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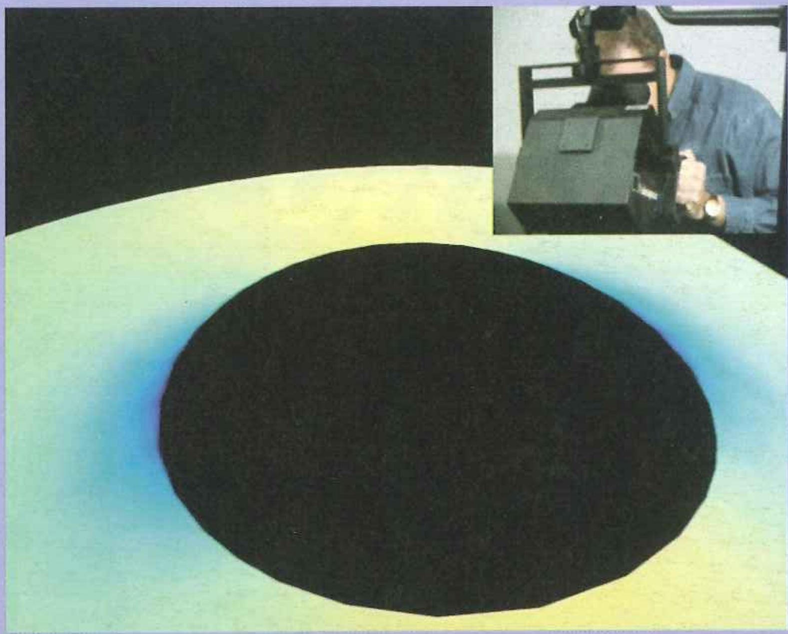

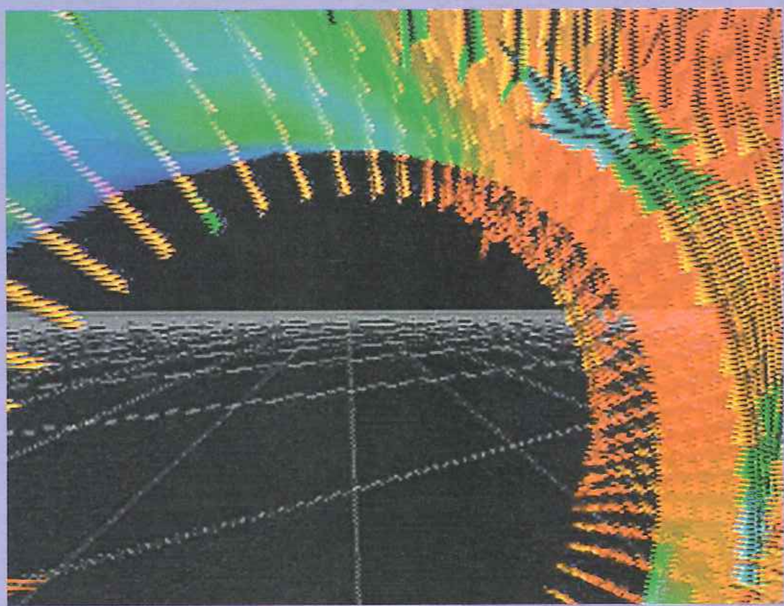

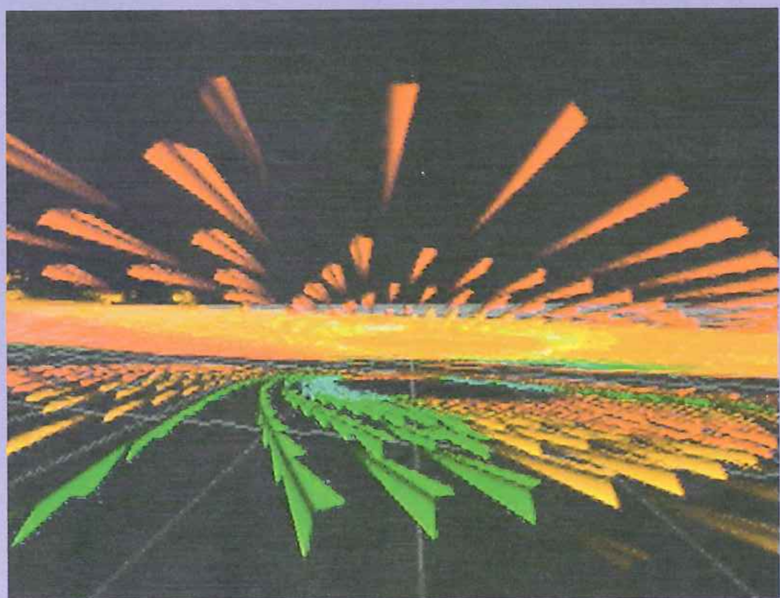

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Front Cover

Intelligent Synthesis Environment provides a New Frontier for Computational Science and Engineering Research - *A.K. Noor and S.L. Venneri,*
Pages 4 - 9 - *Virtual reality facilities used to study response of composite panels*

contents

editorial

Entertained by tango rhythm!

We all look forward to the fourth IACM Congress. Old friends will meet and a new generation of scientists in our field will be there. Old and young will come together and exchange experiences. Our Congress series started in America, in Austin, Texas. Then we went to Germany and after that to Japan.

Now we are back in America, South America, Buenos Aires. The 'Asociacion Argentina de Mecanica Computacional' (AMCA) was one of the first associations to join IACM. Last year 'Associaçion Brasiliera de Mecanica Computaçional' joined and we are now expecting many more associations from the Americas to apply for affiliation to IACM.

When we were in Tokyo four years ago we learned that the Japanese are very interested in tango music. Many of us went to tango clubs. We now meet in the homeland of the tango. We expect to be entertained by tango rhythm.

Alf. Samuelson
IACM President

Intelligent Synthesis Environment provides a New Frontier for Computational Science and Engineering Research

by
Ahmed K. Noor
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University of Virginia
Nasa Langley Research Centre
U.S.A.

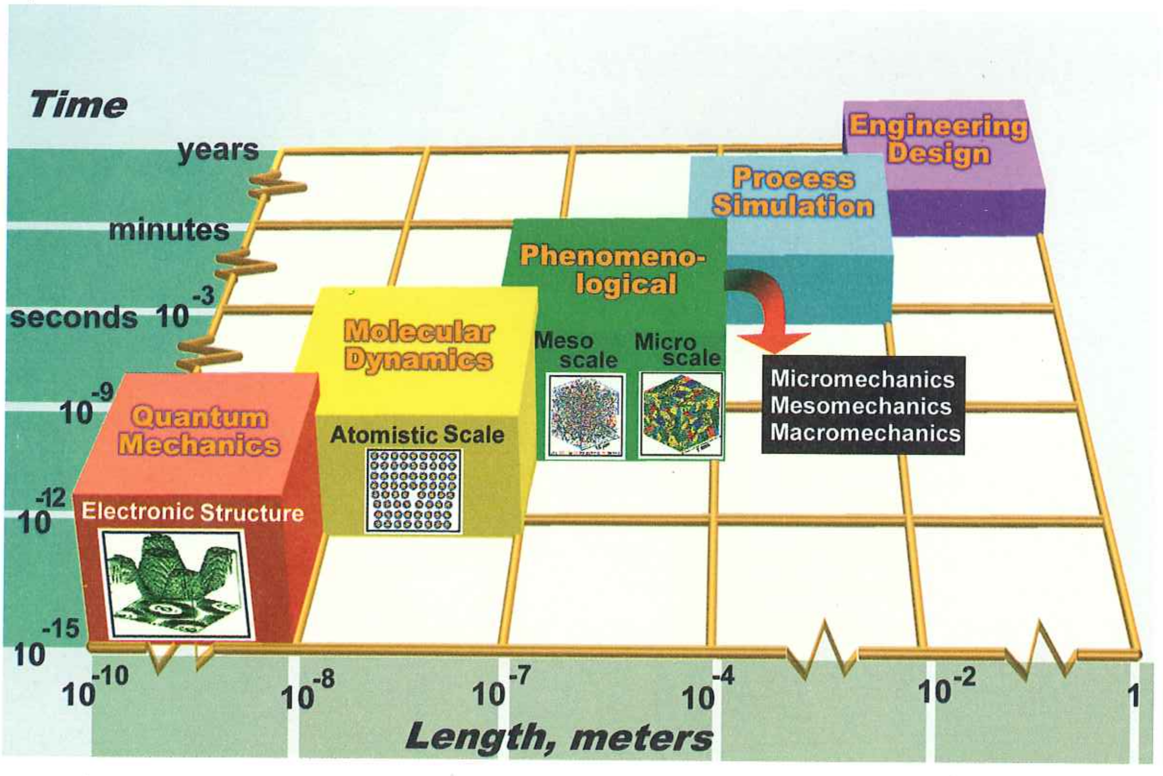
and

Sanuel L. Venneri
Chief Technologist
Nasa Headquarters, Washington D.C.
U.S.A.

The recent explosive growth in computer power and connectivity is reshaping relationships among researchers and organizations, and transforming the processes of discovery and communication. As a result of the technological advances in computer hardware, numerical simulation, networking, and communications, the new paradigm of "parallel, distributed, collaborative, immersive computing" is emerging.

The implications of this paradigm for engineering practice in general, and for research in the field of computational engineering and science in particular, are immense. Complex multiphysics applications involving phenomena at disparate length scales, and requiring interactive collaboration among experts in several disciplines can now be attempted. Future environments will allow diverse, geographically dispersed researchers, and teams to share information and to transform this information into knowledge by combining and analyzing it in new ways. The potential benefits of collaborative, distributed environments for scientific research and virtual product development have led government agencies to initiate several efforts, including the National Science Foundation initiatives on Problem Solving Environments (PSEs) for physical simulation, The National Partnership for Advanced Computational Infrastructure (NPACI), and Knowledge and Distributed Intelligence (DKI); DARPA's projects on Simulation-Based Design, and Intelligent Collaboration and Visualization (IC&V); and the Intelligent Synthesis Environment (ISE) concept being developed by NASA, the University of Virginia's Centre for Advanced Computational Technology, and the Jet Propulsion Laboratory. ISE, which is the subject of the present article, represents a fundamental cultural change in scientific research, engineering design and mission synthesis. It can be used to significantly enhance the understanding of physical phenomena associated with complex engineering products, and advance the field of computational engineering and science.

Figure 1
Computationally-driven material development



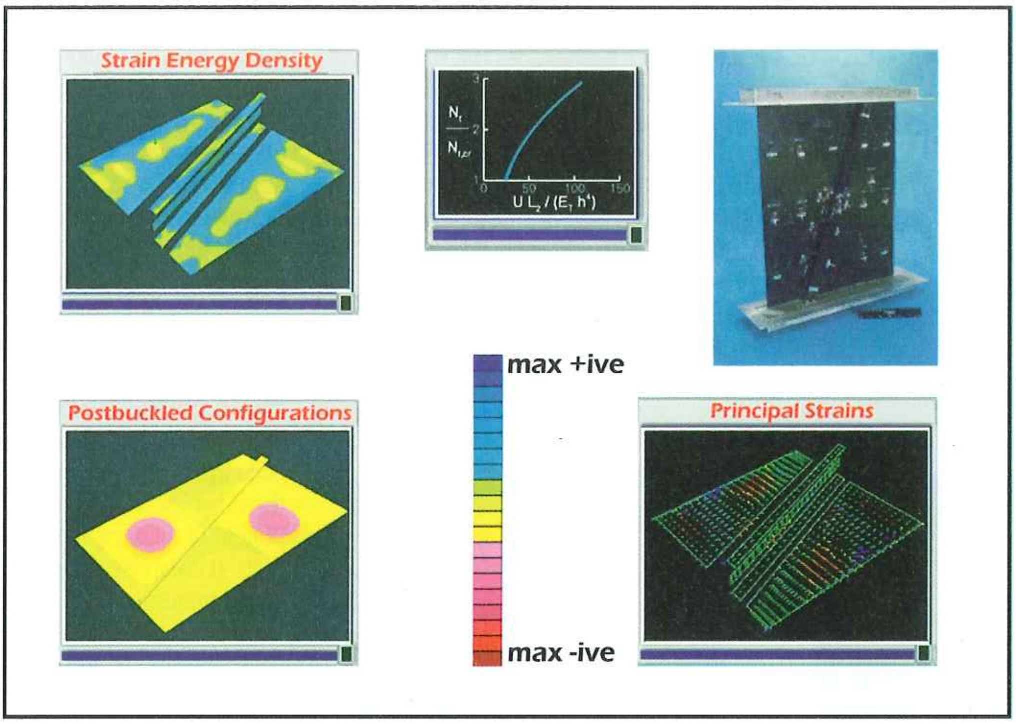


Figure 2
Multimedia facilities

ISE combines leading-edge technologies effectively to build or assemble a widely distributed, integrated collaborative virtual environment linking diverse, geographically dispersed science and engineering teams. The technologies used are high-performance computing, high-capacity communications and networking, modelling and simulation, knowledge-based engineering, computational intelligence, human-centred computing, and product information management. The virtual environment incorporates advanced computational, communication, and networking facilities and tools. The environment is adaptable and intelligent with respect to end users and hardware platforms. ISE should radically advance the process by which complex multi-physics simulations, covering disparate spatial and length scales are performed. Examples of these are simulation of advanced rockets, an computationally-driven material development (Fig. 1). The five components critical to ISE are human-centred computing, infrastructure for distributed collaboration, rapid synthesis and simulation tools, life-cycle integration and validation, and cultural change in the creative process. The objective of the human-centred computing component is to increase the productivity and enhance the creativity of the science and engineering teams by significantly enhancing the communication bandwidth among users as well as between each user and the facilities. ISE will be highly interactive and capable of dynamically mapping information into visual, auditory, or kinesthetic representations. Multimedia information is presented to the user in an intuitive and coordinated form (Fig. 2).

The four subelements of the human-centred computing component are immersive and advanced interfaces, human-machine communication, interactive agents, and human factors. The first subelement includes shared displays and effectors. Shared displays refer to group virtual-reality facilities such as the Vision Dome of Alternate Realities and the Reality Centre of Panoram, which provide users with a wide field of view without head-mounted displays or stereo glasses. Current interaction devices include position trackers and sensing gloves, as well as facilities for visual, audio, and haptic feedback (head-mounted displays, three-dimensional audio localization, and the like).

