest of his family.

This issue completes the second year of the existence of IACM Expressions. According to the comments and letters received, the bulletin is serving its purpose well, and we are therefore planning to move forward towards the end of the century.

By the way, the next Spring/Summer issue of Expressions will be released next June, during the World Congress of IACM in Buenos Aires. It seems that more than 1000 participants from 60 countries will meet to enjoy tango dancing, scientific meetings and the conference on the whole. Indeed, this will be an opportunity to meet many old and new friends from the IACM community worldwide.

In the meantime, please receive our best wishes from the IACM Secretariat for a peaceful and successful New Year.

E. Oñate
IACM Secretary & Treasurer

ARMY HIGH PERFORMANCE COMPUTING RESEARCH CENTRE AND TEAM FOR ADVANCED FLOW SIMULATION AND MODELLING AT UNIVERSITY OF MINNESOTA

by
T.E. Tezduyar
Distinguished McKnight University Professor
Army HPC Research Centre
University of Minnesota

The Army High Performance Computing Research Centre (AHPCRC) was established in 1989. The Centre is funded by the US Army as a cooperative agreement and contract to the University of Minnesota in Minneapolis. Dr. Tayfun Tezduyar, Distinguished McKnight University Professor at Aerospace Engineering and Mechanics (AEM), is the Director and Principal Investigator of the AHPCRC. The Centre is now in its second 5-year phase, and the current total funding for this second phase is approximately $60 million. The University of Minnesota has five subcontractors in this project: four academic partners of the AHPCRC and an industrial partner. The academic partners are Clark Atlanta, Florida A&M, Howard and Jackson State Universities; and the industrial partner is the Network Computing Services, Inc. (NetworkCS).

The AHPCRC research activities are organized into four teams. The Simulation and Modelling Team is lead by Dr. T.E. Tezduyar. The Advanced Materials Science Team is lead by Dr. Jeff Derby, Associate Professor of Chemical Engineering and Materials Science at University of Minnesota. The Environmental Sciences Team is lead by Dr. Jerzy Leszczynski, Professor of Chemistry at Jackson State University in Jackson, Mississippi. The Enabling Technologies Team is lead by Dr. Vipin Kumar, Professor of Computer Science at University of Minnesota. The research activities of the AHPCRC involve extensive research collaborations with a number of Army research sites. These are: Army Research Laboratory; Natick Research,

Figure 1
Parallel 3D computation of free-surface flow past a cylinder at Reynolds number 10 million and upstream Froude number 0.564. An interface-tracking method with the stabilized space-time formulation is used in the computation. The mesh consists of 230,480 wedge-shaped elements and 258,764 space-time nodes. The computation was carried out on the AHPCRC CM-5. The picture shows the free surface, with the colors representing the velocity magnitude on the free surface.

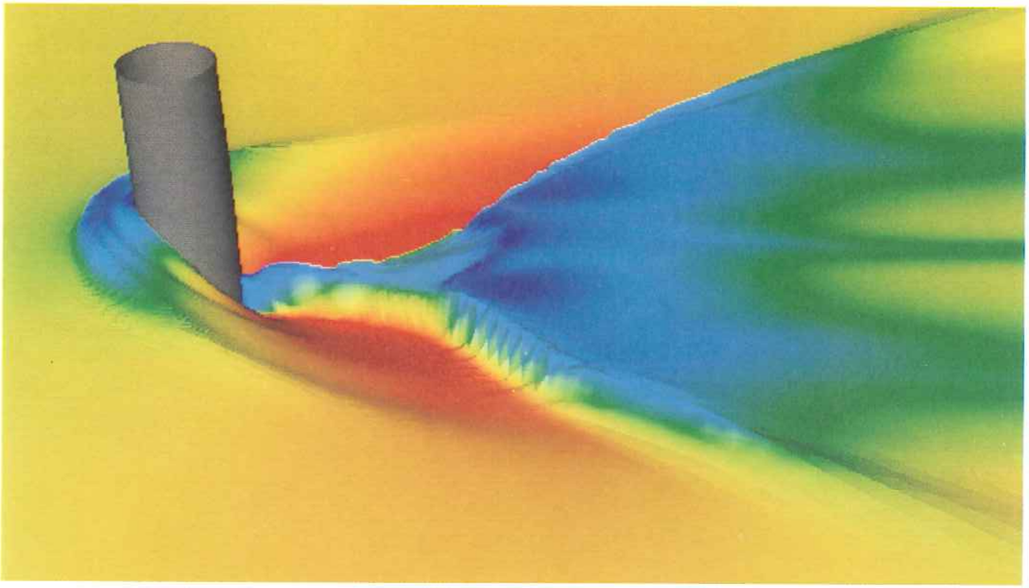
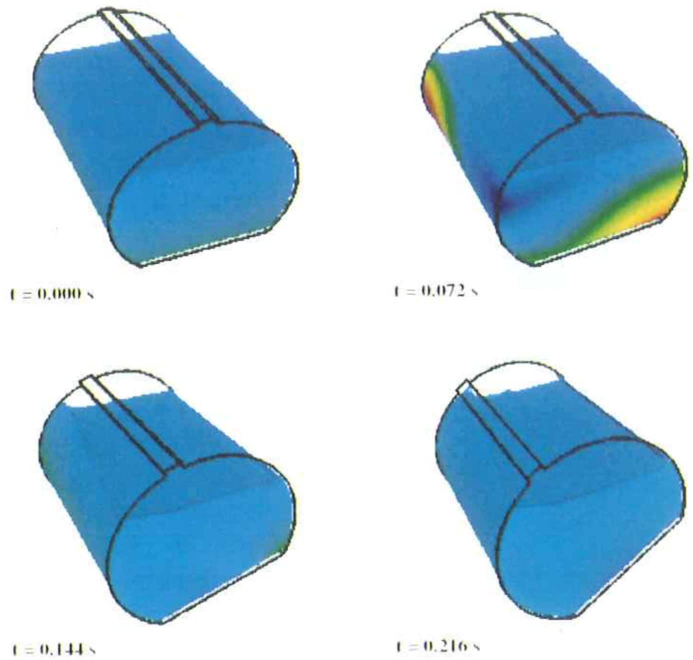


Figure 2

Dynamics of a tanker carrying bulk liquid. A tanker moving at 10 m/s drives over a bump 40 cm high. The suspension system absorbs the initial displacements due to the bump, and transfers the forces generated to the body of the tanker. An interface-capturing method with the stabilized semi-discrete finite element formulation is used in the computation. The mesh consists of 343,560 hexahedral elements and 357,911 nodes, leading to 1,704,661 coupled, nonlinear equations that are solved at each time step of the computation. The computation was carried out on the NetworkCS T3E. The pictures show, at various instants, the motion of the tanker, sloshing and pressure distribution.



Development and Engineering Centre; Waterways Experiment Station; Tank-Automotive Research, Development and Engineering Centre; Army Medical Research Institute for Infectious Disease; and Concepts Analysis Agency.

The high performance computing resources currently owned by the AHPCRC include: a Thinking Machine CM-5 with 896 processing nodes and over 28 GigaBytes of memory; a 20-processor SGI ONYX with 0.5 GigaBytes of memory; a 12-processor SGI POWER CHALLENGE with 2 GigaBytes of memory; large disk arrays; advanced graphics and animation hardware; and a large number of workstations, including an SGI INDY workstation on almost every researcher's desk at the AHPCRC. The AHPCRC also has access to

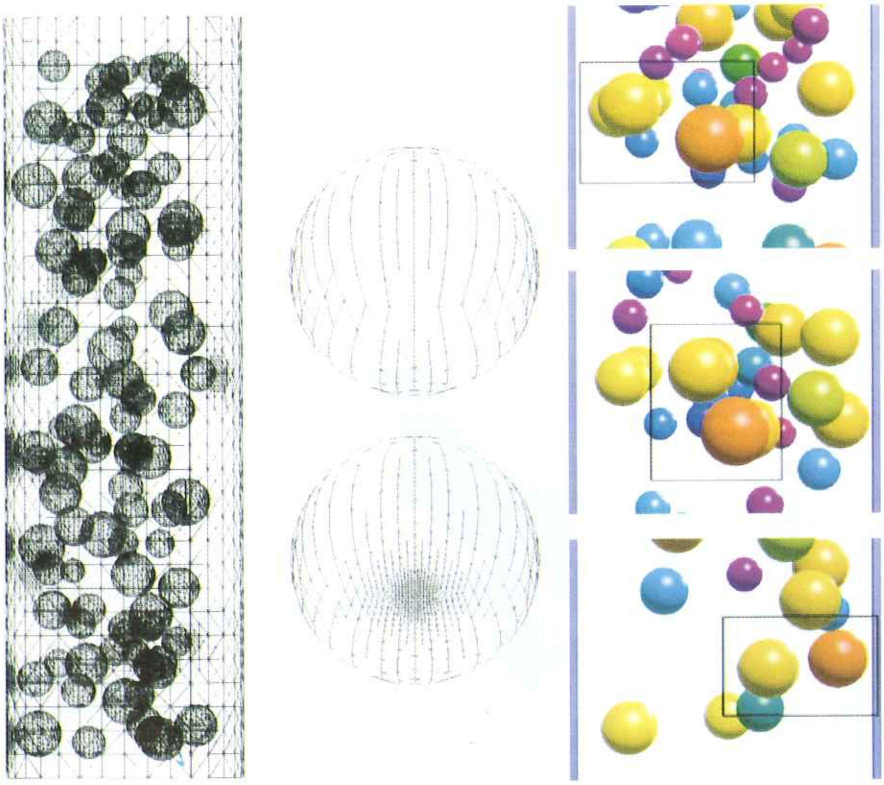


Figure 3

Multi-platform (heterogeneous) parallel computation of fluid-particle interactions with 101 random-sized spheres falling in a liquid-filled tube. This figure shows: initial mesh with 166,877 nodes and 959,152 tetrahedral elements (left); how the surface mesh refinement for a sphere increases as it gets close to another sphere or tube wall (middle); and a sequence of interactions between a pair of spheres (right). Approximately 2.6 million coupled, nonlinear equations are solved at every time step of the simulation for approximately 800 time steps.

*"T*AFSM focuses on development of advanced methods and tools for flow simulation and modelling ..."*

computational resources owned by its industrial partner, NetworkCS. These resources include: a 256-node CRAY T3E with 131 GigaBytes of memory; a 512-node CRAY T3D with 32 GigaBytes of memory; and a 12-processor CRAY C90 with 4 GigaBytes of memory.

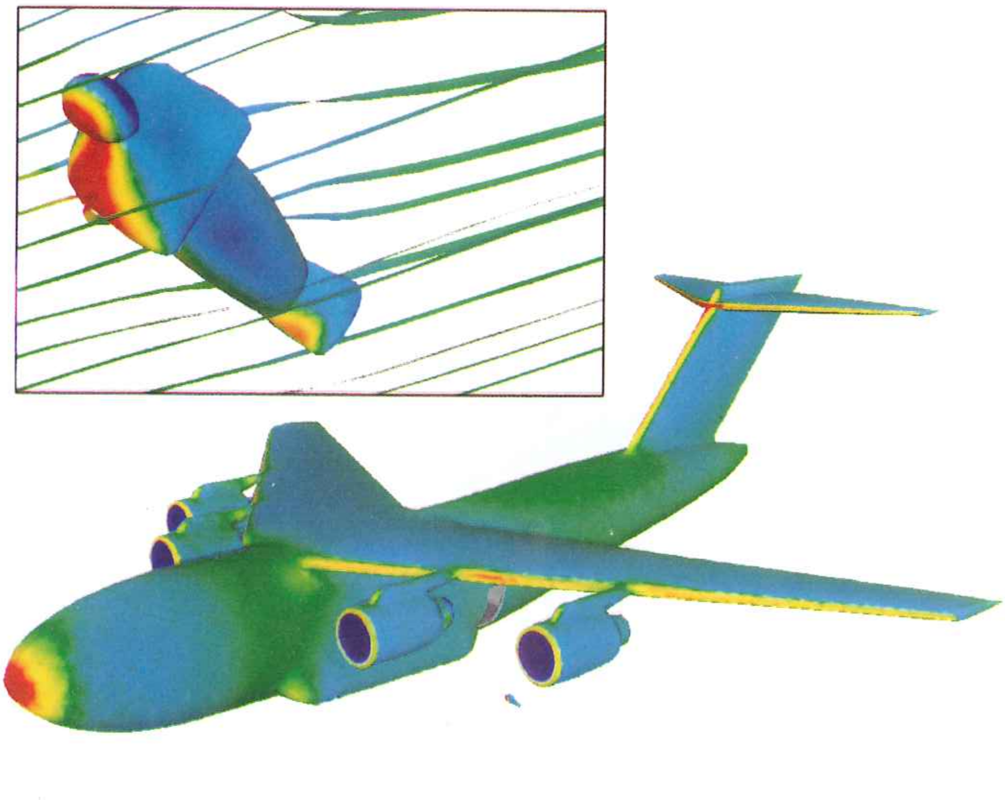
The Team for Advanced Flow Simulation and Modelling (T*AFSM) is a subset of researchers in the AHPCRC Simulation and Modelling Team. The members of the T*AFSM are: Dr. T.E. Tezduyar (Team Leader), Drs. Shahrouz Aliabadi, Marek Behr, and Andrew Johnson (all Research Assistant Professors in AEM); Drs. Vinay Kalro and Steve Ray (Research Associates in AEM); and Mr. Ismail Guler, Mr. Yasuo Osawa and Mr. Keith Stein (all Ph.D. students in AEM). T*AFSM focuses on development of advanced methods and tools for flow simulation and modelling, mainly to address the following classes flow problems: a) unsteady flows with interfaces, such as two-fluid and free-surface flows (see Figures 1 and 2) and fluid-structure interactions; b) fluid-object interactions, such as fluid-particle interactions (see Figure 3); c) airdrop systems, such as paratrooper-aircraft interactions (see Figure 4) and aerodynamic behavior of round and large ram-air parachutes; and d) aerodynamics of complex shapes, such as missiles and aircraft.

