

**On the Numerical
Simulation of Hardened
Cement Paste**

P. Wriggers & M. Hain

**CFD on Near-Future
PetaFlops Computers**

K. Nakahashi

**Guide for Verification &
Validation in Computational
Solid Mechanics**

L.E. Schwer

**2006 Prince Philip Medal
awarded to O. Zienkiewicz**

SCME - Chile

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IACMM - Israel

APACM - Asia Pacific

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IACM World Congress

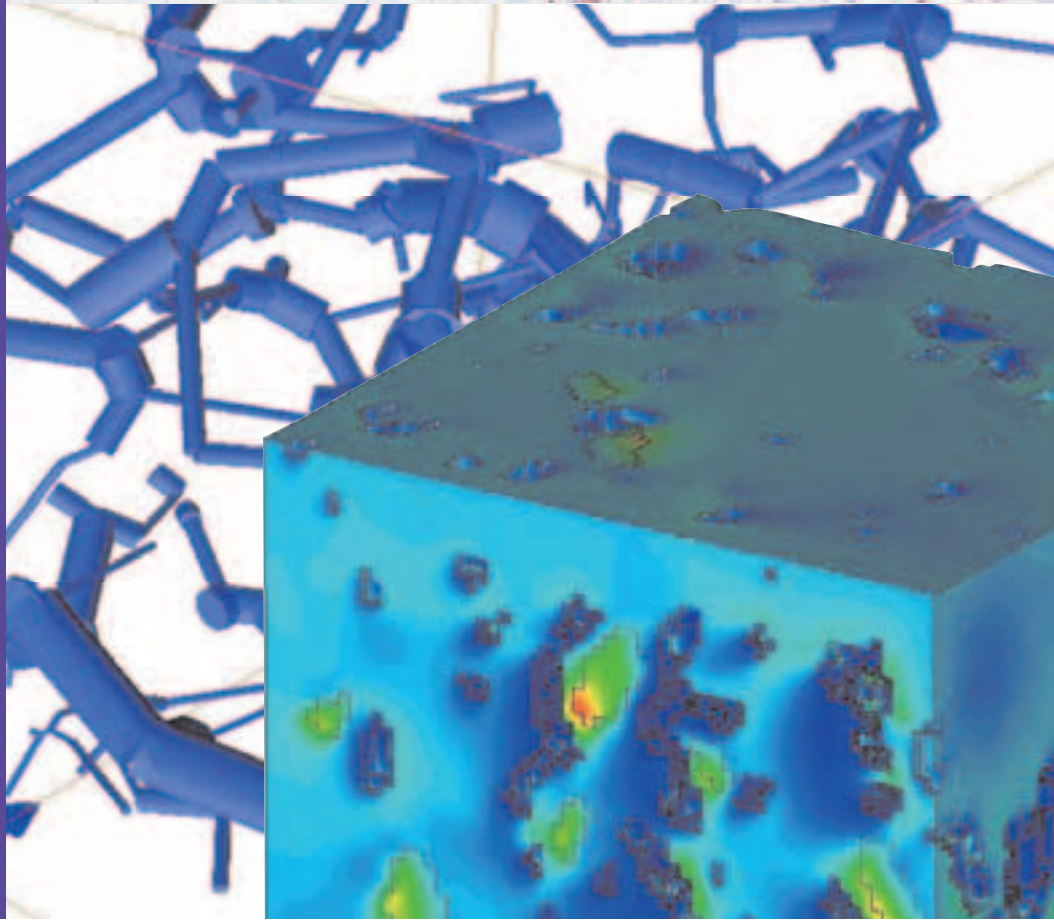
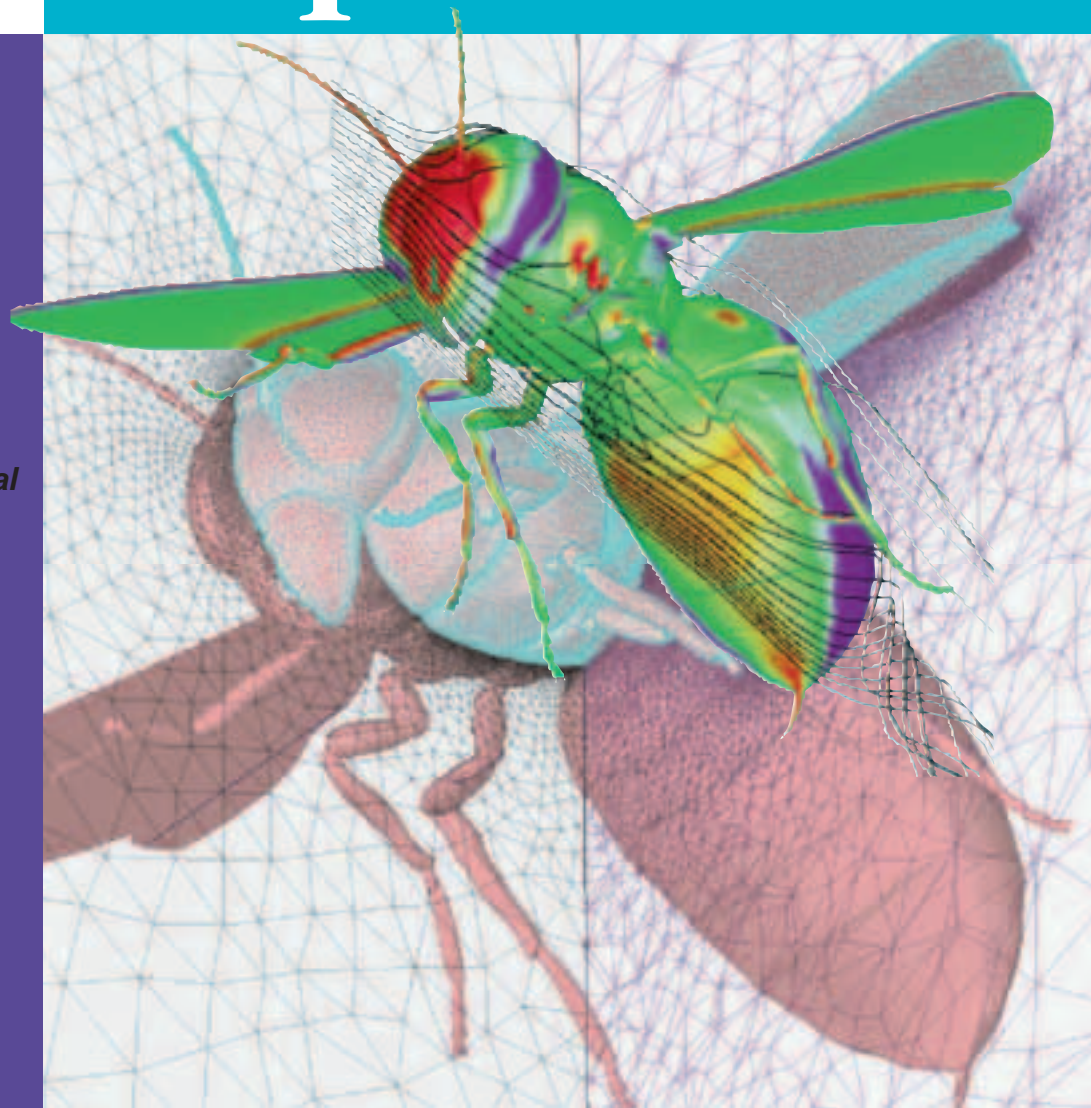
IACM News

**Conference
Report & Debrief**

Conference Diary

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for Computational Mechanics*

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4 *On the Numerical Simulation of Hardened Cement Paste*
Peter Wriggers & Michael Hain

9 *CFD on Near-Future PetaFlops Computers*
Kazuhiro Nakahashi

13 *Book Report*

14 *Guide for Verification and Validation in Computational Solid Mechanics*
Reprinted by permission of The American Society of Mechanical Engineers
L.E. Schwer

22 *2006 Prince Philip Medal awarded to Professor Olek Zienkiewicz*
J. T. Tinsley Oden

24 *IACM International Congress Report*
Wing Kam Liu & J.S. Chen

26 *GACM News - Germany*

28 *Chilean Society for Computational Mechanics*

29 *ABMEC - Brasil*

32 *IACMM - Israel*

34 *USACM Chronicle - USA*

36 *APACM News - Asia - Pacific*
(Including JACM - Japan, JSCES - Japan & IndACM - India)

41 *Conference Debrief*

42 *Conference Notices*

44 *IACM News*

45 *IACM Awards*

46 *Conference Diary Planner*

contents

editorial

The 7th World Congress of Computational Mechanics of the IACM held in Los Angeles on July 16-21, 2006 was a full success. Close to 2000 delegates participated actively in the technical sessions covering most fields in computational science and engineering. We congratulate the congress chairmen, Profs. W. K. Liu (Northwestern University) and J. S. Chen (University of California at Los Angeles) and their teams for an excellent organization of WCCM 2006.