By being immersed in the virtual environment, engineers and scientists can create and modify their models in real time, seeing the effects of their modifications immediately. Emergent virtual environment technology seeks to create perceptual experiences through direct neural stimulation. Also, adaptive reconfigurable interfaces will be developed to take advantage of the advances made in cognitive neuroscience to couple humans with the computing facilities and maximize their performance.

The interactive agents in ISE include not only software agents but also cooperative physical agents such as robots, intelligent devices and other non-human agents.

"... virtual environment technology seeks to create perceptual experiences through direct neural simulation."

Distributed Collaboration

The infrastructure for the distributed-collaboration component of ISE provides the facilities and resources that make location completely transparent to the scientific research teams. It enables the assembly of the best knowledge databases; heterogeneous distributed computing, and other resources, as well as diverse, geographically dispersed teams. It has four major subelements; ultrafast computing concepts, high-capacity communications and networking, diverse team collaboration, and information and knowledge.

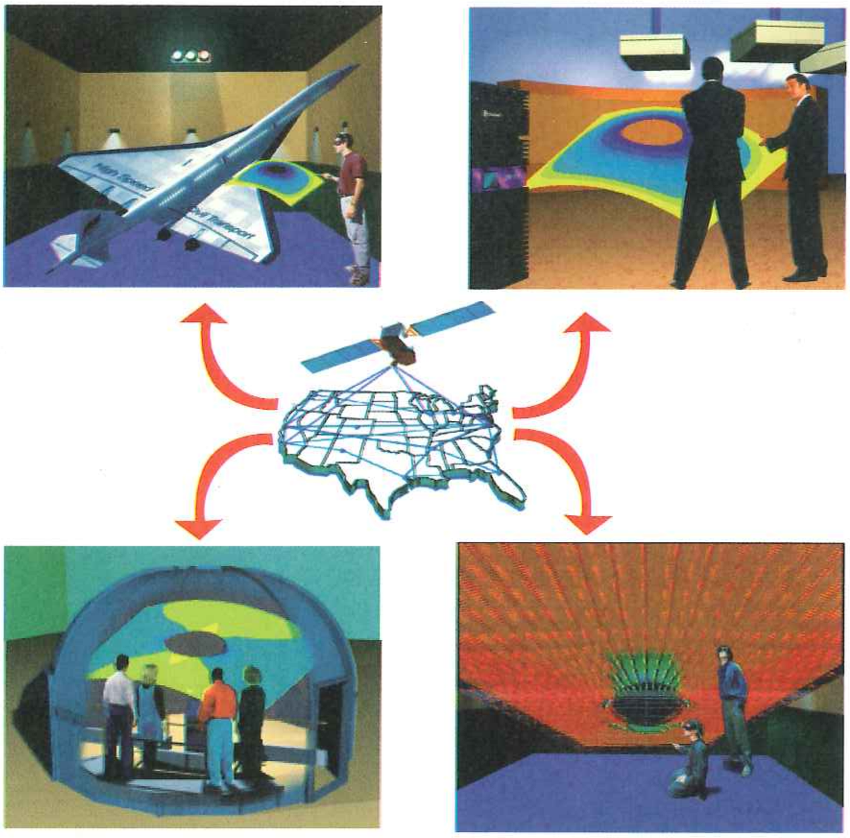


Figure 3
Hetrogemeans distributed virtual reality facilities used to study response of compositepanels

Ultrafast computers include the teraflop-scale computers such as those planned for Department of Energy labs. As for communications and networking, the next-generation Internet and Internet 2 should alleviate performance problems associated with constricted network bandwidth and provide rapid communication of the latest project data, a key requirement for reducing project cost and time. They will also enable high-quality real-time interaction between users in heterogeneous distributed virtual-reality facilities (Fig. 3).

One feature of diverse-team collaborative computing is the virtual collocation facility, based on the concept of immersive telepresence. Participants are able to interact fully, even exchanging objects and walking around each other, in three dimensions. No special glasses, wands or gloves are required. Raw data (small unstructured items) can be organized and refined into more efficient representations (Fig. 4).

Information, knowledge and intelligence are progressively smaller subsets of increasingly more organized data. Hierarchical software agents will generate information and knowledge from the large unstructured data sets. Rapid Synthesis and Simulation The next component of ISE is rapid synthesis and simulation tools. It comprises four subelements: traditional deterministic and nondeterministic simulation methods, non-traditional methods, life-cycle simulations, and design-synthesis methods. The life-cycle numerical simulation tools include high-fidelity rapid modelling facilities and multi-physics simulation tools (Fig. 5), e.g., structures, aerodynamics, controls, thermal management, power, propulsion, and optics. They also include tools for mission design, cost estimating, product assurance, safety analysis, risk management, virtual manufacturing and prototyping, testing for qualification, maintenance and operations, training, and life-cycle optimization. Special optimization tools are used for the entire life cycle of the aerospace system as well.

Many of the ISE tools are provided by commercial modelling and simulation systems, CAD/CAM/CAE suites, and by other codes developed under government-supported programs. Several features distinguish these tools from those of traditional design systems. One is the seamless integration of multiphysics analysis software into CAD/CAM/CAE systems to provide a complete mission-simulation and virtual-product-development facility. Parametric, variational, and feature-based solid modelling methods are combined to generate a single "smart" product model. This eliminates data transfers and interfaces, and allows detailed analyses from within the CAD system on the latest model throughout the design process. It can also reduce simulation time and the number of physical prototypes built.

Another feature that distinguishes ISE tools is the incorporation of Internet-enabling software, rapid-modelling facilities and object-oriented technology, particularly in the user interface and databases for CAD/CAM/CAE systems. The use of object-oriented technology enables a plug-and-play capability for model assembly.

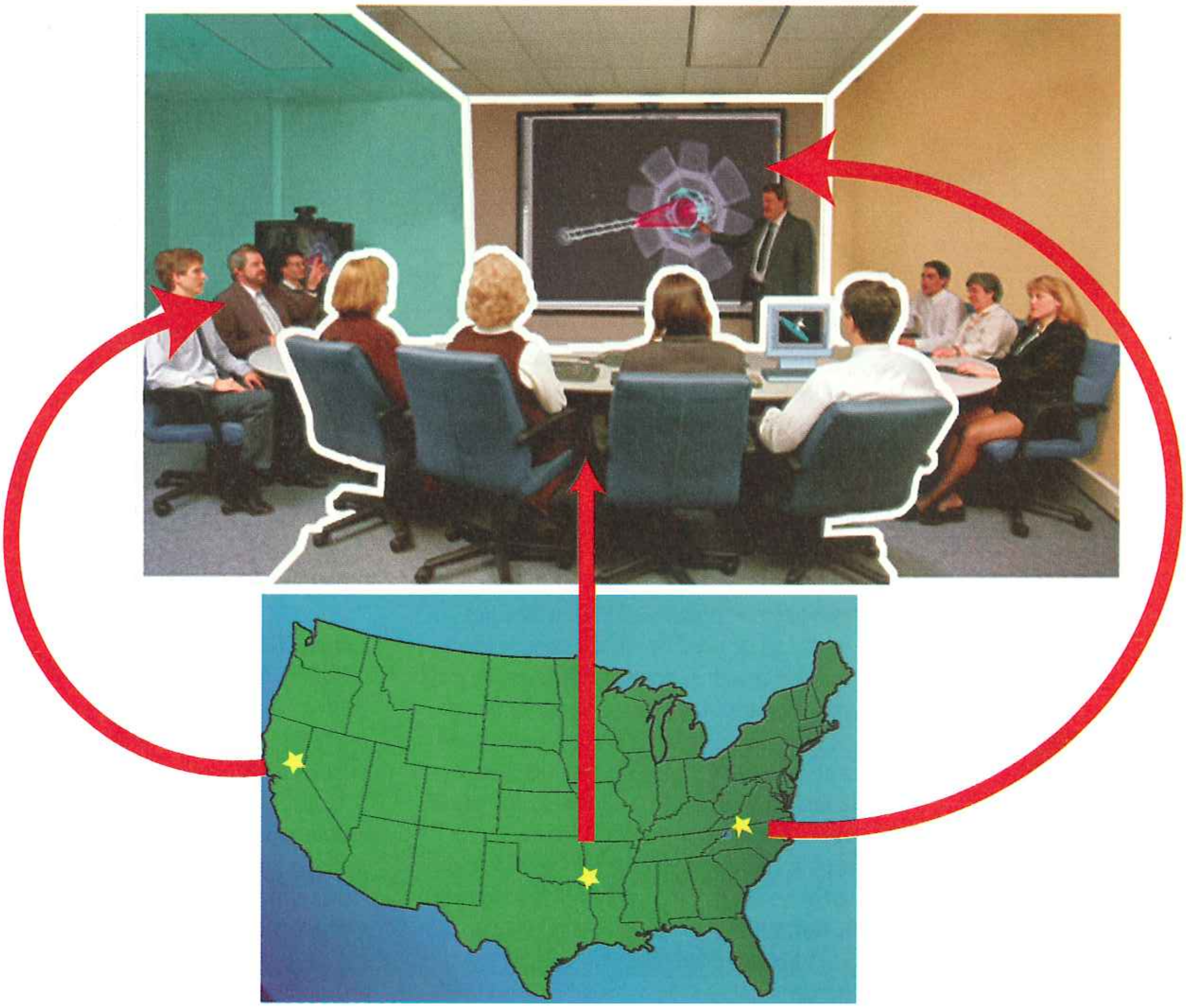
Plug refers to an object-oriented user interface for the rapid assembly of component models. While developing product models can be time-consuming, model generation via assembly and resizing of parts and components is relatively fast. Play refers to immediately available predictions of response, risk, cost and performance information.

Further distinguishing characteristics include seamless interfaces (translation) from the CAE system to the virtual environment, with mathematically correct visualization of the model, and the use of computational intelligence technology and associated soft computing tools to solve complex design problems with system uncertainties.

The principal constituents of soft computing are neuro-computing, fuzzy logic, and genetic algorithms. Soft computing tools exploit the tolerance for imprecision and uncertainty in real engineering systems to achieve tractability, robustness, and low solution cost.
The ISE tools incorporate facilities to assist the designer in selecting the appropriate computational model and analysis technique as well as design-synthesis languages for the rapid generation and modification of engineering specification for large product models. The use of these languages in conjunction with knowledge-based engineering methodologies can enable the detailed description of the different design and synthesis tasks from a high-level specification of the functional requirements.

"... enable the detailed description of the different design and synthesis tasks from a high-level specification ..."

Figure 4
Immervice telepresance (virtual collection of geographically dispersed teams).



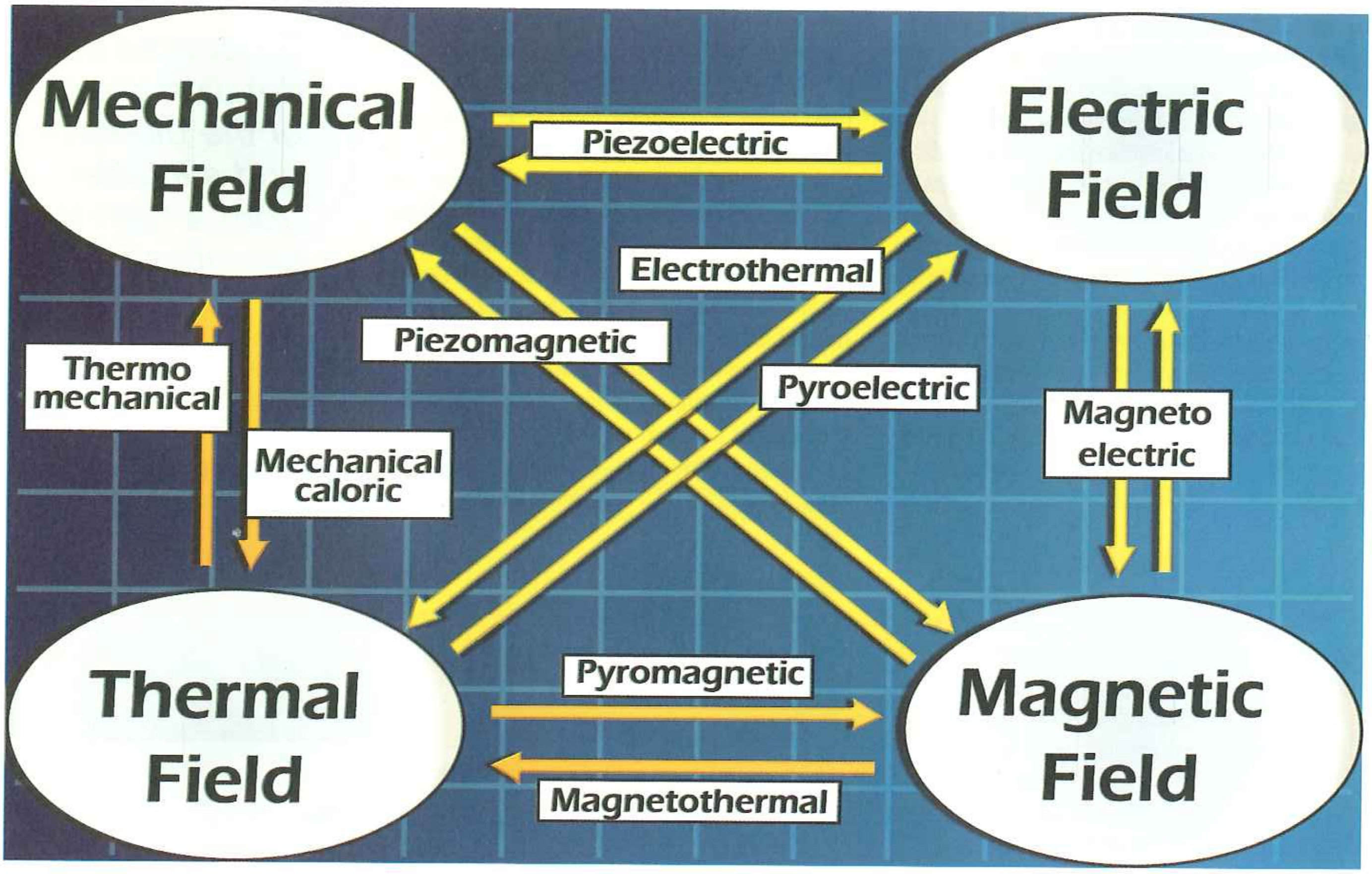


Figure 5
Couplings between mechanical, elastic,magnetic and thermal fields in smart materials

Life-Cycle Integration

The ISE component that covers life-cycle integration and validation has four subelements: engineering process assessment, integration methods, large-scale research and development applications, and large-scale project demonstrations. The last two involve development of a testbed environment to assess, validate and demonstrate the ISE concept and its components. The environment will be distributed, reconfigurable and accessible to geographically dispersed diverse teams. It will provide a showcase for demonstrating how state-of-the-art computational and communication facilities and tools can be used by engineering, science, and training teams to dramatically improve productivity, enhance creativity, and foster innovation at all levels of product and mission development. The tools include knowledge discovery in databases, knowledge sharing, and product-information management software. Simulating and testing all mission and life-cycle phases of an engineering system will be accomplished within the testbeds. Also, large-scope numerical simulations involving diverse geographically dispersed teams will be performed in the testbeds. The capabilities described for the testbed environment require globally accessible object-oriented multidatabase systems. These will initially be used to store simple objects such as drawings, but will later become repositories of information and applications such as intelligent agents. The salient components for semiautonomous agent-based integration of the tools and facilities include mediators, software agents, knowledge-based systems and design advisors, software architecture for design environments, and authoring tools and requirements tracking.