The advanced methods developed by T*AFSM include: special numerical stabilization methods; space-time methods; mesh update methods for problems with moving boundaries and interfaces; accurate and efficient projection methods in remeshing; adaptive mesh refinement; iterative solution methods for large, coupled nonlinear equation systems; parallel computing methods; and visualization techniques.

The simulations carried out by the T*AFSM are all based on parallel computing, sometimes in a multi-platform (heterogeneous)

Figure 4

Aerodynamical interaction between a cargo aircraft and a paratrooper jumping out. The aircraft is flying at 130 knots. The simulation is based on solving simultaneously the Navier-Stokes equations governing the flow around the aircraft and paratrooper and the Newton's law of motion governing the 3D dynamics of the paratrooper, with the aerodynamic forces acting on the paratrooper calculated from the flow field. Computation was carried out on the NetworkCS T3D. Figures show the pressure distribution on the surface of the aircraft and paratrooper, together with the streamlines around the paratrooper.



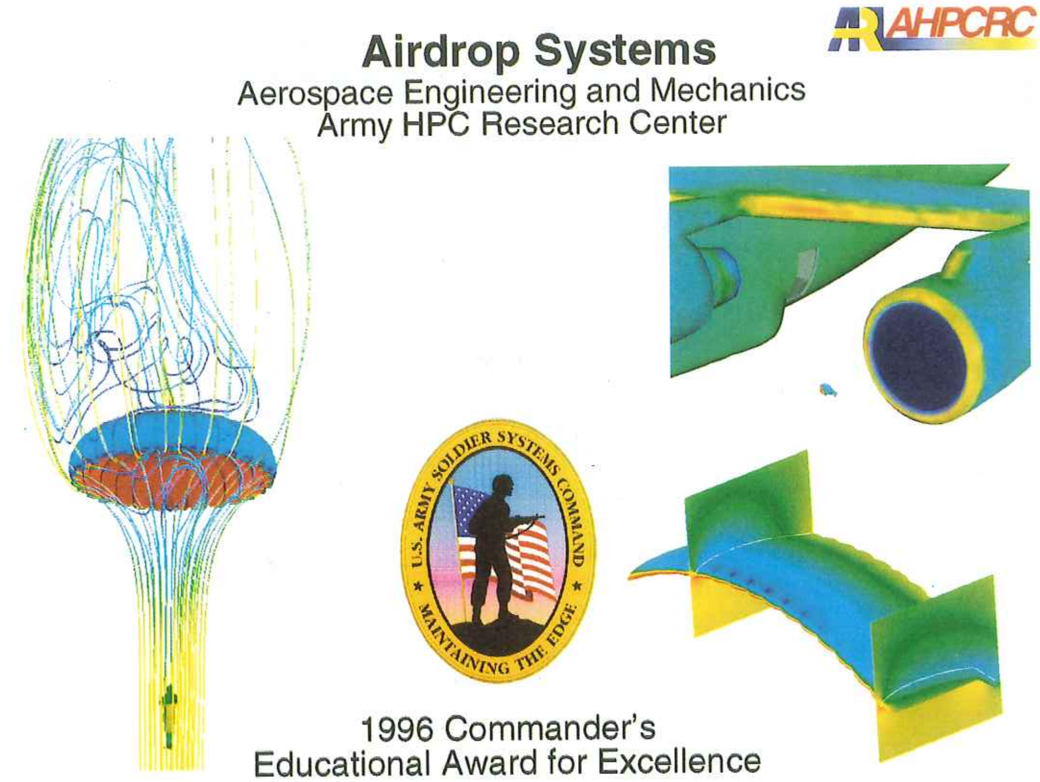


Figure 5

Flow simulations from T*AFSM were featured on a number of cover pages, in magazine articles, in brochures describing national success stories, and by other media of general visibility.

computing setting, on platforms such as the AHPCRC CM-5, ONYX, and POWER CHALLENGE, as well as the T3E and T3D owned by the NetworkCS. These simulations, which are almost all in 3D, typically involve millions of coupled, nonlinear equations (reaching 100 million in some computations) that need to be solved at every time step of the simulation. A good example of multi-platform (heterogeneous) computing carried out by the T*AFSM is the recent 3D simulation of fluid-particle interactions involving 101 particles falling in a liquid-filled tube (see Figure 3). These simulations are based on solving simultaneously the time-dependent, 3D Navier-Stokes equations governing the flow and Newton's law of motion governing the 3D dynamics of the particles, with the fluid forces acting on these particles calculated from the flow field. In these simulations, while mesh partitioning, flow computations, and mesh movements are performed on the AHPCRC CM-5, mesh generation and projection is accomplished on a the AHPCRC ONYX system. These 2 machines communicate via a HIPPI channel.

The T*AFSM research activities have gained, in the past five years, significant recognition as well as national and international visibility. Results from flow simulations carried out by the T*AFSM on advanced parallel computing platforms have been featured on a number of magazine and journal cover pages (see Figure 5). A paper authorised by the T*AFSM and their Army collaborator, Dr. Walter Sturek, was selected as the best paper in the High Performance Computing Session of the 20th Army Science Conference. The T*AFSM, together with their collaborator Dr. William Garrard (Professor and Head of AEM), received the 1996 Educational Award for Excellence from the US Army Soldier Systems Command (see Figure 6). The Award recognizes that the "UNIVERSITY OF MINNESOTA, DEPARTMENT OF AEROSPACE ENGINEERING AND MECHANICS/ARMY HIGH PERFORMANCE COMPUTING RESEARCH CENTRE has distinguished itself as a leader in addressing problems such as parachute modelling, establishing programs for collaborative research between academia and Army researchers, and providing training for the next generation of researchers". •

Analysis of Rigid-Flexible Structural Components

by
Robert L. Taylor
Dept. of Civil Engineering
University of California,
Berkeley, California, USA
and
Alecia J. Chen
Applied Mechanics Division
Stanford University
California, USA

"... incorporates the general features of a finite element model and a rigid body model into a single model."

The finite element method is a technique which is commonly employed to approximately solve general problems in solid mechanics [1]. With this approach it is possible to consider applications in which modelling of the material behavior is either elastic or inelastic, as well as, situations in which deformations are finite. There are a number of widely distributed commercial software packages available to solve this class of problems. Analysis situations arise, however, for which the deformations are concentrated into nearly discrete points while the remainder of the problem undergoes essentially rigid motions. For this class of problems techniques based on rigid body mechanics in which multiple rigid bodies may be interconnected using *joint* constraints which include local deformation effects (e.g., springs or dash pots between points) often provide an efficient modelling approach. There also are several commercially available programs which may be used to solve this class of problems.

The advantage of the finite element approach lies in its ability to treat very general classes of problems involving finite deformations and general material behavior; however, the cost and time to perform a full three dimensional analysis for a typical engineering problem, for example a rollover crush analysis of an automobile, is very large. A rigid body approach can easily treat the first part for such applications but cannot accurately represent the inelastic deformation crushing phase.

In this article we summarize an approach which incorporates the general features of a finite element model and a rigid body model into a single model. We assume that the finite element method is used to describe the reference geometry for both deformable and rigid bodies. Multiple bodies are permitted and a body may be treated as fully flexible, fully rigid, or partially flexible and partially rigid. For each body that is considered to be rigid the response is characterized by the total mass and the inertia diadic, which are computed from the mass matrix of the finite element model and the values of the nodal coordinates for the reference configuration of the body. The linear and angular momentum equations for each rigid part are deduced from the representation of the motion as:

$$\chi(\mathbf{X}, t) = \mathbf{r}(\mathrm{t})\, \Lambda(t)\, (\mathbf{X} - \mathbf{R})$$

where $\mathbf{X}$ is a material point in the reference configuration of the body, $\mathbf{R}$ is a position from a fixed inertial system to the centre of mass of the body, $\mathbf{r}$ (t) is the position of the centre of mass at time t, and $\boldsymbol{\Lambda}$ (t) is an orthogonal matrix defining the orientation of an orthogonal triad fixed to the rotating body. For bodies which are partially flexible and partially rigid the above equation may also be used as a constraint on the position of each boundary node of the flexible part which is contiguous to the rigid part of the body. The remaining parts of the bodies are treated by standard finite element approaches for finite deformation of elastic and inelastic solids. The use of the rigid motion constraint greatly reduces the number of parameters in the rigid part of the finite element model and thus it significantly reduces analysis effort.

To date, temporal discretizations which preserve the conservation of linear and angular momentum as well as the total energy for unloaded or conservative loaded flexible-rigid *hyper-elastic* systems undergoing finite motions are employed in our implementations. These methods are commonly referred to as energy-momentum methods and have been successfully employed for a single continuum body and a single rigid body by Simo, et. al. [2,3,4]. The advantage of these methods is two-fold. First they have inertial terms based on discrete differences of linear and angular momenta, and secondly they ensure that dissipation effects introduced through material constitution or discrete dashpots are preserved in the discrete model. It is possible to extend the methods to include numerical dissipation effects[5]. The energy-momentum method also has been extended to coupled flexible-rigid systems using a Lagrange multiplier method to impose joint and interface constraints and to follow prescribed loading and motions. General types of joints between two rigid bodies may be formulated using constraints on translation and on rotation. These include spherical, revolute, universal, and slider joints, as well as many others. Details of the development are included in Reference [6]. Solution of multiple body problems have also been performed by others using energy-momentum and other methods (e.g., see [5,7]).

As an example of the types of problems which may be considered using the above approach we first consider a modelling of multiple rigid bodies interconnected by revolute joints. The problem represents a person sitting on a rotatable stool while holding a spinning bicycle wheel. The simplest model of the problem consists of rigid bodies for the wheel, the person's arms, and the torso. Each rigid body is discretized using standard 8-node hexahedral elements which are subsequently, declared rigid. Thus, if desired, we can at a later date allow each body to be flexible as the situation dictates. The ability to let each body be rigid permits rapid checking of the overall model behavior, as well as, verification of trajectories.

"... we can at a later date allow each body to be flexible as the situation dictates."