Some important decisions were taken at the IACM Executive Council and General Assembly meetings held in Los Angeles. A number of relevant scientists were chosen to become new members of the Executive Council and the city of Sydney was selected to be the host of WCCM 2010. It was also decided to update the IACM Constitution. Details are given in the IACM News section of this Bulletin.

My personal impression is that WCCM 2006 in Los Angeles has consolidated IACM as a multidisciplinary organization. The different sessions in the congress were a meeting point for academics and engineers from all fields in science and technology, ranging from classical engineering areas (civil, mechanical, aeronautics, etc.) to a wide scope of disciplines in science (mathematics, materials, biology, physics, etc.). The tendency towards multidisciplinary has been a continuous and increasing trend in previous WCCM's. As a consequence IACM is probably nowadays one of the most diverse organizations in the world. Such an heterogeneity of topics and members of different cultural backgrounds, in the broad sense, can only be beneficial for the advance of science and technology worldwide, henceforth fostering cultural and economical progress.

Many challenges ahead are still to be faced so that IACM can contribute effectively to the widespread dissemination of knowledge in computational mechanics. The activity in this field in large parts of the world is practically non-existent, or to say the least, unknown to many. This is the case in most of Africa and in many countries of Central America, Eastern Europe, Middle East and Far East. Extending the activity of IACM to these regions is clearly not an easy task. We are however very conscious of the need to do so, as a modest step towards the development of those countries and their integration in the large scientific and technological community which IACM represents.

A good opportunity for increasing the interaction with members of different communities are the congresses regularly organized by IACM and their affiliated members associations. Some 20 of these congresses will take place in 2007 worldwide. The 8th World Congress on Computational Mechanics will be held in 2008 in the city of Venice, Italy, a gateway for East-West cultural and economical interchanges in the past. Plans are underway to hold the first African Conference on Computational Mechanics in early 2009, with the support of IACM. Details are given on the IACM web page. These are good steps in the right direction for enlarging the activities of IACM around the world.

Let me finish these lines with my best wishes for 2007 to all the worldwide community in computational mechanics.

EUGENIO OÑATE
President of IACM

On the Numerical Simulation of Hardened Cement Paste

by
**Peter Wriggers &
 Michael Hain**
 University of Hannover
 Germany

For a deeper understanding of the constitutive behaviour of multi-scale materials like concrete, one can perform experimental investigations or numerical simulations. While the experimental techniques are applied successfully since several decades, the usage of numerical simulation is relatively new.

Within a numerical multi-scale simulation, different three-dimensional mechanical models are applied on each length scale in order to describe the constitutive behaviour on that scale. The models on a specific scale are referred to as representative volume elements (RVEs) [1-2]. Each RVE normally consists of different materials which have to be taken into account in order to characterize the material on that length scale with sufficient accuracy. The RVEs at a specific scale are

subjected to different loading conditions which lead to a material response. Based on these results, a numerical homogenization process is initiated to describe the material behaviour averaged over the whole RVE. The resulting homogenized constitutive equation is then applied within the next length scale to model the constituents of the RVE belonging to that scale.

A numerical multi-scale approach needs the complex three-dimensional geometry of the structure and therefore considerable computational power, which only in the last decade has reached a sufficient state. Nevertheless, one obtains a powerful numerical tool which can reveal the interior phenomena of a specimen during the loading process and which is able to resolve processes on different time and length scales.