Future Directions

Advances in computer performance, human-centred systems, communication, and networking technologies will include teraflop- and petaflop-scale machines, mobile computing, optical and wireless communications, new modes of human-computer interaction, and the next-generation Internet and Internet 2. Such developments will occur alongside equally significant changes in the distributed heterogeneous immersive virtual environment, modelling and simulation facilities and CAD/CAM/CAE suites. All of these advances will enable rapid accommodation of new modelling techniques as well as dramatic improvements in the predictive simulation capabilities for complex engineering systems.

The ISE will create the overall framework that can radically change scientific research in the future. ISE goes beyond connectivity to achieve new levels of multimodal interactivity and seamless integration of diverse teams. It will significantly increase the creativity, knowledge, and cultural bandwidths among these teams. It will allow the modelling, simulation, analysis, visualization and understanding of complex phenomena involving massive volumes of data in real time.

It will reduce development times, lower life-cycle costs, and improve the quality and performance of future high-tech systems. In the next decade, simpler more-efficient modelling and simulation tools, including a design language, will likely be created. ISE will evolve into a shared, highly flexible, information-based, responsive simulation and synthesis environment with plug-and-play interoperability across dispersed and disparate organizations, including hardware and software facilities. It will expand the scope and quality of scientific research.

Realizing the full potential of ISE will entail educating and training computational engineering and science teams, not only in the component technologies but also in new approaches for collaborative distributed simulations. Researchers need to address a number of fundamental issues, including human factors, group and team dynamics, information security, and the cost and benefits of ISE facilities and tools in various categories of applications. Universities can work with industry, government labs, and professional societies in developing effective instructional and training facilities for the new research and synthesis approach. •

"It will expand the scope and quality of scientific research ..."

New Trends in Computational Geomechanics

by
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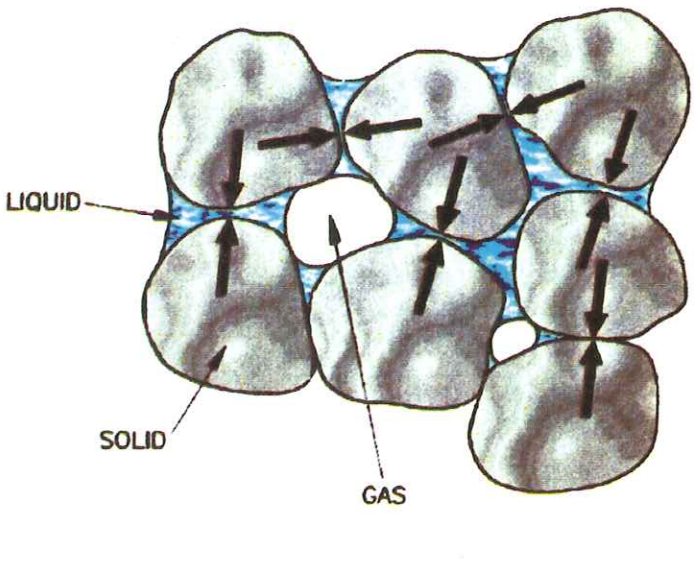
Department of Constructions and Transportations
University of Padua
Italy

Geomechanics covers a wide class of problems ranging from usual geotechnical aspects (foundations, embankments and dams, excavations and slope stability etc.) to underground openings, tunnelling and mining, to environmental engineering (landslides, contaminant transport and waste repository problems). Important both for economic reasons and consequences on anthropized areas is also reservoir engineering related to exploitation of underground resources (water, oil, gas). These problems may be static or steady-state or time dependent such as in presence of earthquakes or consolidation. In some problems attention is focused on interaction between soil and structures (non overlapping domains) in some others we are interested in the interaction between different fields, i.e. overlapping domains (mechanical, hydraulic and thermal), the overall behaviour resulting from the coupling of different actions. For instance to this class belong the problems related to nuclear waste disposal, soil liquefaction and clay barriers against contaminant migration.

Traditional geomechanics provides an answer to such questions allowing for practical prediction and engineering calculations by using simplifications of different kind (1-D models, continuity or homogeneity assumption for the soil, one phase systems etc.). Quite often the approximated results achievable in this way are sufficient for the applications, but in other occasions a more reliable prediction of the real behaviour is mandatory. As an example, a correct evaluation of the surface subsidence due to oil extraction and the ensuing environmental impact allows for a reasonable evaluation of costs and benefits, necessary requirement for a decision to be made. When full understanding of the observed phenomena or justification of simplified procedures are sought we need a more correct representation of the analysed material and its structure.

Reliable quantitative predictions can only be achieved by means of sophisticated computations, which not only require the simplifying assumptions to be abandoned, but also the theoretical model to be strongly improved.

Figure 1
Microscopic view of the soil



All geomaterials (soils, rocks, concrete etc.) can be classified as materials with an internal structure. They comprise a microscopically discontinuous solid phase which presents closed and open pores filled with one or more fluids (Fig. 1), i.e. they are multiphase systems. Fluids may be water, water vapour, dry air, pollutant, hydrocarbons and usually present a relative velocity to each other and to the solid. The overall mechanical behaviour and the macroscopic material properties depend on interactions between the constituents. Also the behaviour of one constituent (e.g. solid) may depend on forcing actions applied to another constituent (e.g. water or gas). The constituents are hence coupled from the mechanical, hydraulic, thermal and chemical point of view.

Owing to the great geometrical complexity and the variation in time of the domain of each component of the multiphase system, the possibility of analysis relies on substitution of the real structure by a continuous macroscopical model where all constituents are assumed to occupy the entire control space. The substitute continua may be treated via the methods of continuum mechanics.

For geomechanical problems where only water or water and air fill the pores, a phenomenological approach such as Biotís theory is still widely used with success. However, if phase change, nonisothermal behaviour, chemical interactions etc. have to be taken into account, mixture theories and especially hybrid mixture theories (or averaging theories) allow for a better insight into the problem, in particular as far as the different interaction terms are concerned.

In the problem areas listed in the beginning not only the solid behaviour is generally nonlinear, but also the constitutive relationships for the fluid involved (e.g. relative permeability, diffusivity, capillary pressure-saturation relationships etc.). The resulting governing equations are hence generally nonlinear, coupled systems of differential equations in time and numerical solution techniques are mandatory. This approach allows to develop efficient tools for quantitative predictions, which is the aim of the endeavours of computational geomechanics.

The initially mentioned problems and the related computational approaches have been of interest to research workers all over the world and the results are published in many Journals and Conference Proceedings. Two forthcoming textbooks [1, 2] present the state of the art of the development of numerical models to study phenomena generally related to heat and mass transfer in fully and partially saturated deforming porous media and the numerical solution of the resulting governing equations. Both static and dynamic aspects are analysed together with the necessary numerical algorithms.

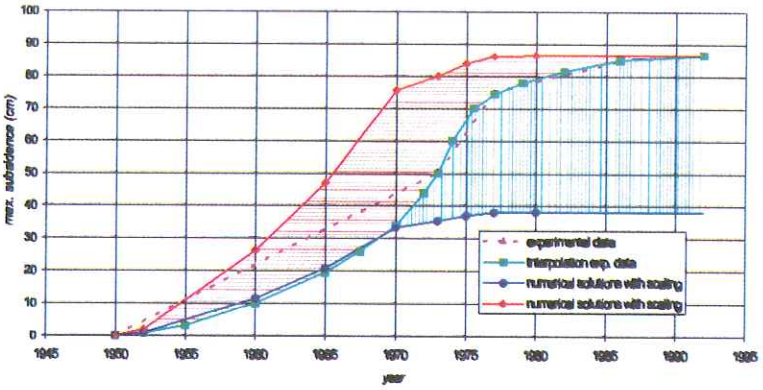


Figure 2
Comparison of real subsidence history and numerical forecasts

The following cases have been chosen from the two textbooks to show the complexity of the problems which can be solved in computational geomechanics. The first test case deals with the problem of surface subsidence due to exploitation of gas reservoirs. This effect has been observed in many parts of the world and prediction of expected displacements is particularly important when the areas involved are low-lying and close to the coasts or in the surroundings of built-up zones. Traditional numerical models fail to represent the recorded displacement history in particular after depletion of the wells. When assuming linear soil models they yield displacement recovery as soon as reservoir pressure increases. This recovery is not obtained when using traditional elastoplastic models, but the real behaviour is often characterised by an ongoing subsidence when pumping is stopped. Only by introducing a new plasticity model which accounts for the effect of capillary pressure is it possible to modify accordingly the numerical response, especially after shutdown and account for the ongoing subsidence observed. Fig. 2 shows for a real case in the north of Italy,

"... with the effect of capillary pressure it is possible to modify accordingly the numerical response..."

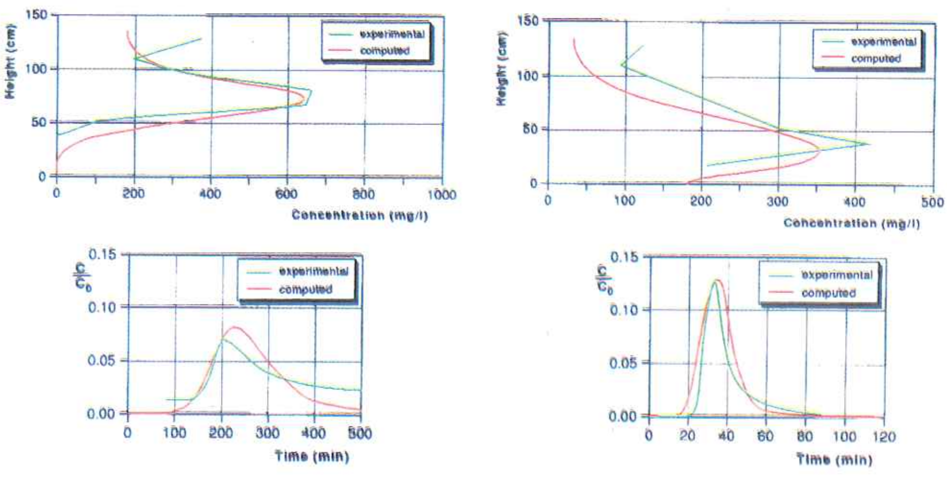
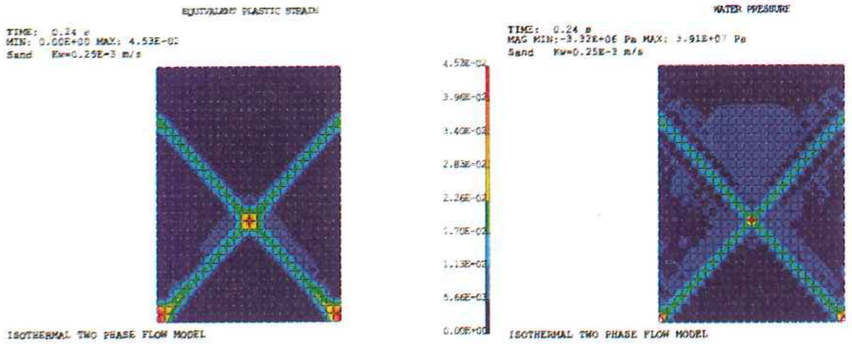


Figure 3
Concentration profiles and breakthrough curves

the inability of elastic models to represent the observed history: if parameters are assumed, such as to obtain the final displacement (by assuming fully saturated conditions), the time history is anticipated, if measured displacements are used to calibrate the forecasts, the effect of structural collapse is overlooked and subsidence is underestimated.

Figure 4
Dynamic sheer band localisation

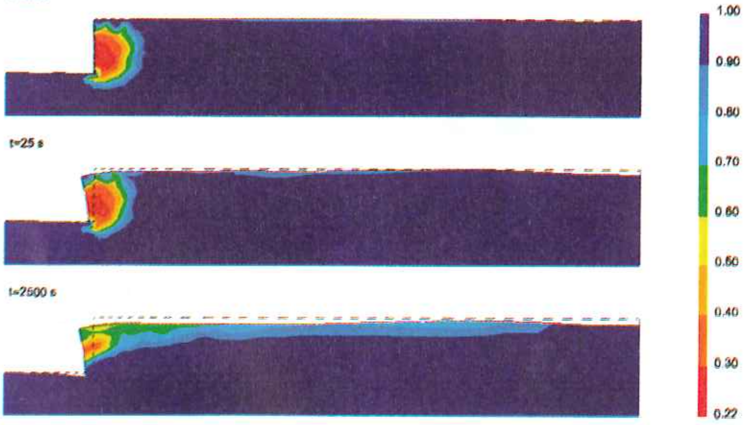


Numerical models can be applied to forecast the fate of pollutant in subsurface water systems. Contamination of subsurface water is a complex phenomenon in which infiltration, evaporation, multiphase mass transfer, groundwater recharge, soil moisture storage and deformation are involved. All these effects may be influenced by temperature fields. Due to the complexity of the problem, a crucial aspect is represented by the availability of benchmark tests for the computer codes. Laboratory experiments have been performed on a vertical sand column where water flow is driven by gravity. In different hydraulic conditions, measures of pollutant concentration at different height and breakthrough at the bottom have been recorded. Fig. 3 presents the comparison of a laboratory experiment in terms of pollutant concentration and breakthrough and the results obtained by using a numerical model. As can be seen, a good agreement has been obtained.