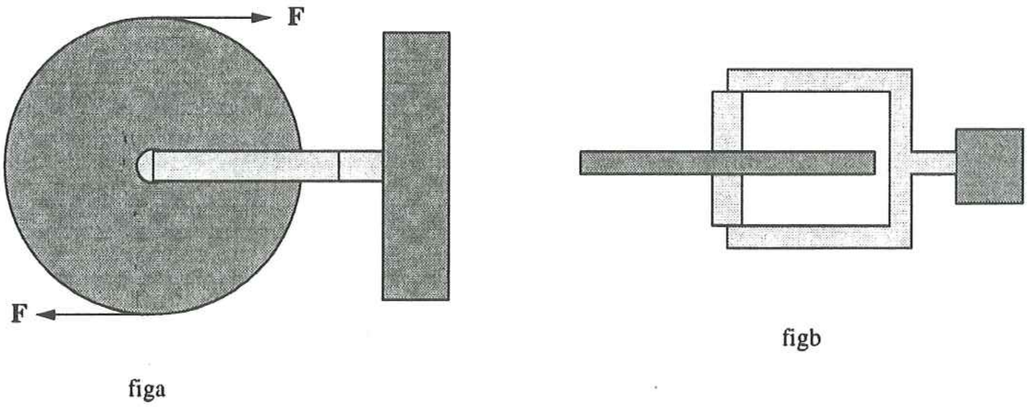


Figure 1 - Initial configuration: (a) Side view; (b) Top view

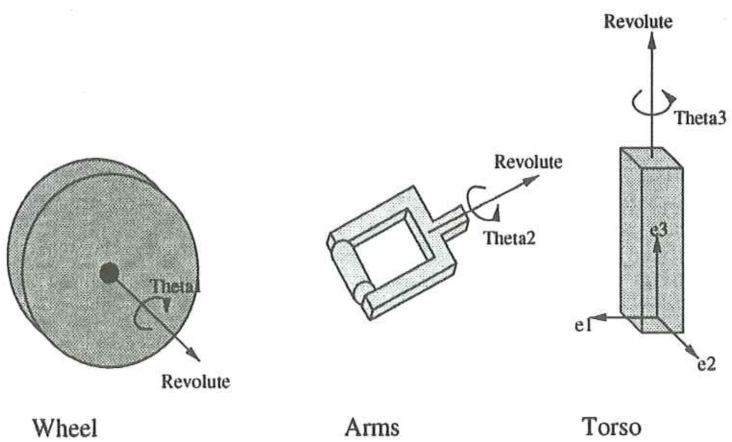


Figure 2 - System showing individual rigid bodies and joints

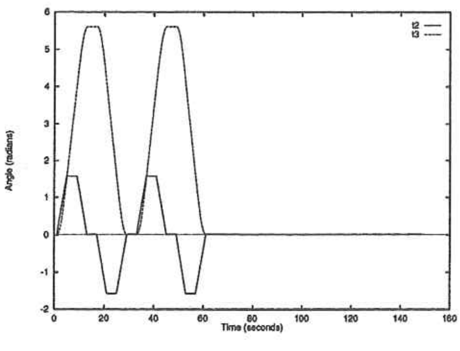


Figure 3
Rotation angles versus time

> *"... stored and kinetic energies have strong transient responses while the total energy is conserved ..."*

To start the simulation, forces are applied to the wheel over time $0 < t < 0.6s$ after which the wheel is remains unloaded, Figure 1(a). Once the wheel is spinning at constant velocity, the arms are rotated in a specified manner from their initial position $\theta_2=0°$ to $\theta_2=90°$ and back to the initial position twice as shown in Figure 3. For the simulation, θ_2 is the only angle subjected to rotational control; the remaining revolutes respond according to a computed response of the rigid bodies. From a physical viewpoint, body 3 should rotate when the angle of the arms is not zero ($\theta_2 \neq 0°$). When the angle of the arms is zero ($\theta_2 = 0°$) the body should stop rotating. The numerical simulations predict this behaviour perfectly as shown in Figure 3.

As a second example we consider a short rigid cylinder which surrounds the lower quarter of a flexible cylinder. No boundary restraints act on the system. The flexible cylinder is spatially discretized using hexahedral elements. The system is initially at rest and then each node along the length of the rigid cylinder at the outer radius along the x-axis is subjected to specified loads for the first unit of time.

The numerical simulations were performed using a constant time step and Figure 4 depicts the motion of the system over time.

The last example demonstrates the coupled flexible-rigid body algorithm's ability to model problems with three dimensional flexible rod elements. The formulation for the energy-momentum conserving algorithm for the flexible rod is based on the work of Simo and Tarnow [8]. A rigid sphere is modelled by hexahedral elements and attached to the flexible rod which is rigidly fixed at the end opposite the sphere. The system is excited by an applied load for a short duration. Figure 5(a) gives the time history of the total energy for the system and Figure 5(b) depicts the motion of the system over time. Note that the stored and kinetic energies have strong transient responses while the total energy is conserved after the removal of the excitation force.

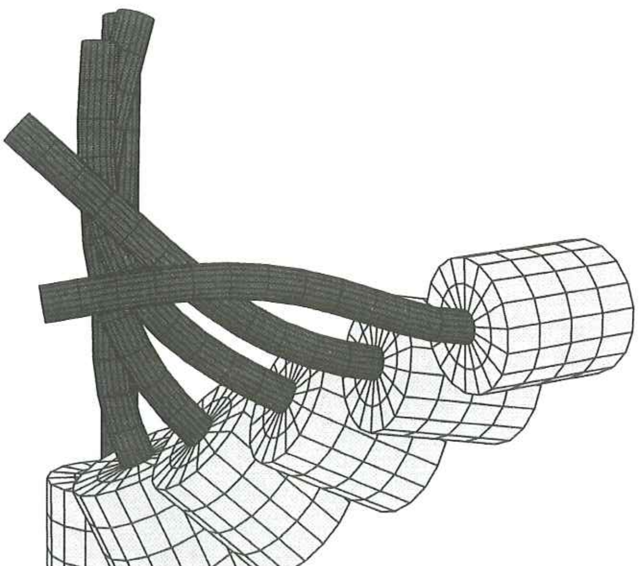
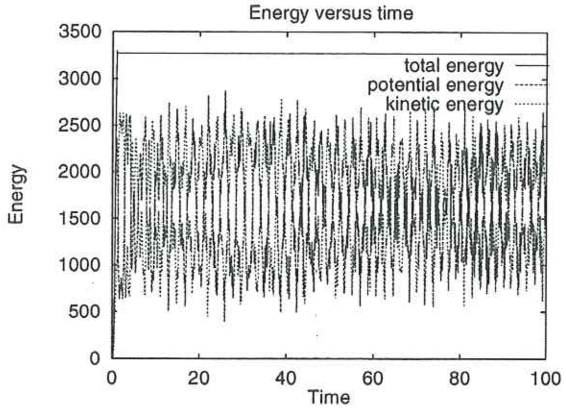


Figure 4
Motion and deformation of flexible-rigid system



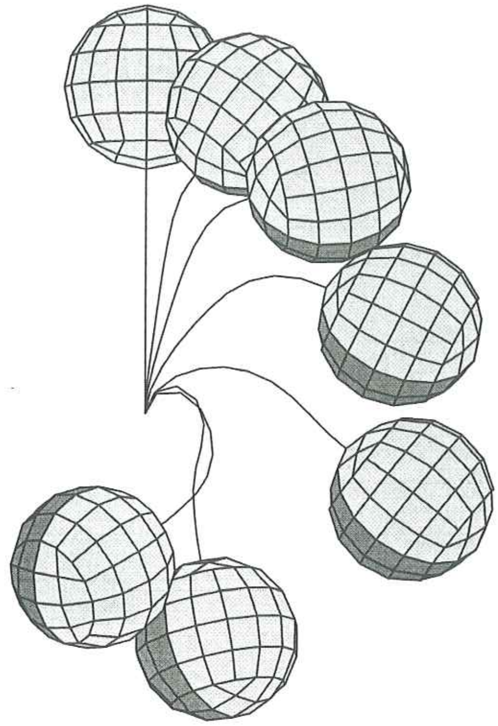


Figure 5
(a) Time history of energies
(b) Motion and deformation of rod-rigid system

The above examples illustrate some of the types of problems which may be addressed using a rigid or a rigid-flexible formulation. Further details on these and other examples may be found in Reference 6. •

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"It takes immense genius to represent, simply and sincerely, what we see in front of us."

Edmond Duranty

"Results! Why, I have gotten lots of results. I know several thousand things that won't work."

Thomas A. Edison

A great engineering scientist and educator

Prof. Richard Hugo Gallagher

17.11.1927 to 30.09.1997

Richard H. Gallagher, known as Dick to his numerous friends, passed away quietly on the 30th of September 1997 after a long illness, which he fought, gallantly to the end. We mourn his untimely death as we loose a close colleague, a brilliant engineering educator and, above all, a man with a big heart.

He took early retirement two years ago to enjoy the closeness and happiness of his family but this retirement was cut short. In the words that follow we celebrate his achievements and his life and give our thanks for it.

Dick was born on November 1927 in New York City from a Catholic marriage uniting a father with Irish roots and a mother born in Bohemia. He had therefore all the attributes of a true American. He graduated from the Cardinal Hayes High School and, after serving in the U.S. Navy, enrolled in a Civil Engineering degree course at New York University where he obtained his Bachelor Degree in 1950. During the next five years Dick worked first as a field engineer with the U.S. Department of Commerce and then as design engineer. Throughout this time he also worked hard as an external graduate student at New York University and was awarded his Master's Degree in Civil Engineering in 1955. He was soon recruited to the aerospace industry where his work not only led to the development of new aircraft but also inevitably to the achievement of space flight. His employer was the Bell Aero Systems Company in Buffalo where his talents were recognised and he was soon promoted to the post of Asst. Chief Engineer.

Dick stayed with Bell Aero Systems until 1967. It was here he realised the immense possibilities that were being placed in the hands of the engineer. Here he encountered the concept of finite elements which was being introduced by the rival company (Boeing), to the solution of complex stress distributions in continua in the mid fifties. The opportunities offered by the finite element method fired his imagination and led to much creative research.

Whilst still at Bell Aero Systems he became a part-time teacher at Buffalo University and simultaneously working to obtain his Doctor's Degree. He presented a dissertation on the analysis of thin shells by curved elements - a subject of great novelty at the time - and was awarded his Ph.D. in 1966. However, as early as 1962 he had published the first three-dimensional form of the finite element method using tetrahedral elements in a paper, which today remains a very often-cited classic.

His simultaneous preoccupation with industrial application, academic studies and research is typical of the tremendous effort Dick has put into his work throughout his life. Throughout his career he has often acknowledged the contribution to his success made by his wife Terry. As a father, Dick succeeded as a role model for all his children. His four sons and one daughter all became engineers in different but important fields, a unique achievement, especially as the choice was entirely theirs.

In 1965 Dick attended two conferences - both memorable to me - as it was there that our friendship started. The first of these was at the University of Newcastle, England. Here he was accompanied by his son Richard introducing him to the joys of finite elements. The second was a very much larger meeting at the Wright Patterson Air Force base at Dayton, Ohio which was held in the fall of 1965. This meeting marked an important milestone in finite element research and for the first time all those working in the field of finite elements were brought together.

It was shortly after the Wright Patterson event that Dick was persuaded to leave the industry and to become an "academic" as a full professor at the prestigious Cornell University where George Winter held, at the time, the Chairmanship of the Department.

By the time Dick became a Professor at Cornell his publications were numerous and his research had already made a significant impact on the profession. His earliest published work was motivated by the needs of the aircraft industry for which he worked and here both analytical and experimental approaches are evident. The subjects of "Low Aspect Ratio" wings and heating of structures point clearly to high-speed flight and aerospace applications.

Indeed it was this last area which became a continuing pre-occupation of his in later endeavours. These resulted in two major edited texts (one in 1979 and one in 1986) on optimization. However at Cornell he continued other areas of work in which he had already recorded his contribution in the "industrial period". These were the stability (buckling) analysis of structures and the analysis of shells. In both areas he made major contributions and in his famous compilation of works on curved thin shells (with Ashwell 1976) he not only explained the various alternative approaches but presented a new and exciting development of his own based on the potential energy formulation. It was during the Cornell period that Dick's interest widened beyond the field of structural engineering and engaged him in the subject of environmentally important shallow water flows (with Liggett and Chen in 1973). This naturally led to the general field of fluid mechanics. Here he felt that this subject of his research had reached a sufficient maturity for a general conference on Finite Elements in Flow Problems and he played a leading role in launching this venture in 1974. The first meeting was held in January of that year at Swansea where Dick was spending his sabbatical. This became the start of a series of conferences and corresponding "state-of-the-art" books. The current year sees the 10th conference at Tucson, Arizona, which had become the home of Dick and his family, and will also see the publication of the most recent state-of-the-art volume. We planned that Dick would be chairman of this meeting but his death intervened. We shall however remember him and his impact on Computational Fluid Mechanics there.