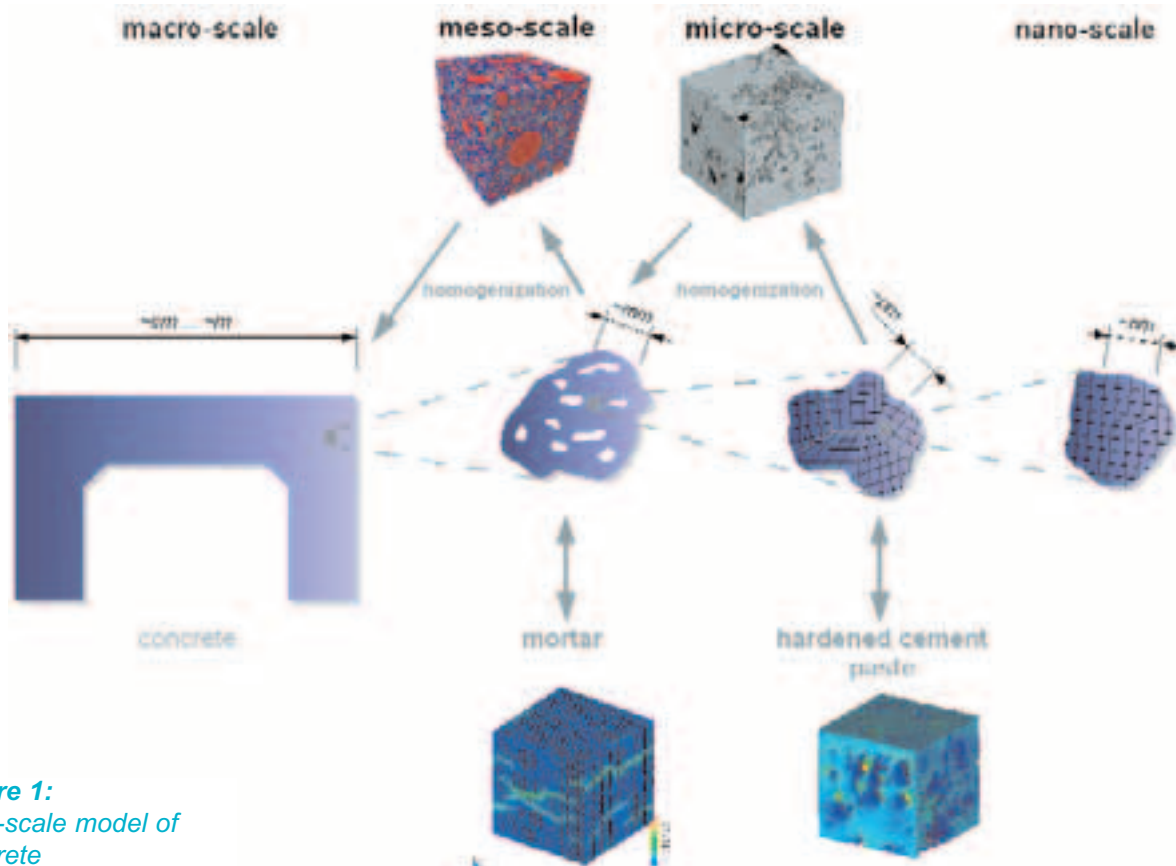


Figure 1:
 Multi-scale model of
 concrete

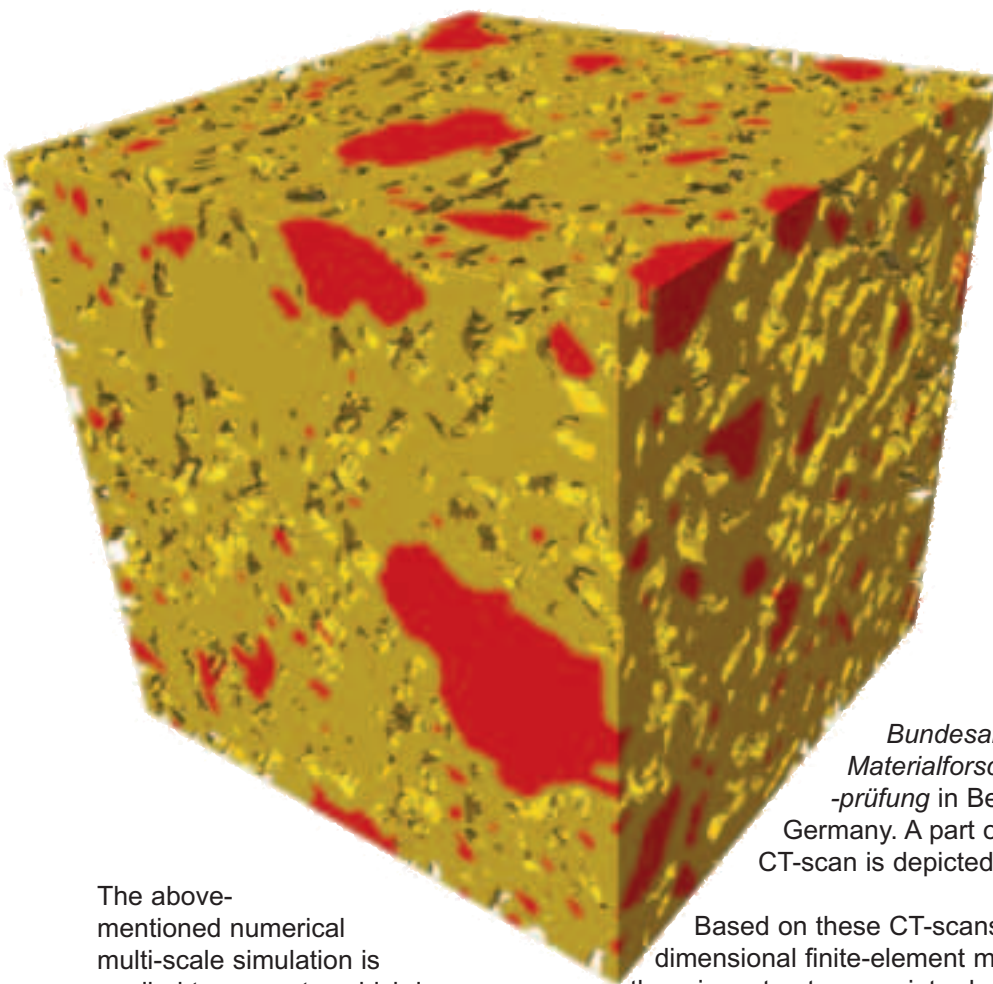


Figure 2:
Part of a CT-scan of HCP
(Visualization from IBAC)

The above-mentioned numerical multi-scale simulation is applied to concrete, which is a complex material used in engineering practice, see Fig. 1. This material has to be investigated at least on three different scales: the micro-scale of hardened cement paste (HCP), the meso-scale of mortar and finally the macro-scale of concrete.

Concrete at the macro-scale is assumed to consist of mortar, large pores and large grains. The underlying meso-scale refers to mortar, which consists of smaller grains, smaller pores and HCP. At the micro-scale of HCP one can distinguish between hydration products, unhydrated residual clinker and micro-pores. These products form the interior structure of HCP and are built up during the hydration process of cement. The hydration products as well as the unhydrated residual clinker at the micro-level subsumes different materials which one may distinguish on the nano-scale.

Here, the numerical multi-scale approach starts at the micro-scale of HCP. The three-dimensional geometry of HCP is based on a computer-tomography (CT), which provides a spatial resolved distribution of the density. CT-scans of several specimens with an edge length of 1750 μm and a resolution of 1 μm have been performed by the

*Bundesanstalt für
Materialforschung und
-prüfung in Berlin,
Germany. A part of such a
CT-scan is depicted in Fig. 2.*

Based on these CT-scans, three-dimensional finite-element models of the micro-structure are introduced. For most of the calculations RVEs with an edge length of 64 μm have been used, which contain 260,000 finite-elements and approximately 820,000 DOFs. With respect to the theory of Powers and co-workers [3-4] one can distinguish between unhydrated residual clinker, pores and hydration products. The hydrated part of HCP is described with respect to a visco-plastic constitutive equation of Perzyna-type including isotropic damage. The other parts of the micro-structure are assumed to remain elastic.

The elastic constitutive data has been obtained through nano-indentation techniques [5-6] and is taken directly from the literature. The inelastic constitutive equation for the hydrated part contains inelastic parameters, which neither can be obtained through experimental tests nor found in the literature. Therefore one has to solve an inverse problem which yields the identification of these properties. The identification is carried out by solving an optimization problem that minimizes a corresponding objective function. For computational efficiency and robustness a combination of the stochastic genetic algorithm [7-8] and the deterministic Levenberg-Marquardt method is used:

*“ ... one has
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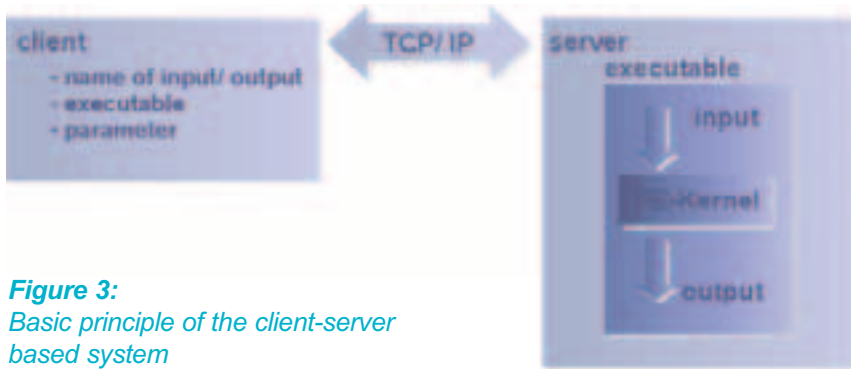


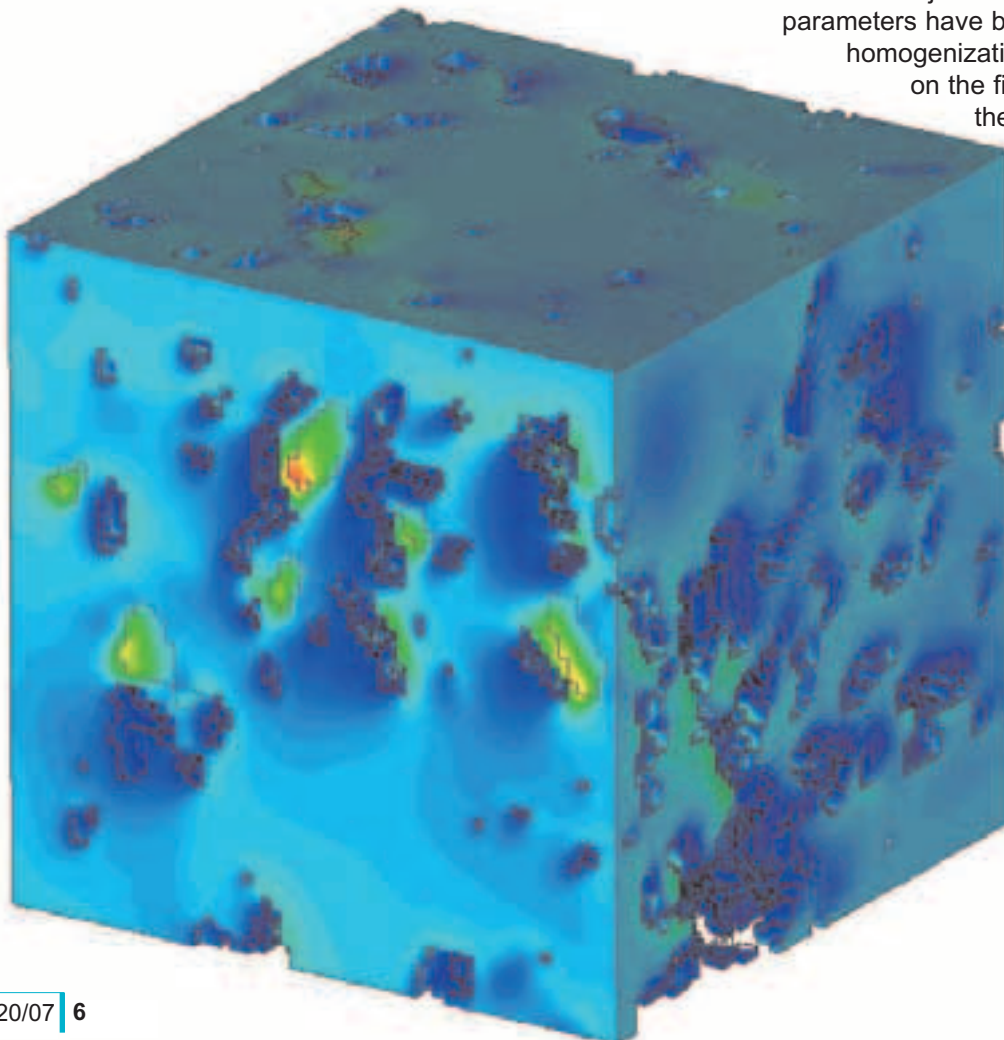
Figure 3:
Basic principle of the client-server based system

In order to keep the overall computation time within reasonable bounds all calculations are distributed within a network environment automatically. Hence, a client-server based system has been implemented [9] that requires a TCP/ IP based network, which is available in almost every company or research institute.