As a third example we consider shear bands which are areas of intense straining in well defined narrow zones of a solid. These bands may arise both in laboratory experiments and field situations when frictional properties of the material are more critical than cohesive ones. Such phenomena also take place in fully and partially saturated porous media. In these bands the material is inelastic, whereas outside it is elastic with infinitesimal strains. The triggering mechanism for the formation of shear bands are nonhomogeneities or stress concentrations. These may be obtained by interaction of incoming and reflected waves and thus localisation may be initiated. Shear bands may be important in pollutant transfer, because they represent preferential escape ways. In any case, this phenomenon is a precursor of failure. For soils the experimental results show the importance of the fluids phases during strain localisation of undrained water saturated dense sands. The use of a multiphase material model is hence necessary. Fig. 4 presents the numerically obtained results for a geological formation of water saturated dense sand. The isolines for equivalent plastic strain and pore water pressure are depicted where a typical shear bands can be observed.

The last case deals with an elastoplastic large strain analysis of a vertical slope subjected to gravitational load during the first 25 sec of El-Centro N-S component of horizontal acceleration and during the following consolidation phase. Static air phase conditions are assumed. Figure 5 shows the saturation distributions over the corresponding deformed configurations in the area close to the slope at different times. •

Figure 5
Saturation contours near a vertical slope during and after an earthquake



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THE INSTITUTION OF CIVIL ENGINEERS

Numerical Methods in Engineering

The Zienkiewicz Silver Medal and Prize

Terms of Reference

The Zienkiewicz Prize was instituted in 1998 following a donation by John Wiley & Sons Ltd to commemorate the work of Professor Olgierd Cecil Zienkiewicz CBE DSc FRS FEng, of the Institute for Numerical Methods in Engineering, University of Wales, Swansea. The prize of £1,000 and a silver medal is awarded biennially to a post-graduate researcher under the age of 35 for the paper selected from those submitted to the Judging Panel which contributes most to research in the field of Numerical Methods in Engineering.

Papers to be Judged

Papers to be considered shall be written in English and shall either be in a form suitable for publication or already have been published in the International Journal of Numerical Methods in Engineering or in the ICE Proceedings. In the case of multiple authorship, the part contributed by the competitor shall be clearly indicated and the submission must be certified by the competitor's supervisor or head of department.

The Judging Panel

The Judging Panel of three will be chaired by Professor Zienkiewicz or someone nominated by him and will comprise one representative nominated by J Wiley & Sons Ltd and another nominated by the Institution of Civil Engineers.

Papers to be submitted to the Competition

Papers should be submitted to the Institution of Civil Engineers no later than **31 July 1998** for consideration by the Judging Panel during July/August 1998.

Papers should be addressed to:

The Awards Section (Zienkiewicz Prize)
The Institution of Civil Engineers
One Great George Street
Westminster
London SW1P 3AA

Presentation of the Award

The winner will be notified by the Institution during August and the prize, comprising a cheque for £1,000, a medal and certificate, will be presented jointly by Professor Zienkiewicz and the President of the Institution at the Institution's Awards Ceremony on 3rd November 1998.

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A historical overview of the development of computational mechanics in Portugal during the sixties and seventies

by
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IDMEC - Instituto de Engenharia Mecanic
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Tracing the research on computational methods, in Portugal, back to its beginnings, it is fair to recognise that Júlio Ferry Borges was its first promoter. Having understood very early, (by the late fifties), the importance of the contribution that computers could give to the development of engineering and science, he successfully promoted their use in his institution, the National Laboratory of Civil Engineering (LNEC), the huge Portuguese public research establishment in the area of civil engineering.

I joined LNEC in 1960 where I assisted Ferry Borges in the development of the method he had conceived [1] for the analysis of the suspension bridge aimed to span the Tagus River in Lisbon which was then being designed by an American firm. The method was enthusiastically adopted by the designers.

In 1962, a NATO ASI was held at LNEC followed by an international symposium on the Use of Computers in Civil Engineering [2] which gathered a large number of participants and was one of the first major scientific events in the field.

A second NATO ASI organised by Ferry Borges was held in 1971, also at LNEC, on Finite Elements in Continuum Mechanics, whose lectures would later be edited by J. T. Oden and myself [3].

"... new computational methods were necessary to take full benefit of the new tool."

One of the grate merits of Ferry Borges' pioneer work was understanding that computers should not merely be used as calculating machines to execute fast and more or less automaticly the computing routines, which before used to be performed by hand. Such routines had indeed become obsolete and new computational methods were necessary to take full benefit of the new tools. In addition, more adequate mathematical models had to be established where equations could now be solved by using such tools: an encouragement for research in Mechanics. Such was the basis of a entirely new research program at LNEC - an institution which had been made famous for its expertise in the use of physical models - a program which would leave it's mark in the history of computational methods in the country.

Working under Ferry Borges, the Head of Structural Engineering, I was invited to collaborate in the program and was in charge of the more theoretically oriented part of it.

My first contribution was a method for plane stress/strain analysis of elastic bodies which was the subject of a thesis submitted to LNEC in 1965. This method may well represent the first instance of the techniques which, 10 to 15 years later, would become popular under the name of boundary element methods. The fact that such contribution was practically overlooked when published [4], and only much later happened to be quoted as a pioneer work, may be explained by the understandable succeed of the finite element methods (f.e.m.).

We were interested of course in the f.e.m. and I myself became particularly interested in its mathematical formulation, including convergence criteria and error estimates. These researches led to the publication in 1968 of an article on the Theoretical Foundations of the Finite Element Method [5] in which I resorted to Functional Analysis to present the method in a rigorous and very general frame. It was in such article that general completeness criteria for two-dimensional plane elasticity elements were first stated and demonstrated.

Well-known difficulties associated with the convergence of the f.e.m. in case of non-conforming plate elements, led to the investigation of tests and criteria capable of replacing conformity, together with completeness, as a convergence criterion. The last research devoted to such subject, aimed to a justification of Irons' patch test, was published in 1976 [6].

The estimation of the order of the discretization error in the finite difference method was the subject of another article [7] published, after years of persistent researches. The assessment of the effectiveness of different finite difference approximations was made possible, not as it had been done before, by evaluating the order of the truncation errors associated to such approximations but, as it was being done for finite elements, by determining the upper bound of the discretization error.

Use was made of the error analysis techniques developed for structural problems to the f.e.m. solution of the navier-Stokes equation, in a paper [8] published in 1975.

The subject of the optimal decomposition of a body into a finite elements became important in the beginning of the seventies. The computational effort associated to the initially used technique, which consisted in minimising the functional with respect to the node co-ordinates, was the reason which made us start to look for optimally topological criteria for finite element networks. In 1971, the so-called *isoenergetic criterion* was found [9] which was numerically confirmed at the University of Waterloo, in Canada, and deserved to be carefully studied by
outstanding numerical analysts. Later, the subject lost interest to adaptive approaches. An important conference on Accuracy Estimates and Adaptive Refinements in Finite Element Computations/ARFEC was proposed by Jorge Gago [10] and held at LNEC in a 1984.

A large part of our interest in convergence was due to the perception of the role that this concept should play in a true Theory of Structures. In such theory, convergence could become indeed a justification, not only for the finite element method, which leads to a discrete model, but for the continuous two-dimensional and one-dimensional models, i. e., the theory of shells and the theory of rods. Such idea of the Theory of Structures represented a contribution, not just for Numerical Analysis, but for Solid Mechanics, within which the Theory of Structures was aimed to represent a new and well-characterised scheme. These ideas were the basis of the thesis [11] I submitted in 1996 for becoming a full professor at the School of Engineering/IST of the Technical University of Lisbon.

"... convergence could become a justification, ..."

Figure 1
Participants in the "Symposium on the Use of Computers in Civil Engineering" Lisbon 1962

The fecundity of such concept was demonstrated by solving a classical problem of Solid Mechanics, the Justification of the theory of shells, which had so far been treated as a problem of an exclusively mathematical nature. The situation is not entirely analogous to the one which arises in the finite element theory, since the aim is not proving that a sequence of approximate solutions tends to the exact solution but that a sequence of exact solutions provided by the theory of shells, i. e., to the approximate solution, as the shell becomes thinner and thinner. The assumption must be made that the values of the membrane and bending stiffness coefficients keep their values as the thickness tends to zero, condition that can be satisfied only if the shell is a Cosserat's shell [12].

"... question the excellence of the finite element paradigm ..."

One of the fields in which LNEC was more active was dams engineering. Although LNEC was outstanding in scaled models techniques, the institution realised, during the sixties, that, at least in Structural Engineering, the future belonged to mathematical models and, therefore to computational methods. Modelling dam-foundation systems resorting to finite elements therefore soon became a challenge to LNEC. The first paper on concrete arch-dams modelling using three-dimensional elements [13] was Oliveira Pedro's thesis, finished in 1967.

During the seventies, the department resorted to three- and four-sided thin and thick shell elements, first flat and then curved, for modelling dams and other kinds of structures, as well as joint elements Three-dimensional elements were specially developed for foundation rock masses. On the other hand, the dam-foundation system was realistically analysed by taking into account the construction sequence. Comparisons were made between the results obtained by scaled models and computational methods [14, 15].

The monitorisation of construction works, one of the fields in which LNEC excelled, due to Manuel Rocha's pioneer ideas, was a source of inspiration for the development of structural modelling, as well as the development occurred in Rock Mechanics, another field mastered by Rocha. The elasto-plastic, visco-elasto-plastic, isotropic considered in the study of typical scenarios under either static or dynamic actions. Also actions were modelled, even those of an exceptional nature, like seismic actions.

It would be fully realised later [16], already in the eighties, that progress in structural engineering did not depend anymore on the development of new kinds of finite elements but on the use of those already existing for simulating collapse scenarios. For these scenarios, prototype and scaled models had been the main source of information, at least from a qualitative point of view. The use of computational methods in such studies could not help to seduce an institution that was at the frontier of structural safety theory, in which Ferry Borges himself had been a pioneer. Ironically enough, it was by that time that a new method, the distinct element method, was being developed which would question the excellence of the finite element paradigm as a discretization technique.

In what concerns geotechnical engineering, the first LNEC research project on the analysis of earth dams was lunched in 1969 at the Geotechniques Department [17]. In 1973, rock masses were already being analysed. In 1975, the numerical simulation, by finite element techniques, of the collapse of a concrete dam due to a fracture of its foundation was achieved and, by the end of the decade, hydraulic models had been developed for the study of the water percolation in the dam rock foundation.

Researches on computational methods attempted in the Hydraulics Department would have a remarkable development at LNEC, but only in the eighties, i. e., already after the period the present paper was intended to cover.

In the early seventies, LNEC established contacts with the International Union of Theoretical and Applied Mechanics / IUTAM in order to promote the adhesion of the country to that organisation. As a result of such contacts, the representation of the country was temporarily entrusted to LNEC and LNEC engaged formally in forming a national body which would become the link between the Portuguese Mechanics community and IUTAM. Such a body, the Portuguese National Committee for Theoretical and Applied Mechanics, was formed in 1972. I, already professor at the IST, was elected as its president. The two Bice Presidents Ribeiro Gomes and Alvares Ribeiro were professors at the Universities of Coimbra and Oporto respectively, and Tovar de Lemos, another IST professor, was made secretary-general.

The fact that the four active members of the Committee were affiliated to universities located in the three main scientific centres of the country clearly showed that LNEC was interested in helping the development of Mechanics outside its walls. After 25 years, it became possible to recognise that such a strategy was right. For many reasons, most of which have to do with the development of research in Portuguese universities, most of the activity in Mechanics and Computational Mechanics now takes place indeed in the university departments.

The Portuguese National Committee for Mechanics organised four national congresses for Theoretical and Applied Mechanics which took place at LNEC in 1974 and 1983 and in Coimbra in 1979 and 1987. Such national congresses were intended to promote the national participation in the International Congresses which would follow.

Meanwhile, the International Association for Computational Methods (IACM) was founded an a parallel series of 4 national conferences on Computational Mechanics were organised by the Portuguese Computational Mechanics community. A discussion was then inniated by the National Committee for Mechanics on its own future which led to the constitution in 1995 of the Portuguese Association for Theoretical, Applied and Computational Mechanics. The national conference, which took place last October 1997 in Guimaraes, was already a joint conference, the 5th of both series. •

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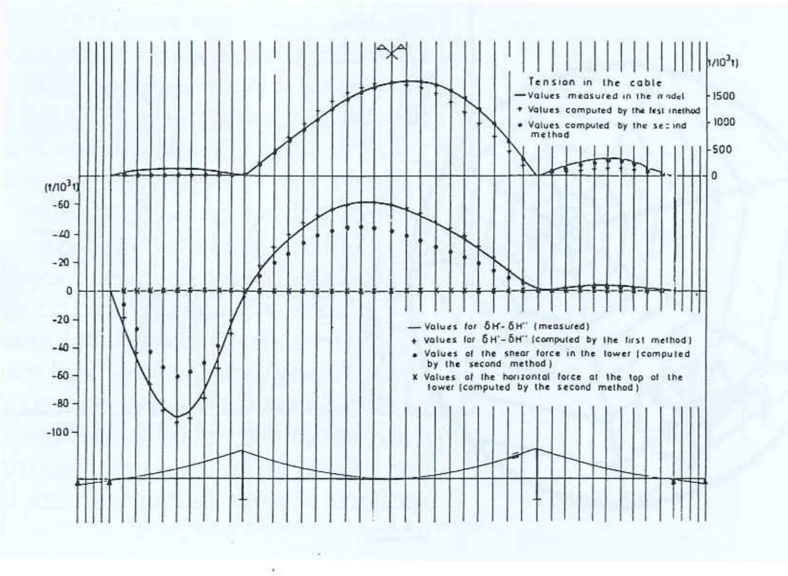
Figure 2
Suspension bridge over the Tagus River
Influence lines obtained for increments due to live loads



Casting the Net

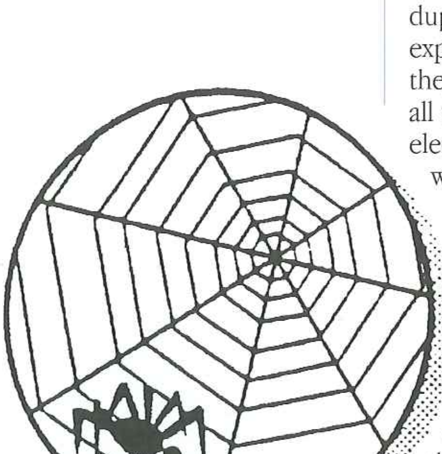
The origins of the Internet, like the messages it carries, are diffuse and fragmentary. But one fall day in 1969 all the pieces came together.