The six months sabbatical period spent by Dick and Terry in Swansea in 1974 as the U.K. Science Research Council Fellow was proceeded by a similar period in the University of Tokyo in the fall of 1973. There he held the post of a visiting professor founded by the Japan Society for the Promotion of Sciences. Both periods allowed him time for writing and research and doubtless were well used in preparing Dick's "magnum opus". This was the book on Finite Element Fundamentals, which appeared first in 1975. This book was an instant success and continued through many printings and translations (the last of this being into the Turkish Language in 1994).

The watershed in Dick's career came in 1978 when he decided to accept the position of Dean of the College of Engineering at the University of Arizona in Tucson. Despite the onerous task of administration he faced in this career change and indeed in later ones, which led him to the final post as a university president, he succeeded in remaining to the end a productive research worker with an up to date knowledge of the subject. Certainly the time in Arizona established Dicks position as a creative academic administrator and leader. In the six years he spent there he succeeded in putting the School of Engineering in Arizona on the map. He appointed many new professors there, obtained new funds and steered many young people into new research and teaching directions. He contributed to and organised special conferences dealing with various applications of finite elements in such fields as Bio-engineering, Optimisation and Material Science. These established important landmarks as state-of-the-art books.

During the same period he became active in many national and international ventures. Outstanding here was his election to membership of the Computational Mechanics Committee of the National Research Council. His commitment to the United Nations took him on a visit to India. Above all the invitation he received from China to be a member of the first Finite Element Group visiting that country in 1981 was important. This first and many subsequent visits to China established for Dick much contact with this country and undoubtedly contributed to his selection in 1992 for a honorary doctorate at the University of Shanghai. His book which was translated into Chinese also contributed much to his fame and connections there which resulted in new graduate students. In 1984 Dick became the Provost and Vice President of the Worcester Polytechnic Institute in Massachusetts.

During the last years of this work in Arizona and the period in Worcester many national and international awards were made to Dick for his successes and achievements. First, in 1983 he was elected to the membership of the US National Academy of Engineering. Then in 1985 followed the award of the Worcester Reed Warner Medal by the American Society of Mechanical Engineers for his books and research writings which contributed so much to the profession. In 1987 he was elected to receive the honorary fellowship of Swansea University (equivalent to doctorate honoris causae). Later the same year he received another honorary doctorate from the Technical University of Vienna.

In 1988 Dick reached the pinnacle of his career and became the President of Clarkson University. He held this position until his retirement in 1995 when he returned to the family home in Arizona. Certainly Dick gave of his best to Clarkson University and during his period of office he more than doubled the endowment of the University, established a new aeronautical degree programme and built the Centre for Advanced Materials Processing (CAMP) after raising some $ 80 million in fund gathering campaigns. Appropriately Clarkson University honoured him with an honorary doctorate and more recently by opening the Richard H. Gallagher Engineering Building commemorating his period of office and achievements.

Also during this period other awards were made. In 1990 he was awarded the AIAA gold medal after which followed the highest award of the American Society of Engineering Education, the "Benjamin Garver Lamme Award". In 1993 The American Society of Mechanical Engineers awarded him the ASME medal - their highest award - for his contributions made to the profession and in the same year The American Society for Engineering Education inducted him into their Hall of Fame and presented him with their Centennial Medal.

Probably the most lasting memorial to Dick's professional work was his leading involvement in establishing the IACM in 1982. As founding secretary, the IACM hoped that Dick would be the special plenary lecturer at the World Congres on Computational Mechanics to be held in 1998 in Argentina, but it is not to be. The IACM and USACM have both awarded Dick their highest medals, the Congress (Newton Gauss) Medal and the von Neumann medal, respectively.

In addition to the formal list of honours and awards made to Dick he leaves, however, an even more important legacy. This is the love and respect which will long remain in the hearts of his students and colleagues. Dick was justly proud of the many of his students who reached high positions in industry and academia. He was a trusted friend of his students, his colleagues and his associates who will miss his advice and generous manner.

We extend our heartfelt sympathy to his wife Terry and his children. •

Olek Zienkiewicz

Prof. Richard Hugo Gallagher

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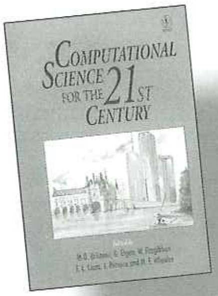

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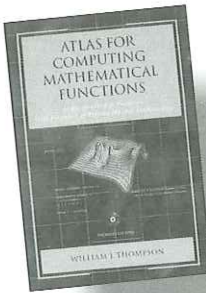

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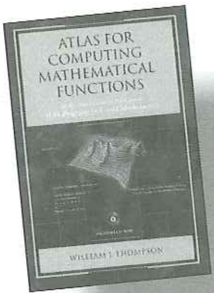

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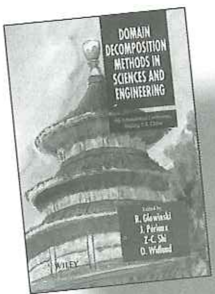

Domain Decomposition Methods in Sciences and Engineering

8th International Conference, Beijing, China

Edited by R. Glowinski, University of Houston, USA, J. Périaux, Dassault Aviation, St. Cloud, France, Z.C. Shi, Academica Sinica, Beijing, China and O. Widlund, Courant Institute of Mathematical Sciences, New York, USA

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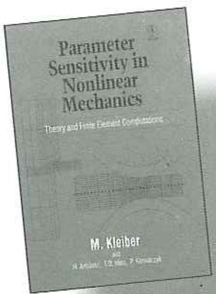

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Theory and Finite Element Computations

M. Kleiber, H. Antunez, T.D. Hien, and P. Kowalczyk, all of Polish Academy of Sciences, Warsaw, Poland

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A Singular IACM/IUTAM Minisymposium

by
Dan Givoli
Department of Aerospace Engineering
Technicon, Haifa, Israel
Israel Association for Computational Methods in Mechanics

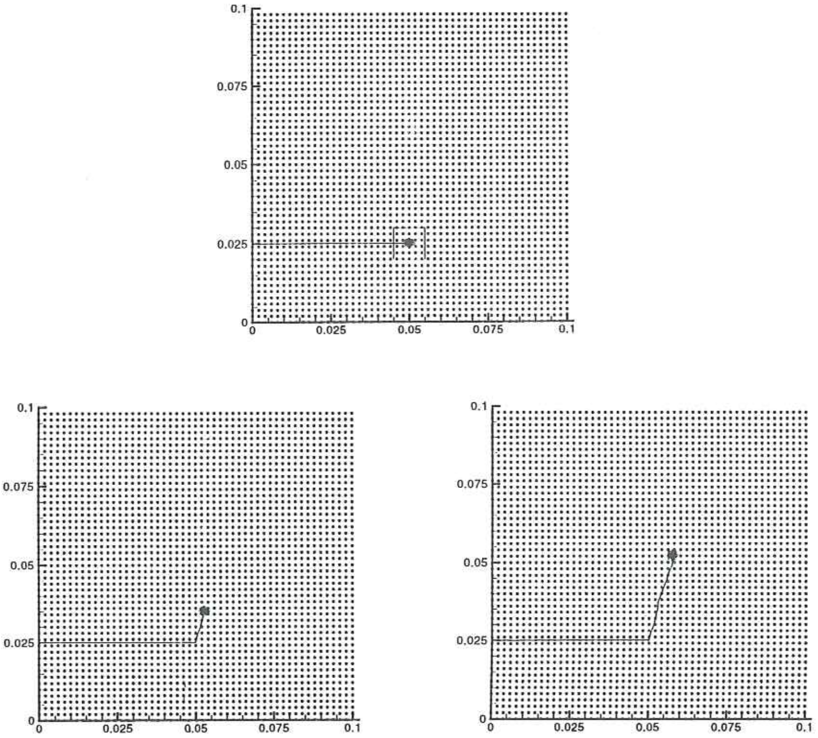
Singularities have always attracted the attention of mathematicians, scientists and engineers. They are present in many of the natural and engineering systems around us. Examples of singular and interfacial phenomena in fluid mechanics include three-phase moving contact lines, cusps generated in an interface with surface tension, flow around a sharp corner, break-up of liquid drops and threads, and the shape of a drop when it freezes. In solid mechanics, examples include crack initiation and propagation, stress fields around sharp corners and cracks, penetration of indenters into a plastic medium, strain localization and shear bands. In addition to their scientific importance, singular phenomena possess a certain beauty. They sometimes look deceivingly simple, but they almost always involve mathematical and physical intricacies and subtleties.

Roughly speaking, there are two general ways to approach singularities: either to prevent them or to live with them.

Those that adopt the former approach develop and use mathematical models which *regularize* the problem under consideration such that no singularity arises. Examples in solid mechanics include the well-known Barenblatt cohesive crack model, and plasticity theories which lead to a bounded stress field around a crack tip.

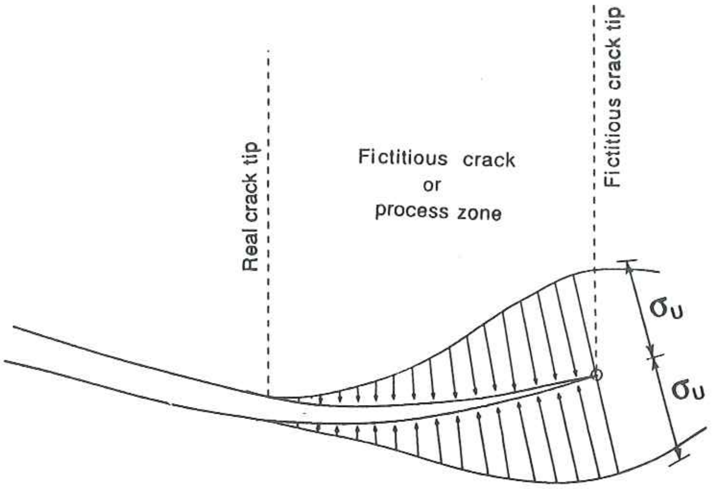
On the other hand, theories which accept and incorporate singularities as idealizations of physical behaviour are sometimes also very useful. A rather extreme example is Linear Fracture Mechanics, which allows infinite stresses at crack tips, and uses the concept of *stress intensity factors*.

J.P. Ponthot and T. Belytschko: Crack growth in a edge-cracked plate.



J.-P. Ponthot and T. Belytschko: Crack growth in an edge-cracked plate.

S. Valente:
Cohesive crack model.



Although infinite stresses are not believed to exist in reality, this concept is extremely important, and, in fact, is constantly used today in the design, analysis and inspection of airplane structures.

"...there are two general ways to approach singularities: either to prevent them or to live with them..."

There is a community of researchers around the world whose work is concerned directly with determining the nature of singularities and their effect on the mechanical behaviour of solids and liquids, and the solution of problems in mechanics involving singularities or sharp interfaces.

Thirty four of these researchers were invited to present their work in special IUTAM Symposium on Nonlinear Singularities in Deformation and Flow, which was held at the Technicon - Israel Institute of Technology, Haifa, Israel, during a week in March 1997.

Within this *singular event*, an *IACM Minisymposium on Numerical Treatment of Singularities and Interfacial Phenomena* was organized by the author, and supported by IACM.

The idea to set up a combined minisymposyum of IACM and the International Union of Theoretical and Applied Mechanics (IUTAM) followed the call heard in the General Council of 3rd World Congress on Computational Mechanics (WCCM III), held in 1994 at Chiba, Japan, to deepen the co-ordination between the two associations. (See report in [1].) The Minisymposium on Numerical Treatment of Singularities and Interfacial Phenomena consisted of a single session of four presentations, and was accepted with a lot of interest by the Symposium attendants.

The *numerical* treatment of singularities and interfaces is a research field in its own right. In the context of the finite element method (FEM), schemes that deal with stationary singularities include the use of special singular elements, non-adaptive mesh refinement, *h*-adaptivity, *J*-integral based schemes, *p*-version and combined analytic-numerical schemes. In addition, special methods have been developed for the treatment of moving singularities and interfaces.