In a first step of the optimization procedure a pre-optimization within a genetic algorithm has been carried out in order to get close to the global minimum of the objective function.

Once the value of the objective function falls below a certain threshold value, the optimization procedure switches to the more efficient Levenberg-Marquardt method. This method needs the gradient of the objective function as well as the Hessian-matrix, both are carried out numerically through a difference quotient.

Figure 4:
Principal stresses within a RVE



For the optimization procedure, a client is started. This client does not evaluate the objective function itself, but distributes the computation to the computation-servers via network connections. The computation-servers perform the time consuming evaluation of the objective function. The result of this computation is transported back to the client automatically where it is used for the next iteration step of the optimization procedure. Using 11 standard PCs one obtains a speed-up factor of approximately 10.4 and the identification procedure is finished within one week.

Once the objective constitutive parameters have been identified, homogenization is needed. Based on the finite-element solution, the stresses and the strains can be evaluated. Subsequently, the effective elastic material properties are calculated numerically. For a reliable analysis the whole RVE is embedded within a matrix of average stiffness, which is sometimes referred to as window-method and is similar to the self-consistency method from analytical micro-mechanics [2].

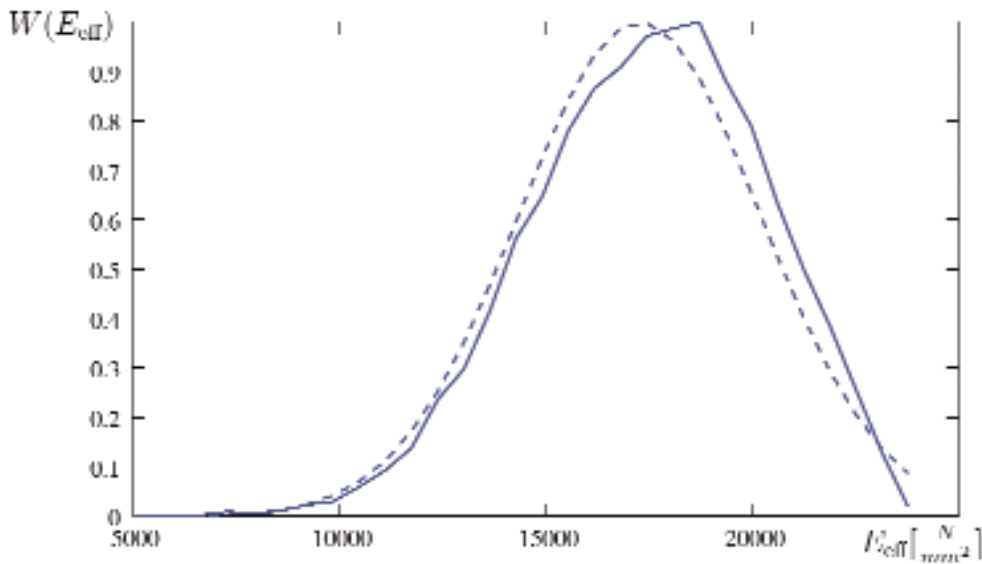


Figure 5:
Probability density of Young's modulus and Gaussian distribution (dashed line)

The homogenization procedure is applied for a sufficient number of different RVEs, where each RVE covers a portion of a CT-scan. One obtains a probability density for the effective Young's modulus which is close to a Gaussian distribution.

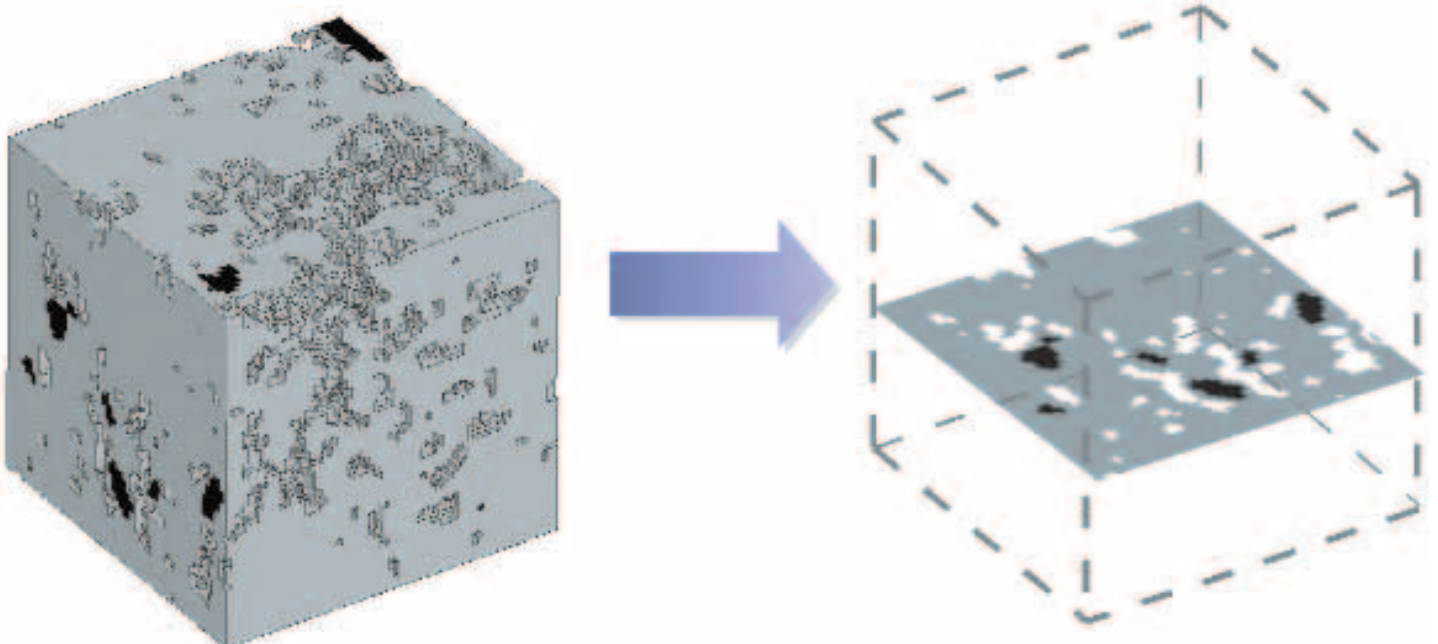
Also, two-dimensional calculations under plain stress and plain strain conditions have been carried out, using cut throughs from the three-dimensional data. While the three-dimensional calculations show a very good accordance to experimental tests, the two-dimensional calculations differ of about 40%,

although the number of DOFs is comparable high.

In [10] the RVEs have been transferred into a network of connected tubes. Therefore, an artificial distribution of water inside the tubes can be simulated. In order to analyze frost heave inside the micro-structure a constitutive model for ice is applied to the water filled parts of the micro-structure. Here, a viscoplastic model of Perzyna-type is chosen. Young's modulus is expected to depend on the temperature, the other constitutive parameters are assumed to remain constant. Transient thermal conduction

“
... three-dimensional calculations show a very good accordance ... two-dimensional calculations differ about 40%.”