Extracts from
Where Wizards Stay Up Late
K. Hafner & M. Lyon
Published by Simon & Schuster

When Robert Taylor joined the federal governmentís Advanced Research Projects Agency (ARPA) in 1965, this divisionís suite in the Pentagon included a small terminal room. There, side by side, sat three computer terminal, each of a different make, each connected to its own mainframe computer. Each mainframe, in turn, had its own operating system and programming language. ARPA was at the leading edge of computer research, but the terminals were irksome to use. Having three computers was like using three television sets, each dedicated to a different channel. "It became obvious", Taylor said years later, "that we ought to find a way to connect all these different machines".

Established in 1958 as a response to the technological challenges posed by Sputnik, ARPA was generous with its money during Taylor's time. Come up with a good idea for a research program, some program directors joked, and you'll get funding for it in about thirty minutes. In 1966, when Taylor was promoted to head of his division, he decided to take the joke at face value. He headed straight to the office of ARPA director. No memos. No schedules meeting.

Each new ARPA investigator seemed to want his own computer, Taylor told Herzfeld. A great deal of work was being duplicated, and it was getting damned expensive. Computers weren't small and they weren't cheap. Why not try tying them all together? If machines were linked electronically, investigators doing similar work in different parts of the country could share resources and results more easily. (It was an idea inspired by J.C.R. Licklider, the renowned psychoacoustician turned computer scientist at the Massachusetts Institute of Technology, whose grand vision of an "intergalactic network" had sparked a revolution in computer engineering that was carried out by Taylor's generation.) ARPA, Taylor suggested, could fund a small test network, starting with, say, four nodes.



"Is it going to be hard to do", Herzfeld asked. "Oh no. We already know how to do it", Taylor responded with characteristics boldness. "Great idea" Herzfeld said. "Get it going. You've got a million dollars more in your budget right now. Go". When Taylor left Herzfeld office, he glanced at his watch. "Jesus Christ", he said to himself softly. "That only took twenty minutes".

Every culture has its creation myths, and cyberculture clings dearly to its own. Taylor's request truly launched the experiment that spawned the internet, yet few people know of it. Instead, a very different story has been passed from hacker to hacker as the Internt has sprawled across popular culture: in the beginning the Internet was a military invention; its original channels were built to keep critical information flowing in the event of a nuclear attack.

Like most myths, that one is a fiction rooted in fact, initiated in the 1960s, before Paul Baran wrote a series of papers that brilliantly foretold the structure of the Internet. A short while later, a physicist named Donald Watts Davies at the British National Physical Laboratory independently came up with many of the same ideas. All told, dozens of people helped invent the Internet, improving on the central concept, now known as packet switching. And for Baran, at least, the concept was born of cold war fears.

In 1959, when Baran was hired by the Rand Corporations in Santa Monica, California, The Americans and the Soviets were building arsenals of nuclear missiles set on a hair trigger. Baran knew that the nation's long-distance communications network could not withstand a nuclear attack. Yet for the president to order a nuclear strike - or to call one off - he would need to use at least some of that network. Designing a robust system was not simply an intellectual challenge; it was a necessary response, as Baran put it, to "the most dangerous situation that ever existed".

Baran just dived deeper in to his work. They key to more robust networks, he believed, lay in redundancy. Looking well beyond mainstream computing, to the future of digital technologies and the symbiosis between people and machines, Baran chose the human brain as his model. When brain cells are damaged, he realised, neural net works sometimes simply bypass them, taking new pathways through the brain. Theoretically it was possible to set up a network with numerous redundant connections. But there was one problem. Analogue signals deteriorate each time they are sent across more than one link like video recordings copied across several generations. For that reason, it was pointless to connect any two points in the telephone system via more than five intermediate connection points.

The solution, Baran thought, lay in computers. Digital signals could be stored efficiently and replicated an unlimited number of times with almost perfect accuracy. If computers could be taught to speak to one another, a redundant network might be created on that, in a modest way, resembled the astonishingly complicated linkages among neurones in the brain. Best of all, computers of fered speed. Almost any digital switching technology, it was thought, could beat the twenty or thirty seconds mechanical telephone switches needed in order to establish a long-distance connection.

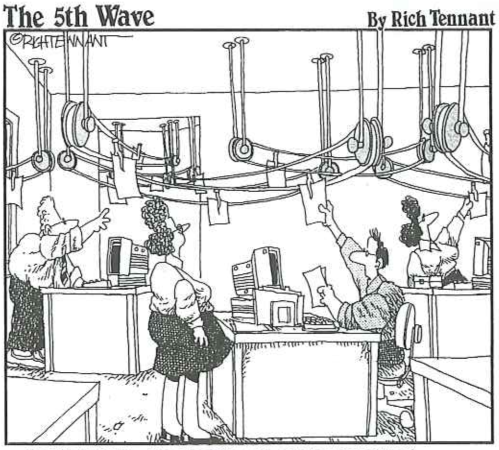
The layout for Baran's theoretical network was a simple as it was dramatically new. Telephone networks have always had central switching points. In the most vulnerable networks, all paths lead to a single nerve centre. In decentralised networks such as the ones in use today with long-distance telephone systems, links are clustered around several nerve centres interconnected by a few long lines. Baran came up with a third kind of design, which he called a distributed network. He imagined a network of many nodes, each redundantly connected to its neighbour, in a lattice reminiscent of a fish net.

Baran's second big idea was a still more revolutionary: fracture the message too. By dividing each message into parts, one could flood the network with what he called message blocks (or 'packets', as Donald Davies later called them), all racing over different paths to their destinations. Upon their arrival, a receiving computer would reassemble the packets into readable form.

Conceptually, Baran's and Davie's approach seemed to borrow more from freight movers that from communications experts. Imagine that each message is a large house. How best to move from, say, Boston to Los Angeles ? Theoretically, one could move the whole structure in a single piece. House movers do that over shorter distances all the times - slowly and carefully. It is more efficient, however, to disassemble the house if possible, load the pieces onto trucks and drive them over the nation's interstate highway system - another kind of distributed network. Not every truck will take the same route; some drivers might go through Nashville. If the driver coming out of Nashville learns that the road is bad around Oklahoma City, he might go through Kansas City instead. But as long as each driver know where to deliver his load, all the pieces should quickly arrive at the destination. Once there, they can be reassembled in their original order.

That innovation, in a communication network, helped solve a number of problems at once. At the time, all such networks were circuit switched, which meant that a line was reserved for one call at time. A call between two teenage girls, for instance, would tie up a telephone line for as long as they commiserated over boyfriends - even during pauses in the conversation. That made a lot of sense, given the most people keep up a fairly steady flow of talk during a phone call.

"No one wanted to relinquish valuable computing cycles to a network of dubious value."

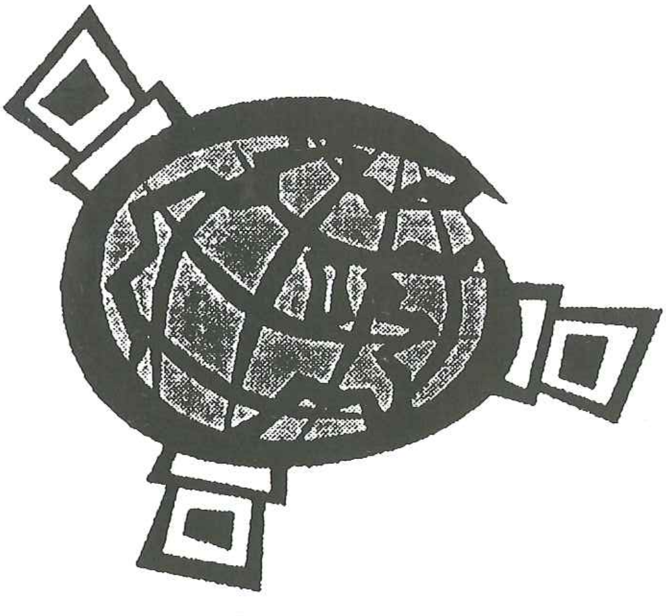


"IT'S JUST UNTIL WE GET BACK UP ON THE INTERNET."

"...you've got it inside out ..."

But data are different from conversation. They usually pour out in short bursts followed by empty pauses that leave the channel idle much of the time. It would cut costs dramatically if packets from different messages could share a line.

Baran envisaged a network of unmanned switches or nodes, each incorporating a routing table. That table would indicate the best routes for packets to take, constantly updating them on traffic and mechanical conditions around neighbouring nodes - much as human dispatchers warn truck drivers over CB radios about obstacles on the roads. If the best path were busy - or blown to bits - the message packet would automatically take the next-best path.



For five years Baran wrote out his ideas and lobbied various organisations. Finally in 1967, two years after he moved on to other projects at Rand, Baran was drawn into a circle of experts gathered by a deep-thinking young engineer named Lawrence G. Roberts. Although Roberts had no real interest in nuclear-war scenarios, he was intrigued with Baran's insights. He was convinced that everything worth doing inside a computer had already been done; the future lay in communications between computers. Now Roberts, the man Taylor had recruited to create the first network for ARPA, had a chance to test his conviction.

At twenty-nine, Roberts had done more in the field of computing than others achieve in a lifetime. Inter- connecting a matrix of incompatible machines, Roberts realised, would require calling on every expert he knew in every area of computing and communications.

Early in 1967 Roberts laid out his initial plan at a meeting for ARPA's principal investigators in An Arbor, Michigan. The idea, he told them, was to interconnect all the big nodes directly, over dial-up telephone lines. The networking functions would be handled by host computers at each site. The hosts, in other words, would do double duty, as research computers and as communications routers. The idea was greeted with little enthusiasm. No one wanted to relinquish valuable computing cycles to a network of dubious value.

Just before the meeting ended, Wesley Clark, a computer scientist at Washington University in Saint Louis, passed a note up to Roberts. "You've got the network inside out", it said. On the way back to the airport, sharing a car ride with Robert and others, Clark sketched out his idea: leave the host computers out of it as much as possible. Instead, insert a small computer between each host computer and the network of transmission lines to handle the message routing. (Donald Davies had independently come up with much the same solution and was already fleshing out the functions of an interface computer in England.) Those helpful little computers would come to be known as IMPs, short for instance message processors.

Clark's suggestion solved several problems: it placed far fewer demands on the host computers and on the people in charge of them. The smaller routing computers that made up the inner network all could speak the same language. Each host computer would have to learn only the language of the routing subnetwork.

With Clark's suggestion, the rest of Robert's design quickly fell into place. It would be engineered according to a few basic principles and specifications. First, the subnet's essential task would be to transfer bits reliably from one location to another. Next, the average transit time through the subnet was to be less than half a second. Third, the subnet would have to be able to continue operating whether or not the host or other individual IMPs were running.

In Cambridge, Massachusetts, the firm of Bolt Beranek and Newman spent most of 1969 designing and building the first IMPs. The IMP Guys, as the firm's hardware designers and programmers called themselves, took on a panoply of crucial problems, with amazing results. They invented the algorithms that would pull packets into one IMP, figure out the best place to send them and push them out to the next IMP down the line. They discovered ways of processing packets ten times as fast as Roberts had required, and they wrote computer code so concise and elegant it was a kind of poetry.

The one responsibility the IMP Guys did not have was figuring out how to get the host computers to understand one another. The IMPs, being go-betweens, had been designed to read only the first thirty-two bits of each packet - the part specifying its source, its destination and its location in the file into which it would eventually be reassembled. The contents of the packet were left for the host computers to translate. To enable translation, research teams at the host sites had to design communication protocols in advance. It was among the hardest jobs in creating the network, and the teams had little more than a year in which to do it.

Roberts had chosen four sites to start the ARPA network: the University of California, Los Angeles; the Stanford Research Institute (SRI) in Menlo Park, California; the University of Utah in Salt Lake City and the University of California, Santa Barbara. In the summer of 1968, more than a year before the first IMP was scheduled for installation at UCLA, a few graduate students from each site (the Network Working Group or NWG) met in Santa Barbara to talk over their task. "We found ourselves imagining all kind of possibilities interactive graphics, co-operating processes, automatic data base query, electronic mail", one attendee says, "but no one knew where to begin".

A computer, Circa 1968, was an extremely egocentric device. Like a monarch surrounded by its subjects, it spent its time telling other devices what to do. The NWG's goal was to get the mainframes to talk as peers, or at least to acknowledge one another's existence.

On October 1, 1969, a month after the first IMP was installed at UCLA, picked up a telephone headset in Los Angeles and pressed a button that rang a bell on the IMI - in Menlo Park. One of the group members at SR1 answered it, and the two began the connection. Nearly ten years after computer networking had first been envisaged, two computers were at least on the verge of talking to each other.

But it was only the beginning. Within a year, four IMPs had been installed and the NWG, under pressure from Roberts, had finally devised a workable host-to host protocol. The network that had begun as a high-risk experiment was well on the way to becoming a reality. The hardware worked; the software worked. Above all, the concept that had been dismissed as impossible, a technology on which the entire enterprise turned-packet switching proved splendidly reliable. Computers networks, the most revolutionary two way communications tool since the invention of the telephone, were born.

"Technological development is like building a Cathedral", Baran remarked in retrospect. "Over the course of several hundred years, new people come along and each lays down a block on top of the old foundations. If you are not careful, you can con yourself into believing that you did the most important part. But the reality in that each contribution has to follow onto previous work. Everything is tied to everything else". •

"Technology development is like building a Cathedral ..."

Reeling in the Years

Thanks in part to yesterday's inventions, new technologies are reaching a quarter of the U.S. population faster than ever.