הפקולטה להנדסת אוירונוטיקה וחלל
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Jean-Philippe Ponthot from the University of Liége, Belgium, presented his joint work with Ted Belytschko from Northwestern University on dynamic crack propagation. This work combines two useful concepts, namely Element Free Galerkin (EFG) and Arbitrary Lagrangian-Eulerian (ALE) formulation, to track the paths of propagating cracks in a numerically effective manner. EFG is a meshless method (see the collection of papers [2]) which, like FEM, uses local basis functions, but, unlike the standard FEM, requires only the definition of nodal points (not elements). This property is advantageous when the problem at hand involves moving interfaces and singularity points [3], because it avoids the need for remeshing, which is required in the standard FEM in order to adjust the mesh to the changing geometry. The ALE formulation allows an easy and continuous relocation of nodes in the computational domain, and thus enable the solution of crack propagation problems with a local refinement of the node pattern in the neighbourhood of moving crack tip.

A model for creep induced crack propagation was described by Silvio Valente from the Politechnico di Torino, Italy, who presented his joint work with F. Barpi, G. Ferrara and L. Imperato. The crack propagation behaviour is based on the cohesive crack model [4], in which an extended portion of the actual crack is defined, where the material, albeit damaged, can still transfer stresses. FEM is used with a special remeshing technique which is applied at each crack growth step (*r*-adaptivity).

A special semi-analytic singular finite element for singularities in three dimensional elastic bodies [5] was described by V.P. Matveyenko from the Russian Academy of Science in Ural, Russia. D.V. Yevdokymov from Dniepropetrovsk University, Ukraine, compared the direct boundary element method to the discrete vortex method in solving certain fluid flow problems.

The proceedings of the entire Symposium and in particular those of the IACM Minisymposium on Numerical Treatment of Singularities and Interfacial Phenomena, will appear in a book form, to be published by Kluwer Academic Publishers in 1998. •

"*Although infinite stresses are not believed to exist in reality, this concept is extremely important ...*"

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2. *Computer Methods in Applied Mechanics and Engineering*, Vol.139, Nos. 1-4, Special issue on Meshless Methods, 1996.
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4. S. Valente, "Bifurcation Phenomena in Cohesive Crack Propagation", *Computers and Structures*, 44, 55 - 62, 1992.
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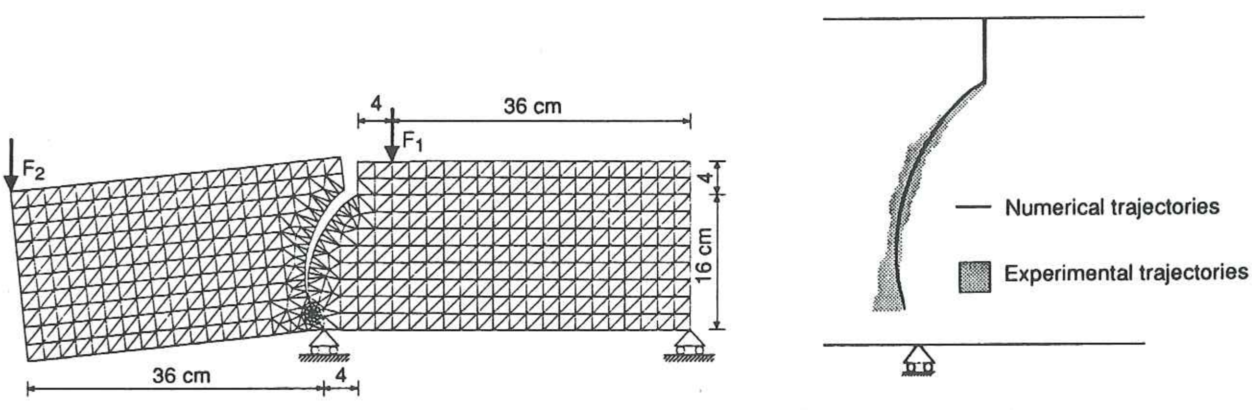
S. Valente:
Sheer test specimen - finite element model and crack path.



How to write a symphony
an interview with Rainald Lohner

Your youth was in Argentina and your studies in Germany. What drew you finally to the USA?
I was born in Braunschweig, Germany, in 1959. My father, a mechanical engineer born in Bolivia to German parents, was working for the largest milling machinery manufacturer in the world at that time, was shortly afterwards assigned to the Argentinian branch. Thus, I was raised in Argentina, where I stayed until finishing school. Two days after receiving the Abitur-diploma, I left for Braunschweig to study Mechanical Engineering. My grandfather's brother was head of the internal combustion engine department, and it was clear from my earliest youth that this would be the place I would study at. Braunschweig has had its share of luminaries in Science and Engineering, including Gauss (Mathematics) and Schlichting (Fluid Dynamics), and has the largest aerospace sciences departments in northern Germany. While conducting research in Finite Elements for my master's thesis, the thought occurred as to 'why not be where the action is ?'. I wrote a letter to Prof. Zienkiewicz, who accepted me as a Ph.D. student in Swansea. Under his and Prof. Ken Morgan's tutelage, I finished the Ph.D. in 18 months. Both the US Navy and NASA made me offers to come to the US. In the end, I favoured the Naval Research Laboratory, as it offered a wider variety of subjects to work on, more freedom to work on several subjects simultaneously, a larger and readily available supercomputer, and Washington as a location (again, the theme 'where the action is').

I believe you and your team do some of the largest computer runs in the world ?
That is correct. We work with several government agencies, and can count on excellent computer resources. The actual runs are not carried out at the University, but at some industrial partners' sites that have the proper clearances. These industrial partners use our codes on a regular basis, and we support them with enhancements. This keeps our research focused while providing them with leading edge technology. Among the record-breaking runs one could mention the explosion inside a commercial airliner (1992, 8.5 million elements, internal and external flow with some topology change), the explosion in the New York World Trade Centre (1993, 20 million elements, 200 different cars and all the architectural data), and recently fragmentation calculations (8-10 million elements, more than 500 independently moving objects) as well as large-scale explosions in urban areas (300 houses, 65 million elements).

What is your key to maintaining such a large and leading edge code?
Serious commitment to quality. Computational Mechanics, like most of life,is 10% skill and 90% will. What I mean by this is that in most instances, what really counts is not to try many algorithms or methods and get them to work 80%, but to take one algorithm or method and push it to its limit. At times, this can be boring, but it is essential. The other key ingredient is to have quality-continuity in research and development. I see many institutions where students are supposed to write what then become production codes. In the long run, this does not work. Students come and go, coding styles and languages change, and the whole simulation base becomes a mess. You will find that most of the good production codes are written and maintained by one or two developers. A well written code is like a symphony. Try to name a great symphony that was written by several composers. We don't allow more than a handful of persons at the Post-Doctoral level to touch production codes, & abide by rigorous coding styles for clarity.

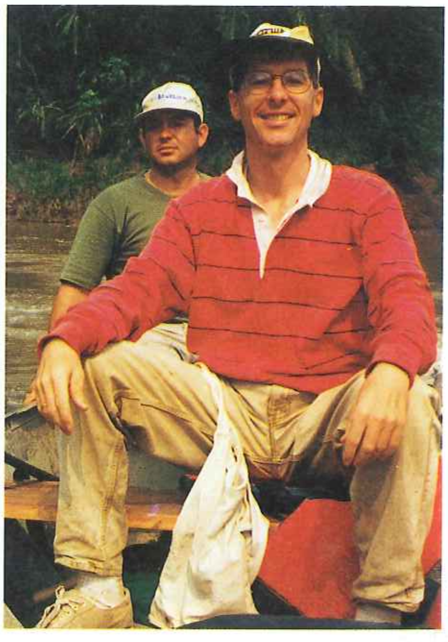
Although most of your work is military, a lot is anti-terrorist work which we must agree is a very positive side of military work. Are you able to describe this side of your work?
Computational Sciences, of which Computational Mechanics is a branch, has emerged as a third arm of exploration and research (besides the traditional two: experiments and theory). Advanced computational tools allow for very detailed answers to 'what if ?' scenarios. In one instance we determined numerically the yield of an explosive device. In another one, we determined the safe perimeter for fences and streets assuming a maximum possible yield.

What kind of spinoff do you get from weapons research?
I contend that most of the technological advances that we all benefit from come from basic military research. I also like to cite the example of Leonardo, who, while being an extraordinary painter, naturalist and inventor - all 'politically correct' disciplines - was employed by kings and dukes to develop fortresses, guns, and other military equipment. It is undeniable that we have all benefited from military research. In Computational Mechanics, one may cite the emergence of crash-codes (now a 500 million dollar industry) and advanced CFD codes (now a 250 million dollar industry) as examples where research developed for military purposes has led to a higher quality of living.

Besides squash and soccer which you play weekly, I believe you also like to hunt. Is this true?
Yes, it is true that I like to hunt and fish in Bolivia, where my uncle has a large farm in the Amazon basin. When being in any industrialized country, our mind is always set on: optimize, optimize, optimize. Any car, airplane, process, building that comes into the field of vision is analyzed for possible improvement. It is part of our subconscious upbringing in these countries. In the jungle, the rhythm of thought is different. When hunting at night, your vision fails completely. Fearing the predators, the animals come out only when there is no moonlight, and the forest is pitch dark. You rely primarily on sound and are forced to concentrate on the here and now. This environment puts our safe and civilized industrial surroundings into perspective, and I relish the experience every time I have the opportunity to visit this disappearing world.

Rainald Lohner is a professor at the Insitute for Computational Sciences & Informatics George Mason University, Fairfax, Virginia, USA

Cruising the Rio Grande, a tributary of the Amizon



More than 1000 people will *TANGO* in Buenos Aires next June

Effectively, over 1000 abstract have been received and are being considered for presentation at the next IACM **IV World Congress on Computational Mechanics,** to be held at the Sheraton Hotel from **29 June - 2 July 1998** in **Buenos Aires**, Argentina.

As at 15 October 1997, abstract from 53 different countries have been received and are summarised below:

Argentina	69	Israel	8	Slovakia	4
Australia	13	Italy	36	Slovenia	1
Austria	9	Japan	49	South Africa	5
Belgium	14	Korea	12	South Korea	2
Brazil	254	Latvia	2	Spain	52
Canada	11	Malasia	2	Sweden	19
Chile	23	Mexico	2	Switzerland	5
Colombia	1	Morocco	4	Taiwan	3
Czech Republic	5	Nigeria	1	Thailand	2
Ecuador	2	Norway	15	The Netherlands	16
Estonia	1	P. R. China	24	Turkey	3
Finland	9	Pakistan	1	Ukraine	6
France	45	Papua New Guinea	1	United Kingdom	26
Germany	45	Poland	23	Uruguay	1
Greece	11	Portugal	14	Usa	93
Hong Kong	5	Puerto Rico	5	Venezuela	12
India	9	Romania	2	Yugoslavia	3
Ireland	2	Russia	16		

Among the confirmed Keynotes and Plenary lectures are:

Jukka **Aalto**
Enriqu, **Alarcsn**
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Special organized session and minisimposium will be also included in the IACM Congress some of them are:

"Error estimation and adaptivity" organized by Nils-Erik Wiberg & Antonio Huerta
"Meshless Methods" organized by Wing Liu & Ted Belytschko
"Computational Methods in Multibody Dynamics" organized by Michel Giradin, Adnan Ibrahimbegovic & Alberto Cardona
"Shape Sensitivity Analysis" organized by Raul Feijoo & Edgardo Taroco
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"Computational methods for the nonlinear dynamics and chaos in structures" organized by Carlo Sansour & Peter Wriggers
"Discrete Element/Comp. Plasticity" organized by Roger Owen
"Computer simulation of fluid-structure interaction (FSI) problems" organized by Charbel Farhat, Carlos Felippa & Roger Ohayon
"Analysis of OCTG connections" organized by Eduardo Dvorkin
"Computational Methods in Contact Mechanics" organized by Michel Raous & Carlos Agelet
"BEM" organized by Thomas Cruse
"Computational damage mechanics for composites" organized by Pierre Ladeveze & Olivier Allix
"Topology Optimization" organized by Ekkehard Ramm
"Grid generation and adaptivity" organized by Rainald Lohner
"Fluid solid interactions and applications" organized by Carlos Conca
"Stabilization techniques in comp. mechanics" organized by Ramon Codina and Leopoldo Franca
"High performance finite elements in nonlinear solid mechanics" organized by Francisco Armero & Eduardo Dvorkin
"Numerical analysis of strain localization in inelastic solids" organized by Francisco Armero
"Symbolic approach in computational mechanics" organized by Peter Wriggers
"Numerical Solution of Transmission Problems" organized by Gabriel Gatica
"Stochastic Mechanics" organized by Alex Barbat & Jorge Hurtado
"Free Boundary Problems in Combustion" organized by Juan Vazquez
"Numerical methods for composite materials" organized by Sergio Oller

Please do not forget the last early payment deadline is next **March 31, 1998.**

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or contact the IACM secretariat. •

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The team MOST (MOdélistation et Simulation de la Turbulence) at the LEGI Laboratory in Grenoble has an opening for a postdoctoral fellowship starting on 1st February 1998. The position is funded by the European Program Training and Mobility of Researchers and concerns the application of LES to rotating turbulent flows with both industrial (e.g. turbomachinery and aerodynamics) and geophysical applications. Complex geometry will be investigated and heat and mass transfer phenomena will be studied. A solid background (Ph.D) degree) is expected in computational fluid dynamics and in advanced numerical techniques.