Figure 6:
Two-dimensional geometry obtained from a cut through



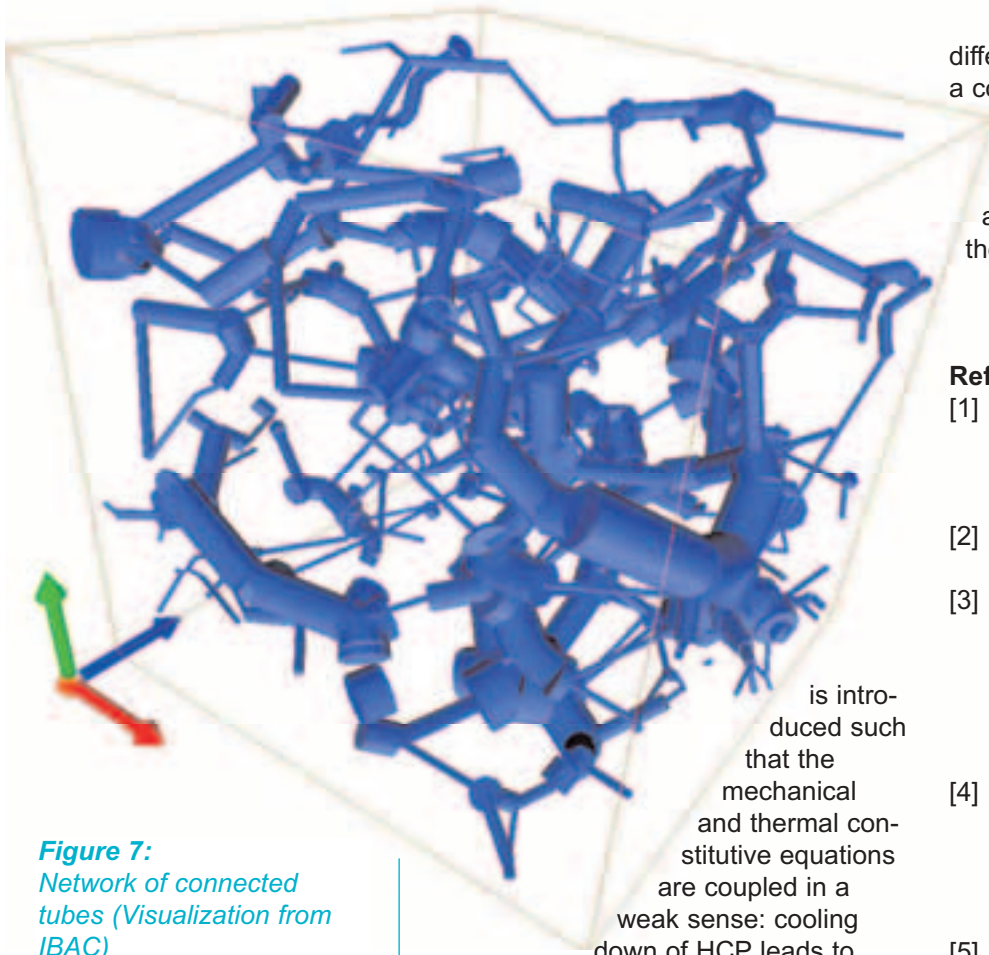
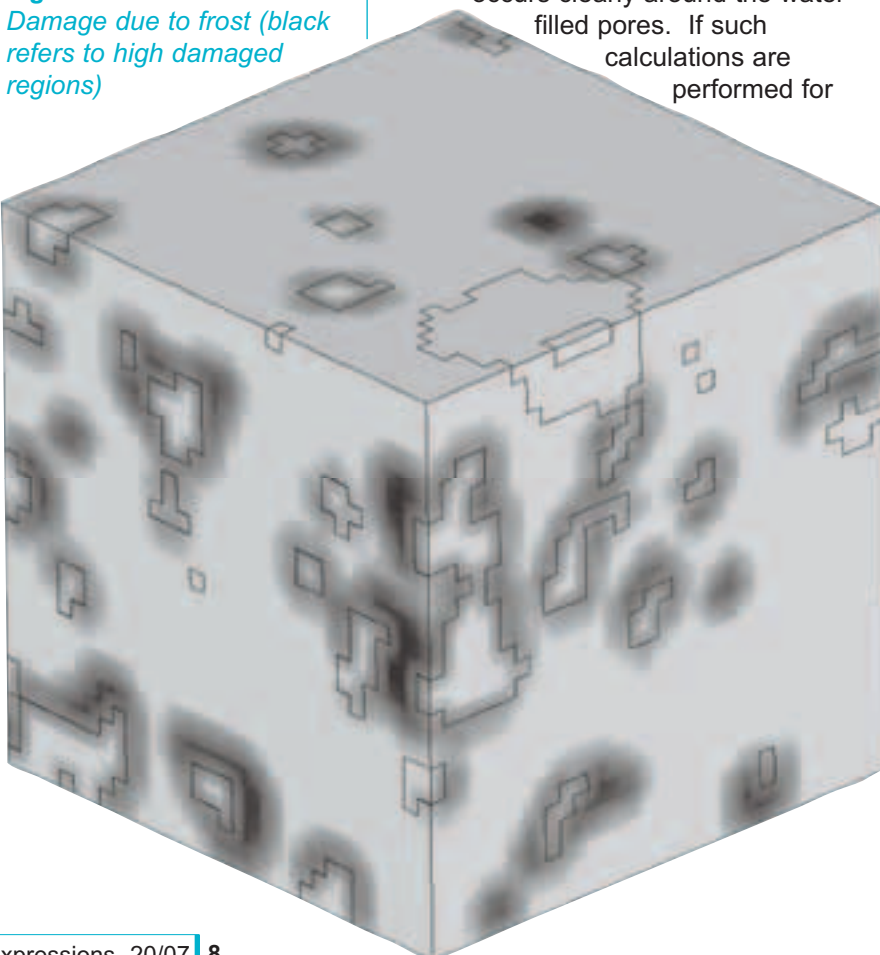


Figure 7:
Network of connected tubes (Visualization from IBAC)

is introduced such that the mechanical and thermal constitutive equations are coupled in a weak sense: cooling down of HCP leads to strains but strain due to mechanical loads does not change the temperature.

The increase of volume during the freezing process of ice yields damage which occurs clearly around the water filled pores. If such calculations are performed for

Figure 8:
Damage due to frost (black refers to high damaged regions)



different moistures and temperatures, a correlation between moisture, temperature and the inelastic material behaviour is obtained. This dependency will be used for a meso-structure model of mortar on the next length scale. ●

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CFD on

Near-Future PetaFlops

Computers

by
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Japan

Will CFD take over wind tunnels?

More than 20 years ago, I heard an elderly physicist in fluid dynamics say that it was as if CFD were just surging in. Other scientists of the day said that with the development of CFD, wind tunnels would eventually become redundant.

Impressive progress in computational fluid dynamics (CFD) has been made during the last three decades. In the early stages, one of the main targets of CFD for aeronautical fields was to compute flow around airfoils and wings accurately and quickly. Body-fitted-coordinate grids, commonly known as structured grids, were used in those days.

From the late eighty's, the target was moved to analyzing full aircraft configurations [1]. This spawned a surge of activities in the area of unstructured grids, including tetrahedral grids, prismatic grids, and tetrahedral-prismatic hybrid grids. Unstructured grids provide considerable flexibility in tackling complex geometries as shown in Figure 1 [2]. CFD has become an indispensable tool for analyzing and designing aircrafts.

So, is CFD taking over the wind tunnels, as predicted twenty years ago?