Date	*Invention*	*Years till mass use*
1873	**Electricity**	**46**
1876	**Telephone**	**35**
1886	**Gas Automobile**	**55**
1906	**Radio**	**22**
1926	**Television**	**26**
1953	**Microwave Oven**	**30**
1975	**PC**	**16**
1983	**Mobile Phone**	**13**
1991	**The Web**	**7**

Source: National Centre for Policy Analysis

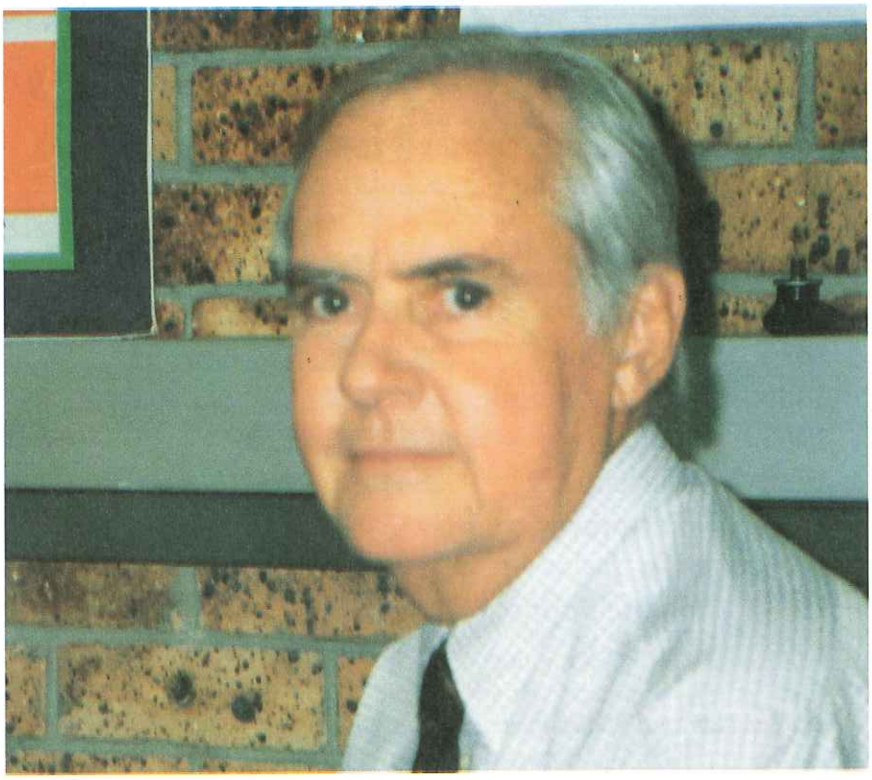
The Winds of Change

an interview with John B. Martin

As the first president of SAAM (South African Association for Theoretical and Applied Mechanics), what were your main objectives for this young society?
Mechanics has slowly become more established in South Africa, with the formation of a number of groups in solid or fluid mechanics at various universities and research institutions. It was appropriate, therefore, to set up a national organization for theoretical and applied mechanics to coordinate activity, enhance interactions and to promote mechanics. In addition, South Africa was not a member of IUTAM, and it was not appropriate to apply for membership before our democratic elections in 1994. The creation of SAAM has now led to our membership of IUTAM as well as IACM.

Within your previous role at UCT you also foresaw the need to set up a research institution within the university. How successful has this been to date?
I have worked on building of research capacity in mechanics at UCT since I returned to South Africa in 1973. Departmental boundaries were fairly strong at that time, and in order to extend beyond Civil Engineering, where I was initially appointed, it was helpful to establish an interdisciplinary unit which also incorporated Mechanical Engineering and Applied Mathematics. The unit has grown steadily since 1984, and has gone through various name changes in the process. It has been successful, I think, in terms of research output and research students who have completed degrees. Although the system has been discontinued, the Foundation for Research Development (the local equivalent of the NSF) recognized units and centres on the basis of external international reviews; CERECAM was one of only two centres in South Africa recognized in this way.

Prof. John Martin



As Deputy Vice Chancellor of UCT, and taking into account the very difficult and changing times in South Africa, your administrative position must be very challenging.
It is very challenging, but it is also very exciting. UCT is truly undergoing a transformation, and there are opportunities to reform the fabric of the institution to an extent which may never be possible again. There is a very real sense that as a society South Africans are breaking new ground, and involvement in this process is very stimulating and fulfiling.

How has the physical nature of your staff and students changed?
A major concern in higher education in South Africa is access and redress for people who were significantly disadvantaged under the previous dispensation. This is also linked to a strong movement to remove gender imbalances. The student body at UCT began to change in about 1984, when restrictions on the registration of black students started to fall away. In engineering, for example, the freshman class has changed from about 10% black in 1984 to 65% black in 1998. In 1997, more than half the engineering graduates were black.

Changing the academic staff is a much slower process. The implementation of UCTís employment equity policy is one of my responsibilities, and we have instituted a number of measures to assist potential black or female academics to develop to a point where they can compete on equal terms for posts on the UCT staff.

What steps have you taken to try and keep white male graduates in South Africa?

Over the next few years, during this period of transition, it is likely that white males with new PhDs will find the job market tighter than it has been in the past. It is a concern that we risk losing many of these well trained people through emigration, and, in order to provide alternative avenues, UCT has instituted an on-campus science park which will provide entrepreneurial opportunities to young scientists and engineers. Small start-up companies can operate in association with the university, renting equipment and space. We hope that this will lead to the creation of jobs, with the expectation that the small companies will spin off as they grow and become successful.

I have heard you use the term 'redress'. Could you explain this concept?

Redress is used generally to describe policies which are intended to address the deprivation and denial of opportunity which were imposed on many people in South Africaís past. It covers such things as the distribution of resources for education and health care, but also the mindsets which dominated decisions in the pre 1994 era. The best description is probably the Afrikaans phrase 'regstellende aksie', which translates as 'corrective action'.

Through all these cultural and monetary changes, what support have you received from local and international industry?

Very broadly, local industry, very often backed by international corporations, has been very supportive. For example, financial aid has been provided for impoverished black students. Significant support has also been received from foundations and state agencies in Europe and the USA.

In research funding, support has been less easy to obtain. However, industry is increasingly funding research and development projects, and a government programme of providing matching grants has added incentives.

As a father of three children, have you encouraged them to follow in your engineering footsteps and more importantly, if so, have they followed?

I tried very hard not to influence them in choosing what they wanted to do. My eldest son is an engineer, although in electronics. He is also more involved in marketing than technical aspects, working with a large computer equipment corporation near San Francisco. My second son is a librarian, and the third has a degree in construction management. •

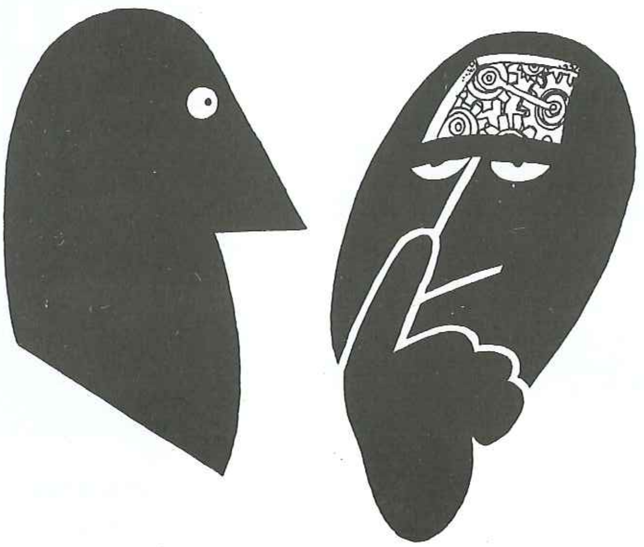
Prof. John B. Martin
Deputy Vice-Chancellor (Research)
University of CapeTown
South Africa

Take control in group situations - *BODY LANGUAGE*

Men have foresight, women have insight - Victor Hugo

"What's the matter with you?"
"Nothing! ... "
Sound familiar? It's another instance of communication breakdown. Social scientists have verified that 70% of the messages transmitted during face-to-face communication is non-verbal or 'body-language'. In other words, the verbal component of any face-to-face conversation may account for as little as one-third of the total message. Research has shown that the non-verbal aspect outweighs the verbal in both accuracy and validity.

The art of seeing what others are thinking.



The topic 'communication' is included in most companies' conference agendas, communication breakdown is the marriage counsellors' favourite subject, parents speak of the communication gap when discussing their teenage children and company directors blame poor communication for all their problems.

Expand your conscious awareness of the non-verbal dimension of communication and you will be rewarded with a better grasp of the real message being transmitted and received.

As someone gains awareness of non-verbal behaviour and attempts to interpret the body language of others, so he becomes inwardly conscious of his own body gestures. This results in more effective communication both ways.

Being aware of body language and observing it in action is fairly simple. Interpretation is somewhat more complex and takes careful study and analysis to gain accuracy. Do not interpret from a single unrelated gesture which could be, and often is, misleading. What must be sought is a gesture cluster or set of related movements, perhaps of arms, feet, head and inclination of the body, which together make for meaningful interpretation.

To better understand body language, adopt the following procedures:

- Keep an open mind.
- Observe your own posture and gesture when you are in differing moods and frames of mind.
  Ask yourself these questions:
  - What is my body language saying?
  - Where are my hands?
  - Am I leaning forward or back?
  - Are my legs crossed?
  - Is my chin up?
  - Is my head to the side?
  - Are my hands clenched?
  - What am I feeling?
- Observe the body language of others. Initially just note that the other person is constantly moving. These move ments indicate thought and emotion. As you develop a dictionary of body language signals, you will learn to read their meaning.

- Learn to put the message you are receiving from the signals together with the spoken message and draw conclusions.
- Learn to control your own body language so as to emit only those signals you want to send.

You know the expression, I know exactly what he is thinking by just looking at him - well here are some basic pointers. The head is the basic indicator of a person's attitude. The head down on the chest is a sign of defensiveness. This may be accompanied by the eyes looking down at the floor or, as the person starts to show interest, the eyes peering upwards from a downwards tilted head.

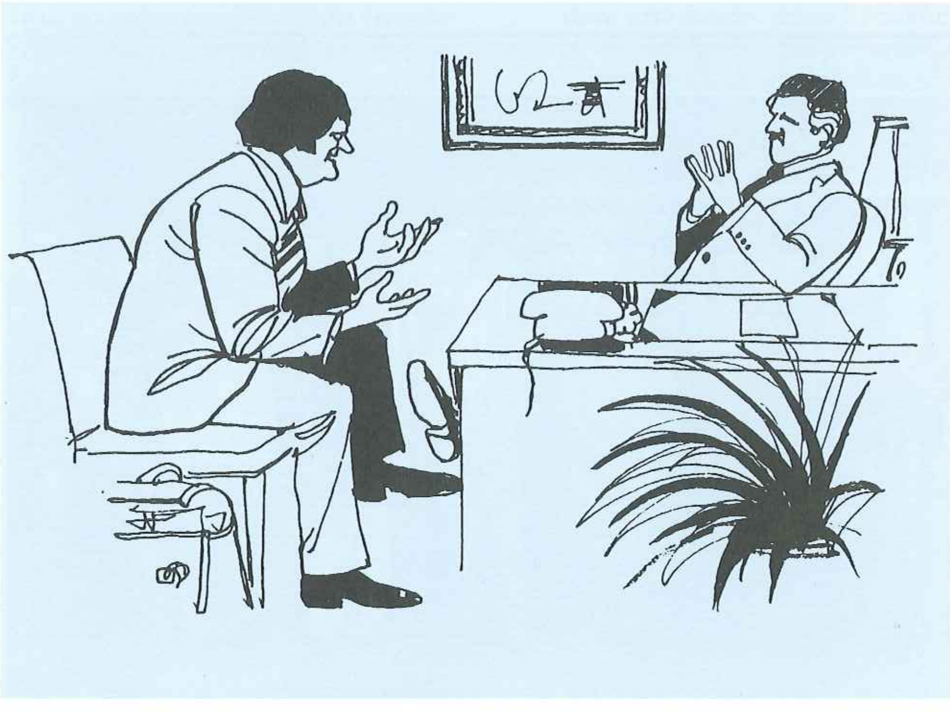
The next move is when the head comes up. Interest is beginning to take shape in the subject's mind. He is becoming receptive. Finally, if the head inclines, this telegraphs interest. In any sales situation, whether it be a commodity or a negotiation, the inclined head is the best methods of recognising willingness and cooperation. The head usually moves first.

Chin stroking is also one of the more common and easily recognised gestures. This indicates thought. People engaged in a game of chess will invariably adopt such a gesture. Notice when the chin stroking stops the individual will tend to put the hand down, lean forward and make his move. It is important then, not only to notice the stroking of the chin but also at what point the stroking ceases and the other actions commence. Quite often when an individual has made up his mind, he takes a deep breath and releases a sigh. This is a sure non-verbal sign that the indecision is over and the prospect is ready to take action.

A follow on hand gesture is the index finger pointing up towards the cheekbone, the middle finger invariably touching the upper lip and the head resting against the hand in a slightly inclined angle (commonly known as the J.F. Kennedy pose). It is often accompanied by leaning backwards or sitting right back with feet fully extended and ankles locked. This subject is in deep subconscious thought expressing doubt, cynicism and/or scepticism.

Treat Body Language as a new language which though foreign to begin with, can be mastered with practice. Observe others at the office, social gatherings and at home. Television interview programmes also provide a ready source to study. Good Luck! •

"One's eyes are what one is, but one's mouth is what one becomes."
John Glasworthy



Typical Buyer versus Seller Situation:
Seller: leaning forward / sitting on edge of chair / knees apart / feet flat on the floor / hands open / palms up / unbuttoned coat / smile / head up / infliction of voice would most definitely be upwards.
Buyer: leaning backwards / against back of chair / knees together / feet extended and heels on the floor / hands closed / palms form pyramid / coat buttoned up / scowl / head down / chin on chest / voice would most certainly be inflected downwards.

ACME - 5 years on

by
Edward Maunder
and
Nenard Bicanic
ACME
The Association for
Computational Mechanics
in Engineering
United Kingdom

ACME-UK, the Association for Computational Mechanics in Engineering in the UK recently celebrated its birthday by blowing five candles on its birthday cake in Exeter. After several years of "good intentions", ACME-UK formally started in early January of 1993. Although the timing of the inaugural conference was squeezed into an unlikely gap between the end of New Years celebrations and beginning of the new academic term, a sizeable number of UK "computational mechanicians" gathered (quite appropriately!) on the OCZ's homeground at Swansea to help the new association get off the ground. For those who know the climate around Swansea and Gower in early January, nice and sunny days were more or less expected, but most participants were surprised how mild and sunny the weather could be, at least for the period when the inaugural photograph was taken!

Since then the tradition of an annual ACME meeting changing location and moving around the country has gained popularity. Venues for the next three years have already been decided and tentative offers to organise an annual meeting have been received for several years ahead. The informal conference format has also been established, comprising an intensive two day programme of 20 min presentations (no invited papers), and the proceedings appear in the form of extended abstracts (typically 4 pages). Participation of doctoral students is particularly encouraged, with an annual award for the best student paper.

ACME Annual Conferences 1993-1998
(Locations and organisers)
1993 Swansea (Nenad Bicanic)
1994 Manchester (Ian Smith)
1995 Oxford (Kevin Parry)
1996 Glasgow (Nenad Bicanic)
1997 London (Mike Crisfield)
1998 Exeter (Edward Maunder)

The 6th annual meeting and conference of ACME - UK took place on 6th and 7th April 1998 in the School of Engineering at the University of Exeter. The Conference was preceded by a meeting of the Executive Committee at which the positions of Chairman and Vice-Chairman for the following year were transferred to Dr. Edward Maunder and Professor Peter Bettess respectively. Professor Roger Owen agreed to act in a liaison capacity with sister organisations in Europe and internationally.