The position will be awarded initially for one year, renewable for two additional years. The salary will be around 28,500 Ecus per year.

Applicants will be considered upon reception closing on 1st December or until the position is filled. A c.v., a list of publications, 3 letters of recommendation and a statement of experience must be sent to:
Prof. M. Lesieur, LEGI/IMG, BP 53, 38041 Grenoble Cedex 9, FRANCE
Phone: (33) 4 - 76 82 50 19, Fax: (33) 4 - 76 82 52 71, e-mail: Marcel.Lesieur@hmg.inpg.fr

Professors elected to join Elite Group

It's almost like diving in at the deep end, but helping to save Venice -and North Sea oil rigs - from sinking without a trace is all in a day's work for **Professor Roland Lewis**.

And working with NASA to overcome re-entry problems for space shuttles may seem a little out of this world, but it's very much a done-to-earth situation for **Professor Kenneth Morgan**.

The pioneering computational techniques they have developed have earned them international recognition and boosted the worldwide prestige of the acclaimed engineering department of the University of Wales, Swansea. They have been elected to join the elite **Royal Academy of Engineering in the United Kingdom**.

This announcement has given much pleasure to all colleagues throughout the world and the IACM, who are delighted to see this honour bestowed, give their sincere congratulations.

Prof. Ken Morgan has made numerous contributions throughout his research career to the field of Computational Fluid Dynamics and was one of the first to adapt the finite element methods to CFD, providing procedures capable of dealing with the complex geometry of modern aircraft and space vehicles at all speeds, ranging from subsonic flow to hypersonics. The procedure developed by Ken are today widely used throughout the world and are used by British Aerospace and Rolls Royce in the U.K., Dassault in France as well as by NASA in the U.S.A.

Ken started his numerical career when he became lecturer in Swansea in 1975 and his progress has been tremendous. In the late '80s, his work in CFD together with his students Lohner and Peraire became known widely throughout the aircraft and aerospace world. In 1991, after a brief two years at Imperial College (where he held the prestigious Zaharoff Chair of Aeronautics) he returned to the Department of Civil Engineering in Swansea. Here, for a period of five years, he succeeded in steering its activities through the very difficult funding times, without giving up his vital research.

Prof. Roland Lewis joined the Swansea group in the late '60's after working with the oil industry in Canada. His work is widely known in thermal field calculations and in the problem of geo-consolidations associated with oil fields. More recently he has contributed to such problems as casting and other metal forming areas. Probably his most important activity has been to carry a substantial load of editorship in the International Journal of Numerical Methods in Engineering which continues to grow in volume through his efforts.

These two distinguished scientists are to join their fellow members from Swansea, Prof. R. Owen and Prof. O.C. Zienkiewicz in the Royal Academy of Engineering. We hope that computational mechanics will continue to be honoured both in Europe and throughout the world and offer our congratulations. •

Prof. Roland Lewis

Prof. Ken Morgan

Robert J. Melosh Medal Competition for the best student paper on Finite Element Analysis

The Robert J. Melosh Medal Competition for the best student paper on finite element analysis was inaugurated by the Department of Civil and Environmental Engineering at Duke University in 1989 to honour Prof. Melosh for his pioneering work on the finite element method and for his dedication to research, teaching, and service during his tenure at Duke University.

Submissions are invited in all areas of finite element analysis, including theoretical development, implementation procedure, programming aspects, novel and innovative applications and integration of finite elements into the design procedures. Additionally, submissions in related areas of computational mechanics i.e. boundary element, meshless methods etc, will be welcomed. The deadline for receipt of papers is January 16 1998. Six finalists are selected annually by a panel of distinguished judges, and these papers are presented orally at Duke University. The winner, as determined on the basis of a submitted extended abstract and an oral presentation of the paper,will receive a Robert J. Melosh Medal and a $500 honourarium.

For further information please contact: The Robert J. Melosh Medal Competition
Department of Civil and Environmental Engineering, School of Engineering
Box 90287, Duke University, Durham, North Carolina, 22708-0287, USA •

San Francisco hosts the USNCCM IV

Over 450 attendees converged on San Francisco to participate in the Fourth National Congress on Computational Mechanics, on **August 6 - 10, 1997**. The three day technical program consisted of 943 technical sessions, covering all aspects of the development and application of computational techniques for the simulation of physical systems.

In addition there were five keynote presentations that included:

- Robert W. Dutton, Stanford University, "Mixed-Technology for Integrated Systems: A Confluence of Electrical and Mechanical Perspectives"
- Charbel Farhat, University of Colorado at Boulder, "High Performance Computational Non Linear Aeroelasticity"
- Christopher R. Johnson, University of Utah, "Computational Steering and Interactive Visualization"
- Michael Ortiz, California Institute of Technology, "Finite Element Analysis of Impact Damage & Ballistic Penetration"
- Horst D. Simon, Lawrence Berkeley National Laboratory, "High Performance Computing in the U.S. - The Next Five Years".

There were also six companies participating in the congress exhibits. The one day short course that followed the congress was attended by over 100 congress participants. In addition to the technical activities, we did have an opportunity to socialize at two receptions and the congress banquet.

As was the case in the first three congresses, there was excellent participation from the academic community, both from the US and abroad (107 non-US participants). We were also pleased to see real growth in participation from industry and government laboratories. Specific efforts were carried out to have more sessions focused on applications and the needs of industrial users of computational mechanics technologies. We want to greatly increase the participation of the industrial sector in the US National Congress on Computational Mechanics. The congress banquet was highlighted by the presentation by Prof. J. Tinsley Oden, The University of Texas, of the US Association for Computational Mechanics Awards. Prof. Thomas J.R. Hughes of Stanford University was awarded the USACM's highest award in the 1997 John Von Newmann Medal. This year also saw the introduction of the four USACM Awards.

Ted Belytschko receiving the USACM Computational Structural Mechanics Award

The 1997 award recipients are:

- Ted Belytschko of Northwestern University, the USACM Computational Structural Mechanics Award
- Tayfun E. Tezduyar of the University of Minnesota, the USACM Computational Fluid Dynamics Award
- Mark S. Shephard of Rensselaer Polytechnic Institute, the USACM Computational & Applied Science Award
- Charbel Farhat of the University of Colorado at Boulder, the USACM Special Achievement Award for Young Investigators.

Members of the USACM Executive Committee at the congress banquet

In addition, five individuals were named Fellows of the US Association for Computational Mechanics. They were Harry Armen of Grumman.Northrop, Ivo Babuska of the University of Texas at Austin, Thomas A. Cruse of Vanderbilt University, Michael Oritz of the California Institute of Technology and Robert L. Taylor of the University of California at Berkeley. USNCCM V will be hosted by the University of Colorado at Boulder in August 1999. Further details can be obtained from Prof. K. William at email - william@colorado.edu •

On the International Union of Theoretical and Applied Mehcanics (IUTAM)

by
Herbert A. Mang
Vienna University of Technology
and
Austrian Academy of Sciences
Vienna, Austria

Opening addresses of joint IUTAM/IACM Symposia usually contain the remark that IACM is an Affiliated Organization of the IUTAM. Actually, IACM is one of twelve such organizations. Some of them, such as the European Mechanics Society (EUROMECH), are of geographic origin. Some others, such as IACM,reflect the rapid development of new fields of mechanics.

When was the organization founded to which IACM is affiliated ? What are the objectives of IUTAM ? How is IUTAM organized ? What are the activities of IUTAM ?

Detailed answers to these questions are contained in a booklet published in 1996 on the occasion of the 50th anniversary of IUTAM. It is remarkable that the First International Congress of Applied Mechanics was held 22 years before the foundation of IUTAM. The site of this scientific congress was Delft.

The suggestion that the Congress of Applied Mechanics should transform itself into a Union was made by the International Council of the Congress Committee during the VIth Congress, in Paris, in September 1946.

The objectives of IUTAM are[1]:

a. to continue the series of International Congresses for Applied Mechanics ;
b. to engage in other lawful activities meant to promote development of mechanics as a branch of science, viz :
   - formation of committees or bodies for special purposes ;
   - organization of meetings of conferences ;
   - entrance into relations with other scientific organizations ;
   - editorial or publishing work ;
   - any other activities which may deemed suitable to the purpose indicated.

The organization of IUTAM consists of the General Assembly, the Adhering Organizations, the Affiliated Organizations, and the Bureau. In the history of IUTAM, the Congress Committee has played an important role.

The General Assembly is the highest authority of IUTAM. It consists of delegates of the so-called Adhering Organization of the individual countries. As regards, e.g., Austria, the Adhering Organization is the Austrian Academy of Sciences. There are five categories of membership for the Adhering Organizations. The highest category is 5. The number of delegates and the level of the financial contribution depend on the category for membership which, ideally, should reflect the ìstrengthî of a country with regard to the mechanical sciences. As of 1996, 45 countries are members of IUTAM.

The Bureau is the executive organ of IUTAM. It is elected for a period of four years. The Bureau consists the President, the Vice-President, the Treasurer, the Secretary General, and four members without portfolio. In 1996, W. Schiehlen was elected to president of IUTAM.

The task of the Congress Committee is to organize the International Congresses of Theoretical and Applied Mechanics (ICTAM).

IUTAM is also organizing Symposia, enjoying a high reputation, and co-sponsoring several scientific meetings including a yearly summer school.

The last ICTAM, i.e., the Nineteenth International Congress, was held in Kyoto, Japan, in 1996. As a novel feature of this Congress, forty so-called "Prenominated Sessions" on topics of mechanics not covered in the 'Mini-Symposia' were selected by the Congress Committee. IACM was invited to collaborate in the organization of three Prenominated Sessions. The topics of these sessions were : 'Computational approach to turbulence and hydrodynamic stabilita' (organized, on behalf of IACM by Prof. E. Stein) and 'Plates and Shells' (organized, on behalf of IACM, by Prof. H.A. Mang).

At the last ICTAM, the General Assembly of IUTAM has approved the creation of Working Parties to foster collaborative work with IUTAM and key affiliate organizations such as IACM. The Working Party on Computational Mechanics consists of the following members : E. Arantes e Oliveira (Portugal) and J.T. Oden (U.S.A.), (Co-chairs), T. Belytschko (USA), H.A. Mang (Austria) and P. Ladeveze (France). This Working Party has met in Austin, Texas, on January 15, 1997. It finalized proposals for several symposia, workshops, and minisymposia under the joint sponsorship of IUTAM and IACM.

The General Assembly of IUTAM will meet on August 28-29, 1998, in Stuttgart, Germany. It will decide on Symposia for the years 2000-2001. Members of IACM, planning to submit a proposal for a joint IUTAM/IACM Symposium are invited to contact a member of the aforementioned Working Party.

The creation of this Working Party is a clear sign of the good development of the relations between IUTAM and IACM. The words of the past president of IUTAM, L. van Wijngaarden, that "IUTAM will also reinforce links which exist with other fields of science, such as computational mechanics" [1] have been well received by IACM. Reinforcement of links with IUTAM without giving up the own scientific identity should be in the best interest of IACM. •

Reference :

[1] IUTAM 1946-1996. Fifty Years of Impulse to Mechanics. IUTAM, Kluwer Academic Publisher, Dordrecht, 1996.

engineering education

1st USICEE Annual Conference on Engineering Education

Under the theme of *Globalisation of Engineering Education*, this conference will be held at Monash University, Clayton, **Melbourne, Australia** from **11 - 14 February 1998**.