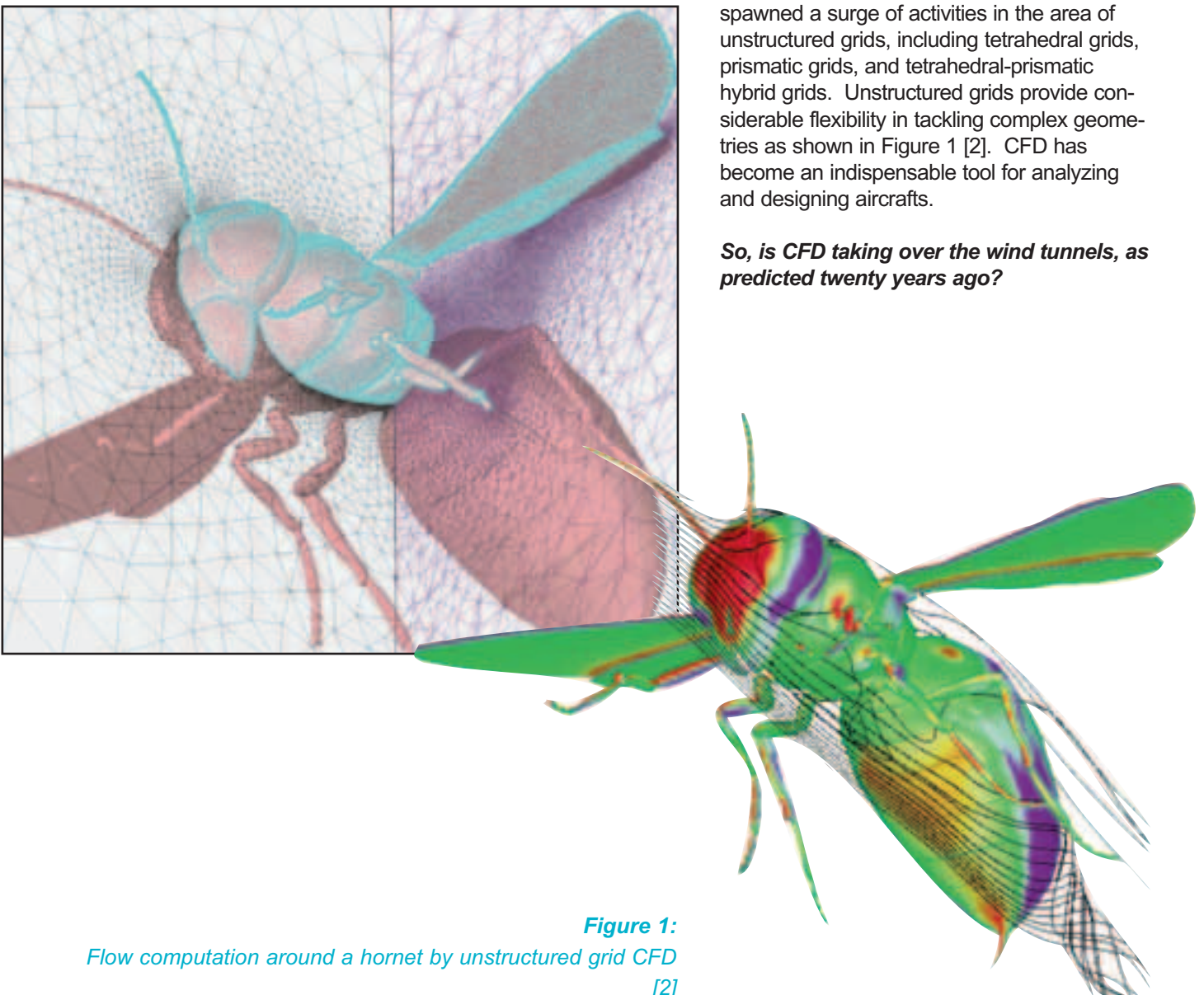


Figure 1:
Flow computation around a hornet by unstructured grid CFD
[2]

Today, Reynolds-averaged Navier-Stokes (RANS) computations can accurately predict lift and drag coefficients of a full aircraft configuration. It is, however, still quantitatively not reliable for high-alpha conditions where flow separates. Boundary layer transition is another cause of inaccuracy. These are mainly due to the incompleteness of physical models used in RANS simulations. Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS) are expected to reduce the physical model dependency. But we have to wait for the further progress of computers for the use of those large-scale computations in engineering purposes. For the time being, the wind tunnel is a central player and CFD plays a subordinate part in aircraft developments.



Figure 2: Performance development in Top500 Supercomputers [3]

Rapid progress of computers

The past CFD progress has been highly supported by the improvements of computer performances. Moor's Law tells us that the degree of integration of a computer chip has been doubled in 18 months. This basically corresponds to a factor of 100 every 10 years. The latest Top500 Supercomputers Sites [3], on the other hand, tell us that the performance improvement of computers has reached a factor of 1000 in the last 10 years, as shown in Figure 2. Increase in the number of CPUs in a system, in addition to the degree of integration, contributes to this rapid progress.

With a simple extrapolation of Figure 2, we can expect to use PetaFlops computers in ten years. This will accelerate the use of 3D RANS computations for the aerodynamic analysis and design of entire airplanes. DNS, which does not use any physical models, may also be used for engineering analysis of wings. In the not very far future, CFD could take over wind tunnels.

Demands for next-generation CFD

So, is it enough for us as CFD researchers to just wait for the progress of computers? Probably it is not.

Let's consider demands for next-generation CFD on PetaFlops computers.

1. Easy and quick grid generation around complex geometries,
2. Easy adaptation of local resolution to local flow characteristic length,
3. Easy implementation of spatially higher-order schemes,
4. Easy massively-parallel computations,
5. Easy post processing for huge data output,
6. Algorithm simplicity for software maintenance and update.

Unstructured grid CFD is a qualified candidate for the demands 1 and 2 as compared to structured grid CFD. However, an implementation of higher-order schemes on unstructured grids is not easy. Post processing of huge data output may also become another bottleneck due to irregularity of the data structure.

Recently, studies of Cartesian grid methods were renewed in the CFD community, because of several advantages such as rapid grid generation, easy higher-order extension, and simple data structure, for easy post processing. This is another candidate for the next-generation CFD.

Let's compare the computational cost of uniform Cartesian grid methods with that of tetrahedral unstructured grids. The most time-consuming part in compressible flow simulations are the numerical flux computations. The number of flux computations on a cell-vertex, finite volume method is proportional to the number of edges in the grid. In a tetrahedral grid, the number of edges is at least twice of that of the edges in a Cartesian grid of the same number of node points. Therefore, the computational cost on unstructured grids are at least twice as large as the costs of Cartesian

grids. Moreover, computations of linear reconstructions, limiter functions, and implicit time integrations on tetrahedral grids, easily doubles the total computational costs.

For higher-order spatial accuracy, the difference of computational costs between two approaches expands rapidly. In Cartesian grids, the spatial accuracy can be easily increased up to the fourth order without extra computational costs. In contrast, to increase the spatial accuracy from second to third-order on unstructured grids can easily increase tenfold the computational cost.

Namely, for the same computational cost and the same spatial accuracy of third-order or higher, we can use 100 to 1000 times more grid points in the Cartesian grid than in unstructured grid. The increase of grid points improves the accuracy of geometrical representation in computations as well as the spatial solution accuracy.

Although the above estimation is very rough, it is apparent that the Cartesian grid CFD is a big advantage for high resolution computations required for DNS.

Building-Cube Method

A drawback of uniform Cartesian grid is the difficulty of changing the mesh size

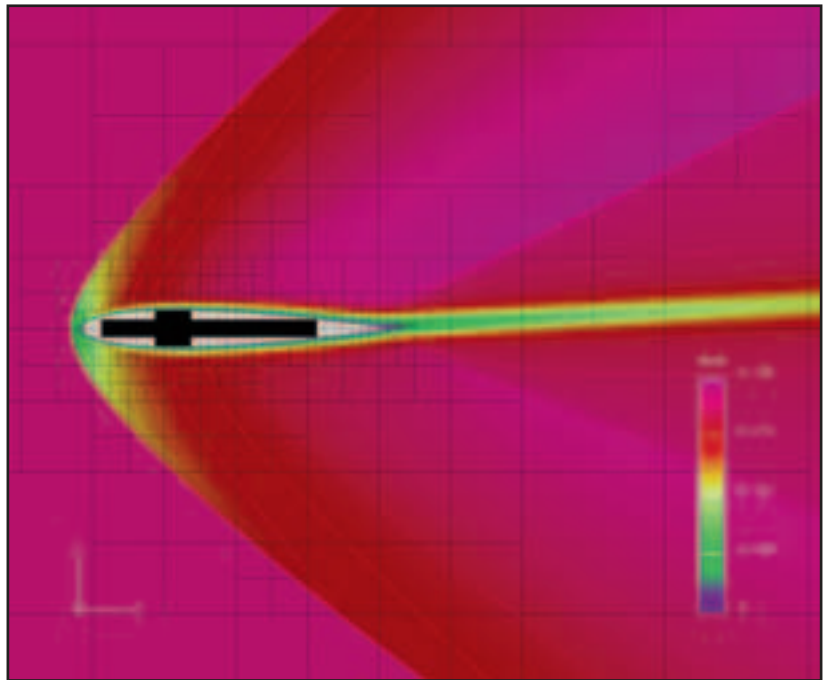


Figure 3: Computed Mach distribution around NACA0012 airfoil at $Re=5000$, $M_\infty = 2$ and $\alpha=3$ deg.

locally. This is critical, especially for airfoil/wing computations, where an extremely large difference in characteristic flow lengths exist between boundary layer regions and far fields. Accurate representation of curved boundaries by Cartesian meshes is another issue.