ACME-UK inaugural annual meeting and first conference, Swansea, January 1993

ACME-UK five years on - delegates at the Exeter conference, April 1998

The Conference was attended by some 55 delegates, mainly academics from UK universities and including 17 post-graduate research students, but also a number of industrialists. Again, research students were encouraged to participate through the organisation of a competition for the best presentations by such students.

Most of the delegates were captured on the enclosed conference photograph. The front row comprises mainly ACME committee members, from left to right: Peter Bettess, Nenad Bicanic, Mike Crisfield, Edward Maunder, Joanna Gordon (secretary for the Exeter Conference), Denys Nicholas, Roland Lewis, Koulis Pericleous (sitting in for Mark Cross), and Frans Molenkamp (not on the committee, but a very active member of ACME). The young man on the right represents the next generation of ACME! Other members of the committee who do not appear are Andrew Chan, Mark Cross, Roger Owen, Ian Smith, and Olgierd Zienkiewicz.

The Conference was opened by Professor Bill Harvey, the first professor of civil engineering at Exeter, who advocated the need for pragmatism when modelling engineering problems in the face of many unknowns, for example when assessing existing arch structures.

The Conference was successful in fulfiling the two principal aims of ACME - firstly it provided a venue for reviewing computational mechanics research across the broad range of engineering disciplines and thereby encouraging interdisciplinary collaboration and cross-fertilisation of ideas; and secondly it enabled many young researchers to present their work. Some 40 papers were presented over the two days in 7 sessions, with a broad theme of computational and numerical methods and their applications to modelling materials, structures and geotechnical problems in solid mechanics; fluid mechanics and dynamics, fluid-structure interaction, forming processes, electromagnetism, acoustics, and crowd movements. Three students were awarded prizes: P.J.Brookes and M.Vaz from Swansea, and D.Wheeler from Greenwich; and three justified a special mention: W.Morgan and A.Tomor from Exeter, and X.Tao from Glasgow.

Plans for future annual conferences were confirmed for the University of Durham, 29th-30th March 1999, the University of Greenwich in 2000, and the University of Birmingham in 2001.

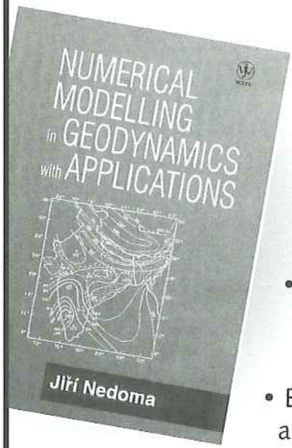
The proceedings of the Exeter Conference,was published by the School of Engineering at the University of Exeter, ISBN 0 9532721 0 9, and copies may
be obtained by request from Dr. Maunder (email: E.A.W.Maunder@exeter.ac.uk).

Further and future news of ACME-UK may be found at our Internet address: http://www.bham.ac.uk/CivEng/acme/ •

Extending the Boundaries of Engineering

Numerical Modelling in Geodynamics with Applications

J. NEDOMA, Academy of Sciences of the Czech Republic, Czech Republic



Provides the reader with the mathematical basis and methods to analyse geophysics problems of the earth and planets.

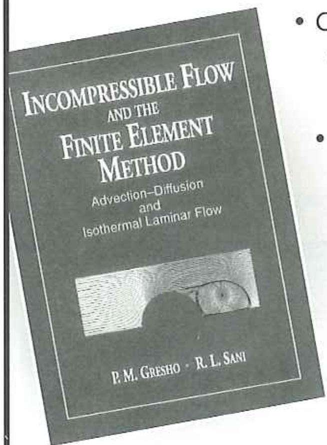
- Presents computational methods in all areas of geosciences
- Details various mathematical techniques needed to recognise geodynamic processes
- Emphasizes variational approaches to problems

0471 974617 500 pp 1998 £140.00

Incompressible Flow and the Finite Element Method Advection-Diffusion and Isothermal Laminar Flow

P. GRESHO, University of California, USA and R. SANI, University of Colorado, USA in collaboration with M. S. ENGELMAN, Fluid Dynamics International, USA

The most comprehensive reference work written on the use of FEM with only occasional use of higher-level mathematics.



- Clarifies the use of finite elements for discretizing Navier-Stokes equations
- Carefully and thoroughly explains confusing concepts such as natural boundary conditions
- Includes section on FVM
- Explains the concept and role of pressure in incompressible flows

0471 967890 1100 pp 1998 £175.00

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Or contact your local bookseller.

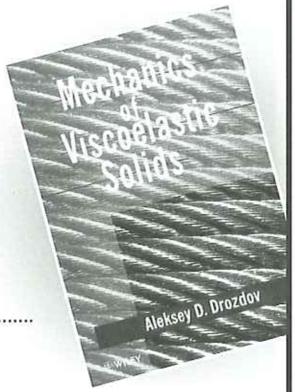
WILEY

Mechanics of Viscoelastic Solids

Professor A. D. DROZDOV, Institute for Industrial Mathematics, University of the Negev, Israel

Addresses modern problems in the mechanics of both viscoelastic solids and structural membranes. Includes:

- New models of behaviour for both finite and infinitesimal strains
- Analysis of technological processes where material viscosity plays an important role
- Features case studies to illustrate concepts and methods



0471 975125 484 pp 1998 £60.00

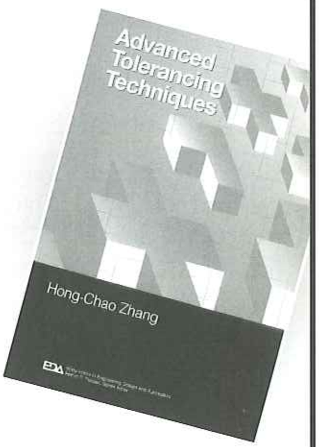
Reviewed in this Issue

Advanced Tolerancing Techniques

Edited by HONG-CHAO ZHANG, Texas Technical University, USA

The first comprehensive reference on tolerancing techniques. Topics covered include:

- Parametric tolerancing
- Statistical tolerancing
- Mathematical definition and modelling
- Tolerance representation within CAD models
- CMM sampling and form-fitting



0471 145947 608 pp 1997 £65.00

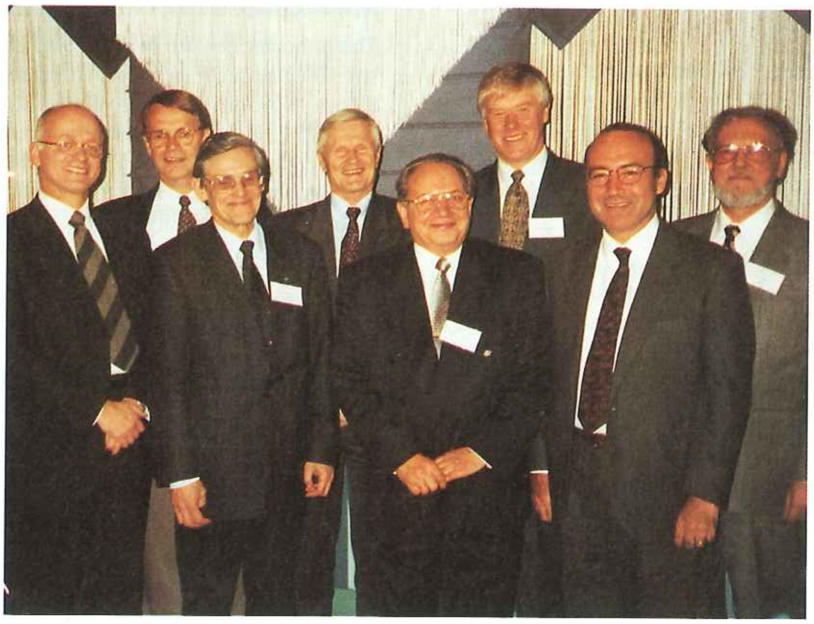
Material Instabilities in Solids

Edited by RENE de BORST and ERIC van der GIESSEN, both of Delft University of Technology, The Netherlands

A cutting-edge collection of papers from 40 renowned scientists, originally presented at the IUTAM conference held in Delft in June 1997. Research is featured in four different materials groups; metals, polymers, soils and concrete. Contributions reflect the three main methodologies; experimental, analytical/modelling and numerical methods, to form a truly unique collection of the latest developments.

0471 974609 600 pp 1998 £70.00

The 10th anniversary of NoACM



Key Note and Invited Speakers at the conference

by
Prof Nils-Eric Wiberg
President of NoACM
Chalmers University of Technology
Göteborg, Sweden

NoACM, The Nordic Association of Computational Mechanics, was created on October 5, 1998 during its first Seminar at Chalmers in Götenburg, on the initiative of Prof. Alf Samuelsson, the president of IACM.

The idea from the beginning was to base it on Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), keeping these small countries together.

The idea was and is:

- to create a forum, a meeting place every year;
- to give training in presentation for young researchers and PhD students, to meet colleagues and create a personal network invaluable for life;
- to allow professors and research leaders a meeting to discuss common matters.

I think we have achieved our goal in this respect.

During the 1990 meeting, in the days of liberation in the Baltic countries, we discussed the possibility of including Estonia, Latvia and Lithuania into the NoACM. So in 1991, invited by Göran Sandberg, a delegation under the leadership of Prof. Maciulevicius of Vilnius was called. The decision to invite the Baltic countries into the NoACM was unanimous. As the year followed, so the co-operation grew and finally the 10th anniversary was held in Tallin, Estonia under the leadership of Prof. Jaan Metsaveer and Prof. Jaan Lellep.

Previous seminars have been held in Göteborg, Oslo, Helsinki, Lund, Aalborg, Linköping, Trodheim, Copenhagen and Tallin.

At this specific event we had invited Prof. Alf Samuelsson of Göteborg, Sweden (the president of the IACM and initiator of NoACM) to open the seminar with Prof. Eugenio Onate of Barcelona, Spain (the Secretary of IACM) and Prof. Erwin Stein of Hanover, Germany (the president of ECCM) to be the main key-note speakers.

Invited speakers from NoACM countries were: Prof. Martin Bendoe (Denmark), Asst. Prof. Andrus Salupere (Eustonia), Prof. Juha Paavola, Henri Perttola (Finland) Prof. L. Buligins (Latvia), Prof. Rimantas Barauska (Lithuania), Prof. Svein Remseth (Norway), and Prof. Marek Klisinski (Sweden).

"... against nature, man is small ..."

The seminar ended with a lecture by Prof. Metsaveer with his personal views of the reasons behind the Estonia ferry accident in autumn 1995 where 800 people lost their lives. The speech was well received and extremely interesting as he was one of the experts appointed to the Eustonia enquiry committee. His conclusion was that against nature, man is small. Human structures and people themselves have shortcomings during exceptional circumstances.

The next seminar will take place on October 16 - 17, 1998 in Stockholm at KTH with Prof. Anders Eriksson as the local organiser:
Tel: (46) 8 - 790 79 50,
Fax: (46) 8 - 21 69 49 or
Email: anders.eriksson@struct.kth.se •

The First Congress of the Century on Computational Mechanics

ECCOMAS 2000

Congress on Computational Methods in Applied Sciences and Engineering

September 2000, Barcelona, Spain

Following the success of the two previous ECCOMAS Congresses held in Brussels (1992)and Paris (1996), the European Community on Computational Methods in Applied Sciences is pleased to announce the European Congress on Computational Methods in Applied Sciences to take place at the new World Trade Centre of **Barcelona**, **Spain** from **11 - 14 September, 2000**.

ECCOMAS 2000 will incorporate the VI International Conference on Computational Plasticity (COMPLAS VI) and is being organised by the Spanish Association for Numerical Methods in Engineering (SEMNI).

ECCOMAS 2000 will encourage the exchange of information, and the transfer between Research and Industry. Its fields of interest are the applications of Mathematical and Computational Methods and Modelling to major areas such as Fluid Dynamics, Structural Mechanics, Chemistry, Electromagnetics, etc. Multi-disciplinary applications of these fields to critical technology gaps encounters in sectors such as Aerospace, Car industry, Chemical Processes, Forming Processes, Construction and Environmental Engineering are of particular interest, among many others.

Scientific Topics will include:

- Computational Fluid Dynamics
- Computational Solid and Structural Mechanics
- Computational Mathematics and Numerical Methods
- Computational Chemistry
- Computational Electromagnetics
- Multidisciplinary Topics

Two page abstracts on topics related to the theme of the congress are invited by **15 September 1999** and completed papers are required by **15 March 2000**.

For further information, please contact the congress secretariat or visit the web site on:
Spanish Association for Numerical Methods in Engineering (SEMNI)
Edificio C-1
Campus Norte (UPC)
C/Gran Capitan s//n
08034 Barcelona, Spain
Phone: 34-93 205 70 16
Fax: 34-93 401 65 17
Email: cimne@etseccpb.upc.es
Web: http://cimne.upc.es/cimne/congring/htm •

book report

Advanced Tolerancing Techniques

H.OC. Zhang (Ed.)
400 pages, 1997, UK£ 60.00,
John Wiley & Sons Ltd.

This is the first book to provide comprehensive coverage of advanced tolerancing techniques. It focuses on the use of toleranceing in a CAD/CAM/CIMM environment and brings together the top tolerancing CAD/CAM experts from around the world as chapter contributors. It covers the basic theory followed by applications to various industries, for example, automotive, electronic and aviation. •

Computational Stochastic Mechanics in a Meta-Computing Perspective

J. Marczyk (Ed.)
200 pages, 1998, US$ 50.00,
Cimne, Barcelona.

Computational Stochastic Mechanics (CSM) may be clearly identified as a new and strong trend in modern Structural Analysis. Due to the advent of accessible High Performance Computing technology, CSM is migrating from the academic community to the industry. Monte Carlo methods in particular, due to their generality and intrinsic parallelism, are establishing new standards and breaking new grounds in modern engineering practice.