USICEE is the worlds first and only centre for engineering education. Their main objective is to facilitate the transfer of information, expertise and research on engineering education and industrial training, with a specific mission to assist developing countries worldwide. Here they hope to bring together members and supporters of USICEE to discuss issues of importance to engineering education, to debate the activities and to foster friendships already established.

All correspondence should be addresses to the Conference Secretariat.
Tel: (61) 3 - 990 51829, Fax: (61) 3 - 990 51547
e-mail: unicee@eng.monash.edu.au
http://www.eng.monash,edu.au/usicee •

Global Congress on Engineering Education

The first Global Congress on Engineering Education, to be held in **Cracow**, **Poland** from **6 - 11 September**, will debate important worldwide issues in engineering education. It will incorporate three ongoing, major international gatherings: the *4th East-West Congress on Engineering Education*, the *5th World Conference on Engineering Education* and the *1998 International Congress of Engineering Deans and Industry Leaders*.

The Congress will concentrate on three important themes: general issues in engineering and technology education, international collaboration in engineering and technology education, academia industry collaboration in engineering and technology education.

Please address enquiries to Z.J. Pudlowsk on Tel: (61) 3 - 990 54977, Fax: (61) 3 - 990 51547, e-mail: ZJP@eng.monash.edu.au •

A European Project on
Development of Educational Software for Finite Element Analysis

A project aiming to develop educational software codes for computer aided education in finite element analysis is currently being developed under the auspices of the Leonardo Programme of the European Community. The participants in the project are the International Centre for Numerical Methods in Engineering of Barcelona, the Universities of Catalunya (Spain), Swansea (United Kingdom), Padova (Italy) and Stuttgart (Germany).

The consortium has already released the first educational codes on finite element analysis of field problems, two dimensional elasticity and coupled geomechanical engineering situations. The codes aim to reproduce a virtual classroom environment where theory lessons, explanatory exercises and worked examples can be accessed in an interactive and user friendly manner.

New educational codes on structural dynamics, fluid flow and introductions to numerical methods are currently under development. For further information contact Mrs A. Hanganu at on e-mail: cimne@etseccpb.upc.es. •

An IACM Special Interest Conference

NUMIFORM'98

The 6th International Conference on Numerical Methods in Industrial Forming Processes

University of Twente, Enschede, The Netherlands

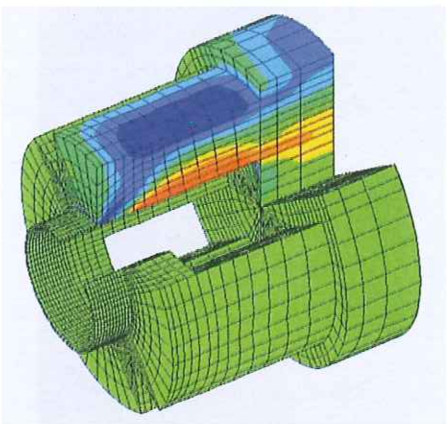
The Sixth International Conference on Numerical Methods in Industrial Forming Processes, to be held at the **University of Twente, The Netherlands**, from **22 - 25 June 1998**, will bring together researchers and practitioners in the fields of numerical simulation of forming processes used in industry.

Topics:
It will provide a forum for discussion of the current state of the art in:

Numerical Methods
hybrid methods, inverse methods, parallel computing, explicit/implicit integration, solution methods, meshing, (adaptive) remeshing, optimization, eulerian/lagrangian formulation, contact algorithms

Mathematical Modelling
constitutive equations, evolving microstructure, phase change, damage/fracture, contact and friction, thermomechanical coupling, free surfaces, steady state problems, residual stresses, springback, chemical reactions, mixing.

Industrial applications
bulk forming, sheet forming, casting, molding, quenching, polymer processing, powder forming, machining, joining, thermal processing, chemical processing, surface treatment, food processing.



Organising Committee:

Conference Chairman
J. Huétink

Steering Committee

J.L. Chenot	France
P.W. Dawson	U.S.A.
A. Samuelsson	Sweden
E.G. Thompson	U.S.A.
R.D. Wood	U.K.
O.C. Zienkiewicz	U.K.

Location:
The conference will be held at the campus of the University of Twente. The University of Twente is located between the cities of Enschede and Hengelo in the eastern part of The Netherlands.

The city of Enschede can be reached by air from Amsterdam airport in half an hour and by train within two hours. The organisers have obtained block reservations at hotels in and near Enschede.

Fees:
The registration fees, including lunches, banquet and Conference Proceedings, with early registration applicable if received before March 15, 1998, are:

	Early	*Late*
First Author/Delegate	Dfl. 950	Dfl. 1100
Students	DFL. 800	Dfl. 950

Correspondence:
For technical questions regarding the conference, please contact:

Prof Han Huétink
Tel: (31) 53 - 489 2576
E-mail: J.Huetink@wb.utwente.nl

Inquiries should be addressed to:

Numiform '98
University of Twente, WB-N136
P.O. Box 217
7500 AE ENSCHEDE
The Netherlands
Tel: (31) 53 - 489 2460
Fax: (31) 53 - 489 3900
E-mail: numiform@wb.utwente.nl

The home page located at:
http;//www.numiform98.wb.utwente.nl •

book report

Structural Analysis of Historical Constructions

P. Roca, J.L. Gonzalez, A.R. Mari & E. Oñate (Eds.)
1997, US$ 80, CIMNE Barcelona..

This book includes extended versions of the conferences presented at the International Seminar on Structural Analysis and Historical Constructions held in Barcelona on November 8 - 10, 1995. The aim is to provide updated information on the possibilities of the available techniques for inspection, analysis and repair of historical constructions. It simultaneously attempts to introduce the reader to the more conceptual and methodological aspects involved in the analysis and intervention on the ancient monuments. This book will be useful to architects and engineers interested in a deep understanding of the structural performances of ancient constructions in order to define a truly effective, although fully respectful, strategy for intervention and repair. •

Model-Aided Diagnosis of Mechanical Systems

Fundamentals, Detection, Localization, Assessment.
H.G. Natke, & C. Cempel (Eds.)
248 pages, 1997, US$ 129.50, Springer-Verlag.

This book is concerned with the diagnosis of the damage and faults of mechanical systems in the diverse fields of engineering. It takes into consideration the various stages of the life cycle of a system from a diagnosis-orientated point of view and from a methodological one. Analysis, testing and diagnosis is linked with all stages of a system's life, with an enormous effect on cost, reliability and safety. The classical methods of diagnosis based on signature analysis are reviewed in the introduction. The main subject is the model-supported diagnosis using system identification methods for adjusting mathematical models to various states of the system under investigation at pre-given life times. These adjusted models perform the best knowledge base available about the system which serve the purpose of fault detection localization and the cause- finding of faults and their assessment, predictions due to future forcings and trend predictions. The Diagnostic decision-making is based on validated models. The assessment to be made with the resulting consequences also is discussed.

This book provides the foundation for the model-aided diagnosis, so that the reader will be able to develop a formulation for his particular application and to find stimulation for further applications and investigations. •

Parameter Sensitivity in Non-linear Mechanics

M. Kleiber, H. Antunes, T.D. Hien, P. Kowalczyk (Eds.)
350 pages, 1997, UK£ 55.00,
John Wiley & Sons Ltd.

There are various methods for the evaluation and design of bodies subject to static and dynamic loadings in structural and solid mechanics. Sensitivity analysis (SA) is concerned with the relationship between parameters, describing the structure under consideration and the function describing the response of that structure under loading conditions. This book addresses the finite element computational techniques typical of sensitivity analysis for solid mechanics systems with any nonlinearity. Besides the theory and results of numerical computation presented, many suitable finite element codes have been developed by the authors and used for computing examples, available on the Internet via anonymous ftp. •

Boundary Element Topics

W.L. Wedland (Ed.)
498 pages, 1997, US$ 129.00,
Springer-Verlag.

This volume contains papers presented at the final conference of the DFG Research Programme in Boundary Element Methods, Stuttgart, October 2 - 4, 1995. The contributions deal with the offer solutions for problems arising in the application of BEM to engineering tasks. •

Riemann Solvers and Numerical Methods for Fluid Dynamics

A Practical Introduction

E.F. Toto (Ed.)
1040 pages, 1997, US$ 129.00,
Springer-Verlag.

High resolution upwind and centred methods are today a mature generation of computational techniques applicable to a wide range of engineering and scientific disciplines, Computational Fluid Dynamics (CDF) begin the most prominent up to now.

This book gives a comprehensive, coherent and practical presentation of this class of techniques. The book is designed to provide readers with an understanding of the basic concepts, some of the underlying theory, the ability to critically use the current research papers on the subject, and above all, with the required information for the practical implementation of the methods. Applications include compressible, steady, unsteady, reactive, viscous, non-viscous and free surface flows. •

France

The title of Doctor Honoris Causa of Ecole Normale Supérieure de Cachan has been conferred to O.C. Zienkiewicz. The ceremony was held during the Workshop "New Advances in Adaptive Computational Methods in Mechanics" co-organized at Cachan by P. Ladeveze and J.T. Oden (September 17-18-19).

United Kingdom

Professors Roland Lewis and Kennith Morgan from the University College of Swansea, Wales, have been elected to join the elite Royal Academy of Engineering.

USA

It is with sadness that we announce that Prof. Richard Hugo Gallagher passed away on 30 September 1997 after a long illness.

Prof. Thomas J.R. Hughes of Stanford University was awarded the USACM's highest award in the 1997 John Von Newmann Medal.

Five scientists were named Fellows of the US Association for Computational Mechanics. They were Harry Armen of Grumman.Northrop, Ivo Babuska of the University of Texas at Austin, Thomas A. Cruse of Vanderbilt University, Michael Oritz of the California Institute of Technology and Robert L. Taylor of the University of California at Berkeley.

Spain

The annual meeting of SEMNI, the Spanish Association for Numerical Methods in Engineering took place on December 4th in Granada. Invited lectures were given by Profs. R.L. Taylor, M. Guiggiani and R.M.H. Aliabadi.

The 4th Spanish Conference on Numerical Methods in Engineering is planned in Seville on June 1999. Further details can be obtained from the IACM Secretariat.

Brazil

The Brazilian Association for Computational Methods was created in September 1997 with the President as Prof. E. B. Las Casas For details please contact Prof Las Casas on e-mail: estevam@dees.ufmg.br

Portugal

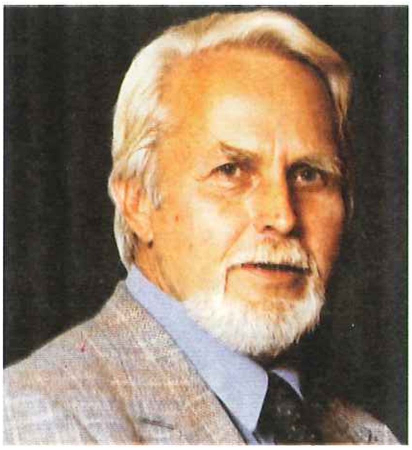
The National Conference of the Portuguese Society of Theoretical, Applied and Computational Mechanics took place in the city of Porto in September 1996.

Nordic Association

The 10th annual meeting and seminar of the Nordic Association for Computational Mechanics was held in Tallim, Estonia on October 24 - 25. The seminar was attended by some 100 participants and keynote lecturers included Profs. E. Stein and E. Oñate.

iacm news news news news news news

Prof. O.C. Zienkiewicz, recipient of the title Doctor Honoris Causa of Ecole Normal Supérieure de Cachan



conference notices

First ESAFORM Conference on Material Forming

The European Scientific Association for Material Forming originated through a network of 14 European laboratories, bringing together and supporting the field of metal forming.

Now, their first conference will be held on **17 - 20 March 1998** at **Sophia Antipolis, Southern France**.

This conference is devoted to all topics connected to scientific studies on all material forming processes (solid or molten state, etc.). All types of materials (polymers, metals, ceramics, composites, glass, biopholymers, etc.) will be considered in the following areas: numerical modelling, physical approaches, experimental investigations and industrial case studies.

The conference will be held at the Centre de Mise en Forme des Matériaux in Sophis Antipolis, about 20km west of Nice on the French Riviera.