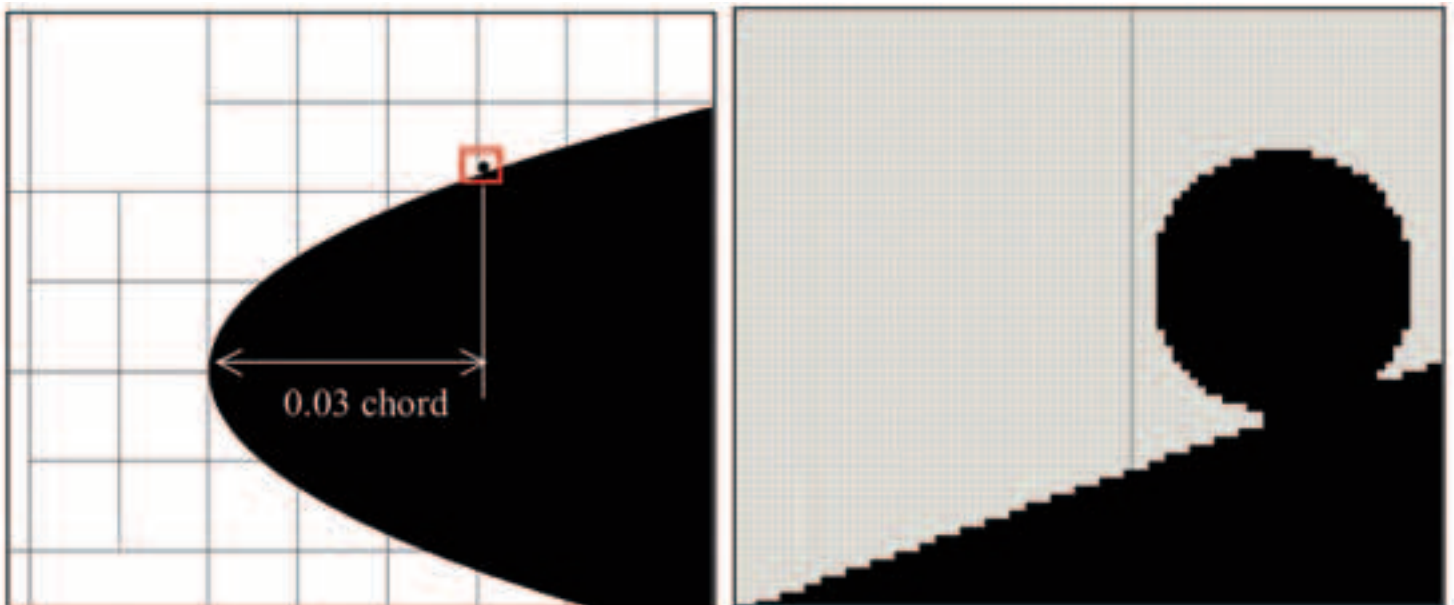


Figure 4: Cube frames around RAE2822 airfoil (left) and an enlarges view of Cartesian grid near tripping wire (right).

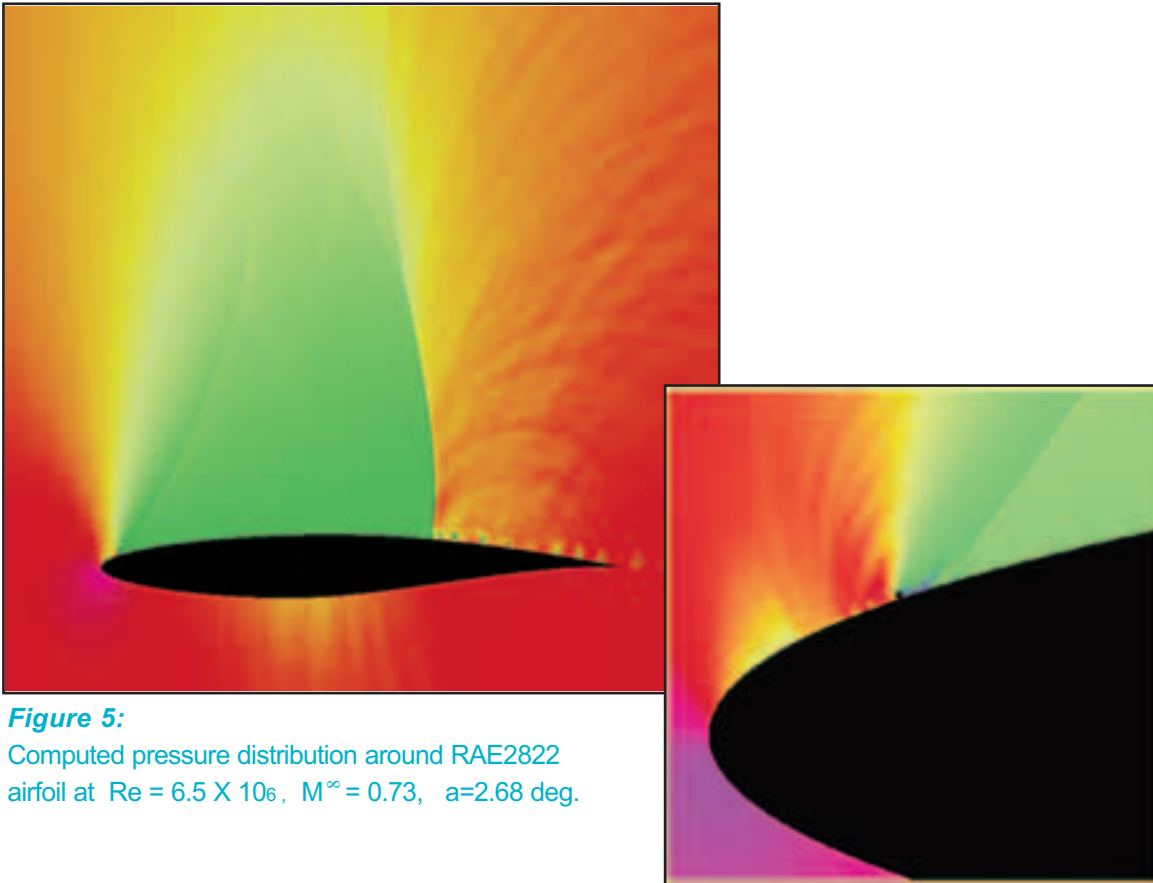


Figure 5:
 Computed pressure distribution around RAE2822
 airfoil at $Re = 6.5 \times 10^6$, $M^\infty = 0.73$, $\alpha = 2.68$ deg.

“
*In the
 not very far
 future,
 CFD could
 take over
 wind tunnels.*”

A variant of the Cartesian grid method is to use the adaptive mesh refinement [4] in space and cut cells or the immersed boundary method [5] on the boundaries walls. However, introductions of irregular subdivisions and cells into Cartesian grids complicate the algorithm for higher-order schemes. The advantages of the Cartesian mesh over the unstructured grid, such as simplicity and less memory requirement, disappear.

The present author proposes a Cartesian grid based approach, named Building-Cube method [6].

Basic strategies employed here are;

- (a) zoning of a flow field by cubes (squares in 2D as shown in *Figure 3*) of various sizes to adapt the mesh size to local flow characteristic length,
- (b) uniform Cartesian mesh in each cube for easy implementation of higher-order schemes,
- (c) same grid size in all cubes for easy parallel computations,
- (d) staircase representation of wall boundaries for algorithm simplicity.