Meta-Computing constitutes the ideal and natural platform for Monte Carlo based CSM. Meta-Computers, i.e. agglomerates of networked computers, provide formidable computing power that may be easily harnessed by Monte Carlo-type applications. The Promenvir system,developed by an international R & S Consortium with financial support of the European Community, offers a unique industrial platform for CSM applications of high industrial relevance. •

This book gathers extended versions of selected papers presented at the First International workshop on Stochastic Mechanics in the Industry held on 5-6 March 1997 in Turin, Italy. The selected papers provide a general overview of the main industrial applications that Monte Carlo techniques enable to attack with considerable success. These range from automotive crash to satellite dynamics.from stochastic multi-physics to multi-scale problems. A chapter on the basic theoretical aspects of Monte Carlo Methods closes the book and turns it into a self-contained text on the industrial applicability of CSM •

book report

Mathematics of Fractals

Masays Yamaguti, Masayoshi Hata & Kigami Jun (Eds.)
1998, UK£ 19.50, Oxford Science Publications.
This book aims at providing a handy explanation of the notions behind the self-similar sets called "fractals" and "chaotic dynamical systems". The authors emphasized the beautiful relationship between fractural functions (such as Weierstrass's) and chaotic dynamical systems; these nowhere-differentiable functions are generating functions of chaotic dynamical systems. These functions are shown to be a sense unique solutions of certain boundary problems. The last chapter of the book treats harmonic functions on fractal sets. •

Boundary Integral Equations Methods

M. Bonnet (Ed.)
315 pages, 1997, UK£ 40.00,
John Wiley & Sons Ltd.
This book addresses the general subject of boundary integral equations, of which there are 2 computational methods available for designing structures, ranging from aircraft and ships,to dams and tunnels. The Finite Element Method and The Boundary Element Method are both used to numerically solve integral equations. The Boundary Element Method is more appropriate than the finite element method in tackling linear wave propagation,infinite domain, mobile boundaries and unknown boundary problems,whilst in other engineering applications both methods are combined. The contents includes boundary integral equations for static problems, boundary integral equations for wave and evolution problems, advanced topics and additional topics in solid mechanics. •

Discrete Mathematics in the School

J.G. Rosenstein, D.S. Franzblau and F.S. Roberts (Eds.)
1998, UK£ 21.00, Oxford Science Publications.
A description of discrete mathematics providing the opportunity for a fresh start for students who have been previously unsuccessful in mathematics. This volume is a collection of articles written by experienced primary, secondary and collegiate educators. The book explains why discrete mathematics should be taught in K-12 classrooms and offers practical guidance on how to do so. Teachers of all levels will find a great deal of valuable material to help them introduce discrete mathematics in their classrooms. •

iacm news news news news news news

HONOURARY DEGREE

On February 18th 1998, Prof O.C. Zienkiewicz and Prof P. Moin were awarded the degree of Honourary Doctor for the Universidad Politécnica de Madrid. Professors Zienkiewicz and Moin were awarded this high degree by Prof. Manuel Pastor Pérez of the F.T.S.I. de Caminos, Canales y Puertos (Civil Engineering) department of the Universidad Politécnica de Madrid.

Prof. F. B. Damjanic - Slovenia

It is with sadness and respect that we remember Prof. Damjanic, who passed away earlier this month after a long and gallantly fought illness. We mourn the untimely death of our colleague and friend as we extend our deepest sympathy to his family.

IACM / ECCOMAS Agreement

An agreement between IACM and ECCOMAS (European Community of Computational Methods in Applied Sciences) was signed on March 20th by Prof. Alf Samuelsson, president of IACM and Prof. Oskar Mahrenholtz, president of ECCOMAS. It took place during a small ceremony in the library of the Department of Structural Mechanics at Chalmers University of Technology, Goteborg in Sweden. The agreement basically states that ECCOMAS will become an affiliate member of IACM and that subsequently ECCOMAS will promote and coordinate IACM's activities in Europe.

During an informal meeting after the signing, the two presidents discussed future cooperations through joint conferences and congresses and other matters of mutual interest. •

Prof.Oskar Mahrenholtz, President of ECCOMAS and Prof. Alf Samuelsson, President of IACM

conference notices

ECCM '99
European Conference on Computational Mechanics

On behalf of the European Council of Computational Mechanics, the German Association for Computational Mechanics (GACM) announces the first European Conference on Computational Mechanics to be held in **Munich**, **Germany** on **13 August - 3 September 1999**

The aim of this conference is to promote the development of numerical methods in civil, mechanical, naval, aeronautical and bio engineering and their application in engineering practice. In particular, it will reflect state of the art of Computational Mechanics in science, software development and industry.

Topics will be grouped under the following broad headings: solid mechanics, structural engineering, coupled problems, numerical methods and geometrical design, and industrial applications. Extended abstracts (2 pages) are invited for submission before 1 October 1998.

For further information please contact:
Lehrstuhl für Statik
Technische Universität München
Arcisstrasse 21, D-80333, Munich, Germany
Tel: (49) 89 - 2892 2422 Fax: (49) 89 - 2892 2421
Email: eccm@statik.bauwesen.tu-muenchen.de •

ASEM '99
Advances in Structural Engineering and Mechanics

The Structural Engineering and Mechanics, an *International Journal*, in its fifth year of publication, introduces it's new series of conferences with the title The 1st International Conference on Advances in Structural Engineering and Mechanics. This conference, ASEM '99, is being planned to be held on **10 - 13 August 1999** in **Seoul**, **Korea**.

ASEM '99 will guarantee a good start to this series by bringing together academics and practicing engineers to promote an exchange of new ideas and experiences in Structural Engineering and Mechanics.

The conference will focus on *'Emerging Technologies in Structural Engineering and Mechanics'*. Authors are invited to submit two page abstracts no later than 31 October 1998 to the Conference Secretariat.

For a list of conference topics and Abstract Submittal Forms, please contact:
Secretariat, ASEM '99, Department of Civil Engineering, Korea Advanced Institute of Science and Technology
Taejon 305 - 701, Korea
Tel: (82) 42 - 869 8451 / 3621
Tax: (82) 42 - 869 84 50
Email: technop@chollian.net •

ICTAM 2000
20th International Congress of Theoretical and Applied Mechanics

This congress, to be held on **27 August - 2 September 2000** in **Chicago**, will cover theoretical and applied mechanics.

The following topics will receive special attention as subjects of a Mini-Symposia:
- Turbulent mixing
- Granular flows
- Electromagnetic processing of materials (jointly with HYDROMAG)
- Damage and failure of composites
- Mechanics of cellular materials
- Vehicle system dynamics (jointly with IAVSD)

The following topics have also been selected as Pre-Nominated Sessions:
- Fluid mechanics
- Solid mechanics
- Both fluid and solid mechanics

Participants who wish to contribute to the Congress are asked to examine the World Wide Web site at: **http://www.tam.uiuc.edu/ICTAM2000** for instructions. Selection of papers will be based on a brief Abstract of 100 - 150 words and an extended 2 page summary. All material must be received no later than January 16, 2000.

Information is also available from:
Prof J. Phillips, Setretary-General of ICTAM 2000, University of Illinois at Urbana-Champaign
Phone: (1) 217 - 333 2322
Fax: (1) 217 - 244 5707
Email: ICTAM2000@tam.uiue.edu •

LCSE '98
International Conference on Lightweight Structures in Civil Engineering

To be held in **Warsaw**, **Poland** on **30 November - 4 December 1998**, this conference has been organized by the Polish Chapter of International Associations for Shell and Spatial Structures.

It intends to bring together experts in the following topics: spatial lattice structures, plate and shell structures, domes and membranes, high-rise buildings, towers, reservoirs, bridges, thin-walled, tension, cable and pneumatic structures.

The thought is to bring together leading researchers and practitioners in the fields of structural analysis, design and architecture. The conference will include an exhibition by consultants, contractors and systems manufacturers as well as a symposium technical tour to interesting construction sites and completed buildings.

For further information on the conference or details about early registration fees before 31 August, please contact J.B. Obrebski on:
Tel: (48) 22 - 660 65 06
Fax: (48) 22 - 25 69 85
Email: dz@omk.il.pw.edu.pl •

SEMNI
IV Congress on Numerical Methods in Engineering

This conference, jointly organised by SEMNI, the Sociedad Español de Métodos Numéricos en Ingeniería and Escuela Superior de Ingenieros de Sevilla will by held in **Sevilla, Spain** from **7 to 10 June, 1999**.

This conference aims at compiling the most relevant work in research as well as practical applications that have recently been developed in the field of numerical methods.

An Iberian - Latin American meeting point for all those interested in the use and research of numerical methods, it will enable interchange research, expressions and common interests. It is anticipated that the presentations will provide the most complete reference possible on the scope and possibilities of numerical methods in solving scientific and technological problems.

For further conference information or abstract submissions (before 16 October 1998) please contact:
Sociedad Española de Métodos Numéricos en Ingeniería,
Tel: (34) 93 - 401 60 39
Fax: (34) 93 - 401 65 17
Email: semni@etseccpb.upc.es
Web: http//cimne.upc.es/cimne/congresos/congresos.htm •

EUROMECH - MECAMAT
3rd European Mechanics of Materials Conference
on
Mechanics and Multi-physics Processes in Solids:
Experiments, Modelling, Applications

To be held in **Oxford**, **United Kingdom**, on **22 - 25 November 1998**, this conference has been organized jointly by Imperial College in London and Ecole des Mines in Paris.

The micro structure-related properties and the mechanical integrity of advanced components and composites can critically depend on the interaction between the mechanical behaviour of the materials involved and physico-chemical processes. Coupling between such processes and the solid can take place at free-surfaces, at bi-material interfaces, or at local inhomogeneities within the material, and may alter the original characteristics of the materials. In many instances, it can also lead to a gradual degradation of the micro-structure. This interdependency requires that their constitutive behaviour be formulated in terms of the dominany physio-chemical process.

The proposed conference aims to bring together researchers working on coupled phenomena in a variety of material related disciplines interested in a multi-physics approach. To our knowledge, no conference has yet addressed this topic as a unifying theme. It will also provide a forum for researchers to compare experimental procedures and numerical techniques.

The conference will focus on combined experimental techniques and constitutive formulations formulti-physics processes where at least one process is linked to the mechanics of the solid. Emphasis will be placed on linking fundamental processes and properties at the micro and macro scales.
For more information please contact E. Busso, Dept. of Mechanical Engineering, Imperial College, University of London
Tel: (44) 171 - 594 70 84
Fax: (44) 171 - 823 88 45
Email: e.busso@ic.ac.uk •

conference diary planner

29 June - 2 July 1998	**IACM - Fourth World Congress on Computational Mechanics** *Venue:* Buenos Aires, Argentina. *Contact:* IACM Secretariat. Tel: (34) 93-401 6036. Fax: (34) 93-401 6517, Email: iacm@etseccpb.upc.es
6 - 8 July 1998	**GIS for the 21st Century - Geographical Information Systems in the next Millennium** *Venue:* Udine, Iltaly. *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
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
1 - 3 October 1998	**AMIF - Applied Mathematics for Industrial Flow Problems - an ESF International Conference** *Venue:* Hotel Eden Roc, Sant Feliu de Guixols, Spain. *Contact:* C. Werner, Tel: (33) 3-88 76 71 28, Fax: (33) 3-88 37 05 32, Email: cwerner@esf.org
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27 - 30 October 1998	**Chileno Congreso de Ingenieria Mechanica** *Venue:* Universidad de Concepción,Concocatoria, Chile. *Contact:* Tel: (56) 41-204 306, Fax: (56) 1-259 190, Email: edufeu@udec.cl
23 - 25 November 1998	**EUROMECH - 3rd European Mechanics of Materials Conference** *Venue:* Oxford, United Kingdom. *Contact:* E. Busso, Tel: (44) 171-594 7084, Fax: (44) 171-823 8845, Email: e.busso@ic.ac.uk
30 November - 4 December 1998	**International Conference on Lightweight Structures in Civil Engineering** *Venue:* Warsaw, Poland. *Contact:* J.B. Obrebski, Tel: (48) 22-660 65 06, Fax: (48) 22-25 69 85, Email: dz@omk.il.pw.edu.pl
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
24 - 26 May 1999	**4th International Symposium on Engineering Turbulence Modelling and Measurements** *Venue:* Hotel Frantour Corse Marina, Corsica, France. *Contact:* D. Laurence Tel: (33) 1-30 87 72 57, Email: Dominique.Laurence@der.edfgdf.fr
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
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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
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27 August - 2 September 2000	**ICTAM 2000 - 20th International Congress of Theoretical and Applied Mechanics** *Venue:* Chicago Marriott Downtown, Chicago, Illinios, USA. *Contact:* J.W. Phillips, Tel: (1) 217-333 2322, Fax: (1) 217-244 5707, Email: ICTAM2000@tam.uiue.edu
16 - 18 November 1998	**UHMK '98 - Third Turkish National Conference on Computational Mechanics** *Venue:* Ayazaga Campus of Istanbul Technical University, Turkey Contact: Mehmet Bakioglu, Tel: (90) 212-285 3700, Email: gakioglu@sariyer.cc.itu.edu.tr
12 - 15 September 2000	**ECCOMAS 2000 - European Congress on Computational Methods in Engineering and Applied Science** *Venue:* Barcelona, Spain Contact: Barbara Schmitt, Tel: (34) 93-401 6037, Fax: (34) 93 - 401 6517, Email: semni@etseccpb.upc.es

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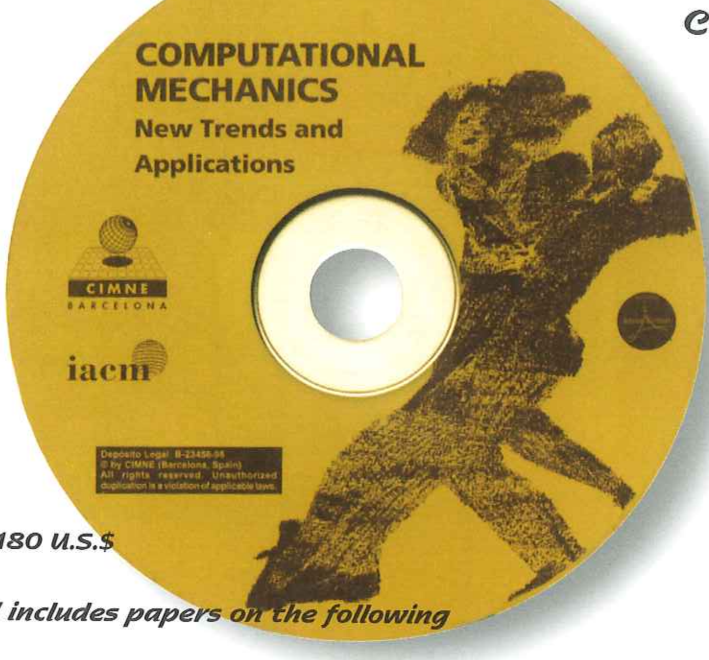

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