For further information, contact:
Dr N. Billon, Ecole des Mines de Paris
CEMEF, B.P. 207
06904 Sophia Antipolis Cedex, France.
Tel: (33) 4 - 93 95 74 20
Fax: (33) 4 - 93 65 43 04
e-mail: noëlle.billon@cemef.cma.fr
http://esaform.cma.fr •

1st International Conference GIS for th 21st Century
Geographic Information Systems in the next Millennium

Geographic Information Systems (GSI) technologies are rapidly penetrating a number of application domains such as environmental conservation, economical planning, resource utilisation, cartography, urban planning, risk assessment, pollution control and transport management systems.

To be held at the **University of Udine, Italy** on **6 - 8 July 1998**, the meeting will discuss data acquisition facilities, data base features, human interface capability and learning aids of GIS systems.

One of the primary aims of the conference is to identify the GIS technology state of the art and to monitor its development in various fields of application. This will ensure that GIS continues to develop into a tool for virtual management systems in the next millennium.

Enquiries should be sent to: Sue Owen
Conference Secretariat, GIS
Wessex Institute of Technology, Ashurst Lodge
Ashurst, Southampton, SO40 7AA, U.K.
Tel: (44) 1703 - 293 223
Fax: (44) 1703 - 292 853
e-mail: liz@wessex.ac.uk •

SACAM'98 2nd South African Conference on Applied Mechanics

Organised by the UCT Centre for Research in Computational and Applied Mechanics under the auspices of the South African Association of Theoretical and Applied Mechanics, we are pleased to announce SACAM'98 will take place at the **University of Cape Town, South Africa** from **12 - 15 January 1998**.

Their objective is to provide a forum for the discussion and promotion of research in theoretical, experimental and computational aspects of solid, structural and fluid mechanics.

The first day will be devoted to a pre-conference workshop, exposing delegates to advanced aspects of select topics in mechanics that have a wide current interest. These lectures will be expository in nature and will be presented by well known experts.

Over the following three days of the conference, it is intended to divide activities into plenary and parallel sessions.

Topics to be included in the main conference include:
- structural mechanics (beams, plates & shells), inelastic material behaviour
- fluid mechanics
- finite element and finite volume analysis in solid and fluid mechanics
- simulation of manufacturing processes
- experimental mechanics
- aeronautical applications and structural design optimization

All correspondence should be sent to:
SACAM'98,
UCT Centre for Research in Computational and Applied Mechanics,
University of Cape Town,
7701 Rondebosch, Cape Town, South Africa.
Tel: (27) 21 - 650 3817
Fax: (27) 21 - 685 2281
e-mail: sacam98@engfac.uct.ac.za •

1st International Conference on Engineering Computational Technology

To be held in **Edinburgh**, **Scotland** on **18 - 20 August 1998**, this conference runs concurrently with the Fourth International Conference on Computational Structures Technology. Participants may attend sessions from either conference.

The themes for this conference will include: computer aided manufacture, computational fluid dynamics, computer aided design and computer aided engineering, simulation, virtual reality and virtual environments, virtual prototyping, visualisation and graphics, multi-phase problems, thermal problems, geotechnical problems and biomechanics.

In addition to this, the world famous Fringe Festival runs simultaneously, as do Film, Jazz, Book, Television Festivals and the Edinburgh International Arts Festival.

For further enquiries please contact:
Prof. B.H.V. Topping
Department of Mechanical Engineering
Heriot-Watt University
Riccarton, Edinburgh
EH14 4AS, United Kingdom.
Tel: (44) 131 - 451 3141
Fax: (44) 131 - 451 3593 •

4th International Conference on Computational Structures Technology

Running concurrently with the First International Conference on Engineering Computational Technology, this conference will be held from **18 - 20 August 1998** in **Edinburgh**, **Scotland**.

Themes for this conference will include: structural analysis and design, non linear analysis, dynamic analysis, finite element analysis, boundary element analysis, computer aided design, structural optimization, structural re-analysis and sensitivity analysis, geomaterials, plates and shells, structural modelling, micro-mechanics models, reliability problems, software standards and quality control, adaptivity, mesh generation, shape and topology optimization, visualization and graphics, impact and contact simulation, post and pre processing and smart structures.

For further enquiries please contact:
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EH14 4AS, United Kingdom.
Tel: (44) 131 - 451 3141
Fax: (44) 131 - 451 3593 •

Metal Forming '98 The 7th International Conference on Metal Forming

Metal Forming '98 is the 7th in a series of International Conferences held alternately in the University of Birmingham and Academia Górniczo-Hutnicza, Kraków.

Hosted at the University of **Birmingham**, **United Kingdom**, on **1 - 3 September 1998**, this will provide a forum for academics and industrialists to discuss and disseminate recent developments and advances in metal forming processes. It will provide an opportunity for those working on experimental research, as well as those involved in numerical modelling, to present their recent work.

Conference topics will fall under the following outlines: processing, materials, deformation mechanics, numerical modelling and manufacturing systems.

For more information please contact:
Conference Secretary, Metal Forming '98
School of Manufacturing and Mechanical Engineering, The University of Birmingham
Edgbaston, Birmingham, B15 2TT, U.K.
Tel: (44) 121 - 414 4232
Fax: (44) 121 - 414 3958
e-mail: metalform@gham.ac.uk •

THE UNIVERSITY OF BIRMINGHAM

Akademia Górniczo–Hutnicza Kraków

VECPAR 98 3rd International Meeting on Vector and Parallel Processing

VECPAR'98 is a multidisciplinary meeting on vector and parallel processing, providing an ideal forum for researchers from industry and academia to disseminate knowledge, research results and applications in many areas of activity. This will be the third of a series of conferences, initiated in 1993, which is organised and hosted by the Faculty of Engineering at the **University of Porto**, **Portugal** on **21 - 23 June 1998**.

Meeting schedules will be started by an one hour invited lecture, followed by contributed papers. Invited talks will highlight some of the major accomplishments, trends and technical challenges in the field.

Papers will address a broad range of research fields or current interests. A list of possible topics include (but is not limited to) the following:

- parallel and distributed algorithm,
- parallel and distributed computing in education
- computer architectures
- algebra (linear and non-linear)
- computational fluid dynamics
- crash and structural analysis
- image (processing and syntheses)
- parallel database servers
- data warehousing and data mining
- real-time and embedded systems
- industrial and commercial systems and applications

For more information please contact:
Viagens Abreu SA, VECPAR'98
Avenida dos Aliados, 207, 4000 Porto, Portugal
Tel: (351) 2 - 314 127 / 324 524
Fax: (351) 2 - 200 5141
e-mail: cgiopo@abreu.pt
http://www.fe.up.pt/~vecpar98/ •

conference diary planner

5 - 8 January 1998
FEMIF '98 - 10th International Conference on Finite Elements in Fluids
An IACM Special Interest Conference
Venue: University of Arizona, Tuscon, U.S.A.
Contact: Tel: (1) 520-621 3054, Fax: (1) 520-621 1443, Email: baltes@bigdog.engr.arizona.edu

12 - 15 January 1998
SACAM '98 - Second South African Conference on Applied Mechanics
Venue: University of Cape Town, South Africa.
Contact: Prof.B.D. Reddy. Tel: (27) 21-650 3817, Fax: (27) 21-685 2281, Email: sacam98@engfac.uct.ac.za

17 - 20 March 1998
First ESAFORM Conference on Material Forming
Venue: Material Processing Centre, CEMEF, Ecole des Mines de Paris, Sophia Anitpolis, France
Contact: Dr. N. Billon. Tel: (33) 4-93 95 74 20, Fax: (33) 4-93 65 43 04, Email: noëlle.billon@cemef.cma.fr

31 March - 3 April 1998
EURO-C 1998 - Computational Modelling of Concrete Structures
Venue: Hotel Salzburger hod, Badgastein, Austria.
Contact: Prof. N. Bicanic. Tel: (44) 141-330 5200, Fax: (44) 141-330 4557, Email: n.bicanic@civil.gla.ac.uk

21 - 23 June 1998
3rd International Meeting on Vector and Parallel Processing
Venue: Fundacao Cupertino de Miranda, Avenida da Boaviata 4245, Porto, Portugal.
Contact: Tel: (351) 2-314 127, Fax: (351) 2-200 5141, Email: cgiopo@abreu.pt http://www.fe.up.pt/~vecpar98/

22 - 25 June 1998
NUMIFORM '98 - The 6th International Conference on Numerical Methods in Industrial Forming Processes
An IACM Special Interest Conference
Venue: Department of Mechanical Engineering, University of Twente, Enschede, The Netherlands.
Contact: Prof. H. Huétink. Tel: (31) 53-489 2460, Email: numiform@wb.utwente.nl

29 June - 2 July 1998
IACM - Fourth World Congress on Computational Mechanics
Venue: Buenos Aires, Argentina.
Contact: IACM Secretariat. Tel: (34) 3-401 6036. Fax: (34) 3-401 6517, Email: iacm@etseccpb.upc.es

6 - 8 July 1998
GIS for the 21st Century - Geographical Information Systems in the next Millennium
Venue: Udine, IItaly.
Contact: Sue Owen. Tel: (44) 1703-293 223, Fax: (44) 1703-292 853, e-mail: liz@wessex.ac.uk

18 - 20 August 1998
4th International Conference on Computational Structures Technology *and*
First International Conference on Engineering Computational Technology
Venue: Edinburgh, Scotland.
Contact: Prof.B.H.V. Topping. Tel: (44) 131-451 3141, Fax: (44) 131-451 3593

19 - 21 August 1998
BEM 20 - 20th World Conference on the Boundary Element Method
Venue: Orlando, Florida, U.S.A.
Contact: L. Kerr. Tel: (44) 1703-293 223, Fax: (44) 1703-292 853, Email: liz@wessex.ac.uk

1 - 3 September 1998
7th International Conference on Metal Forming
Venue: School of Manufacturing and Mechanical Engineering, University of Birmingham, United Kingdom.
Contact: Tell: (44) 121-414 4232, Fax: (44) 121-414 3958, Email: metalform@bham.ac.uk

7 - 11 September 1998
ECCOMAS '98 - 4th ECCOMAS Computational Fluid Dynamics Conference
Venue: Astir Palace Hotel, Vouliagmeni, Greece.
Contact: Tel: (30) 1-772 1638, Fax: (30) 1-772 1658, Email: eccoma98@central.ntua.gr

4 - 8 January 1999
PACAM VI - 6th Pan American Congress of Applied Mechanics
DINAME - 7th International Conference on Dynamical Problems in Mechanics
Venue: Rio de Janiero, Brazil.
Contact: D. Pamplona, Email: pacam99@civ.puc-rio.br, or C.R. Steele, Email: chasst@lelend.stanford.edu

Spring 1999
7th International Conference on Civil & Structural Engineering Computing *and*
5th International Conference on the Application of Artificial Intelligence to Civil & Structural Engineering
Venue: Edinburgh, Scotland.
Contact: Prof.B.H.V. Topping. Tel: (44) 131-451 3141, Fax: (44) 131-451 3593, http://www.saxe-coburg.co.uk

4 - 6 August 1999
The Fifth U.S. Congress on Computational Mechanics
Venue: University of Colorado at Boulder, U.S.A..
Contact: Tel: (1) 303-492 7011, Fax: (1) 303-492 7317, Email: william@colorado.edu

31 August - 3 September 1999
ECCM '99 - European Conference on Computational Mechanics
Solids, Structures and Coupled Problems
Venue: Munich, Germany
Contact: Prof. W. Wunderlich Tel: (49) 89-289 224 22, Fax: (49) 89 - 289 224 21

12 - 15 September 2000
ECCOMAS 2000 - European Congress on Computational Methods in Engineering and Applied Science
Venue: Barcelona, Spain
Contact: Barbara Schmitt, Tel: (34) 3-401 6037, Fax: (34) 3 - 401 6517, Email: semni@etseccpb.upc.es

Fourth World Congress on Computational Mechanics

Current Confirmed Sessions and Abstracts Received

as at 1 November 1997

- 15 Plenary Lectures
- 28 Organized Sessions
- 200 Keynote Lectures
- 750 Abstracts received

For further information contact:

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Güemes 3450
3000 Sante Fe
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Tel: (54) 42 - 55 66 73
Fax:: (54) 42 - 55 09 44
Email: rngtm@arcride.edu.ar
HTTP://cimne.upc.es/cimne/congring.htn

International Association for Computational Mechanics

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