It is similar to a block-structured uniform Cartesian mesh approach [7], but unifying the block shape to a cube simplifies the

domain decomposition of a computational field around complex geometry. Equality of computational cost among all cubes significantly simplifies the massively parallel computations. It also enables us to introduce data compression techniques for pre and post processing of huge data [8].

A staircase representation of curved wall boundaries requires a very small grid spacing to keep the geometrical accuracy. But the flexibility of geometrical treatments obtained by it will be a strong advantage for complex geometries and their shape optimizations. An example is shown in *Figure 4* where a tiny boundary layer transition trip attached to an airfoil is included in the computational model. *Figures 5* are the computed pressure distributions which show the detailed flow features including the effect of trip wire, interactions between small vortices and the shock wave, and so on.

The result of *Figure 5* was obtained by solving the two dimensional Navier-Stokes equations. We did not use any turbulence models, but just used a high-density Cartesian mesh and a fourth-order scheme. This 2D computation may not describe the correct flow physics, since the three-dimensional flow structures are

essential in the turbulent boundary layers for high-Reynolds number flows. However, the result indicates that a high-resolution computation, using a high-density Cartesian mesh is very promising, with a progress of computers.

Simplicity is essential for next-generation CFD

CFD, using a high-density Cartesian mesh, is still limited in its application due to the computational cost. The discussions about Cartesian mesh CFD and computer progress in this article may be too optimistic. However, it is probably correct to say that the simplicity of the algorithm from grid generation to post processing of Cartesian mesh CFD will be a big advantage in the days of PetaFlops computers. ●

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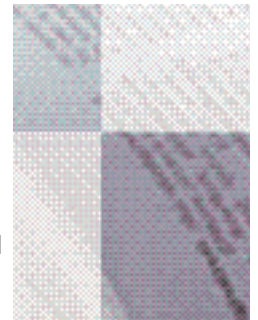
~ Book Report ~

Computational Intelligence in Reliability Engineering Evolutionary Techniques in Reliability Analysis and Optimization

Series: Studies in Computational Intelligence , Vol. 39
Volume package Computational Intelligence in Reliability Engineering

Levitin, Gregory (Ed.)
2007, XIV, 398 p., 99 illus., Hardcover, Available: Dec 2006, \$169.00
ISBN-10: 3-540-37367-5, ISBN-13: 978-3-540-37367-4
Edited by: Springer

This book covers the recent applications of computational intelligence techniques in reliability engineering. This volume contains a survey of the contributions made to the optimal reliability design literature in the recent years and chapters devoted to different applications of a genetic algorithm in reliability engineering and to combinations of this algorithm with other computational intelligence techniques. Genetic algorithms are one of the most widely used metaheuristics, inspired by the optimization procedure that exists in nature, the biological phenomenon of evolution. This book is written for researchers, engineers, graduate students in Computational Intelligence and Reliability Engineering ●



ACCELERATED QUALITY AND RELIABILITY SOLUTIONS

Lev Klyatis & Eugene Klyatis(Eds.)

544pp., ISBN: 0-08-044924-7 2006
Edited by: ELSEVIER, EUR 136

Drawing of real-world issues and with supporting data from industry, this book overviews the technique and equipment available to engineers and scientists to identify the solutions of the physical essence of engineering problems in simulation, accelerated testing, prediction, quality improvement, and risk during the design, manufacturing, and maintenance stages. For this goal the book integrates Quality Improvement and Accelerated Reliability/ Durability/ Maintainability/Test Engineering concepts. The book includes new and unpublished aspects in quality: - complex analysis of factors that influence product quality, and other quality development and improvement problems during design and manufacturing ; in simulation: - the strategy for development of accurate physical simulation of field input influences on the actual product – a system of control for physical simulation of the random input influences – a methodology for selecting a representative input region for accurate simulation of the field conditions; in testing: - useful accelerated reliability testing (UART) – accelerated multiple environmental testing technology – trends in development of UART technology; in studying climate and reliability; in prediction: - accurate prediction (AP) of reliability, durability, and maintainability - criteria of AP - development of techniques, etc. ●



Guide for Verification and Validation in Computational Solid Mechanics



transmitted by
L. E. Schwer

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The American Society of Mechanical Engineers (ASME) Standards Committee on Verification and Validation in Computational Solid Mechanics (PTC 60/V&V 10) approved their first document (Guide) in July 2006. The Guide has been submitted to ASME publications and to the American National Standards Institute (ANSI) for public review. It is hoped the *Guide* will be published in early 2007.

Some Motivation

Question: *Are the sometimes lengthy and costly processes of verification & validation really necessary?*

Consider the following scenario that perhaps you can relate to first hand. A project review meeting is taking place and the project manager needs to make a critical decision to accept or reject a proposed design change. A relatively new employee, freshly minted from the nearby engineering university, makes an impressive presentation full of colourful slides of deformed meshes and skillfully crafted line plots indicating the results of many CPU and labour hours of non-linear numerical analyses, ending with a recommendation to accept the design change.

Hopefully, an astute project manager, aware of the vagaries of nonlinear numerical analyses, will not accept the analysis and its conclusion at face value, especially given the inexperience of the analyst. Rather, the project manager should seek some assurance that not only are the results reasonable, but a sound procedure was followed in developing the model and documenting the numerous physical and numerical parameters required for a typical analysis. The degree of assurance sought by the project manager is directly related to the criticality of the decision to be made.

The processes of verification & validation are how evidence is collected, and documented, that help establish confidence in the results of complex numerical simulations.

A Brief History of the Committee

In 1999 an ad hoc verification & validation specialty committee was formed under the auspices of the United States Association for Computational Mechanics (USACM). The purpose of this committee was to pursue the formation of a verification & validation standards committee under a professional engineering society approved to produce standards under the rules of the American National Standards Institute (ANSI). This goal was achieved in 2001 when the then Board on Performance Test Codes (PTC) of the American Society of Mechanical Engineers (ASME) approved the committee's charter:

*'To develop standards for assessing
the correctness and credibility of modeling
and simulation in computational solid mechanics'*

and the committee was assigned the title and designation of the ASME Committee for Verification & Validation in Computational Solid Mechanics (PTC 60¹).

The committee maintains a roster of slightly less than the maximum permitted 30 members, with a few alternate and corresponding members. The membership is diverse with three major groups being industry, Government, and academia. The industry members include representatives from auto and aerospace industries and the Government members are primarily from the Departments of Defence and Energy. Particularly well represented are members from the three national laboratories under the National Nuclear Security Administration. This latter membership group is key to the committee as much of the recent progress in verification & validation has come from these laboratories and their efforts under the Advanced Simulation and Computing (ASC) Program, started in 1995.

¹The committee may be designated as V & V 10 in the near future.

A Brief History of the Guide

The motivation for forming the ASME committee was provided by PTC 60's elder 'sister' committee, the Computational Fluid Dynamics Committee of the American Institute of Aeronautics and Astronautics (AIAA). After the 1998 publication of their seminal work in verification & validation, i.e. the *AIAA Guide for the Verification and Validation of Computational Fluid Dynamics Committee on Standards*, the AIAA CFD committee thought it would be good for the overall computational mechanics community, if the solid and structural mechanics² community produced a similar guide.

The road from committee formation to approval of the *Guide* was neither straight nor fast, but it was rewarding. Starting from the naive idea that the AIAA Guide could easily be modified to suit the purposes of computational solid mechanics, the committee soon realized that forming a consensus means understanding the point of view of others, and it is the significant effort expended in forming of a consensus view that lends authority to standards documents such as the present *Guide*.

While some may view five years to produce a 30+ page *Guide* as an excessive amount of time, several factors contributed to this duration:

1. PTC 60 was a newly formed committee, and thus time was needed for the group to become cohesive,
2. This is an all *volunteer* committee with the members donating most generously of their time and resources,
3. The area of verification & validation is growing rapidly, with improvements arriving at a pace that caused the committee to revisit the initial parts of the *Guide* and include important improvements in V&V.

After an extensive Industry Review process, and associated changes to *Guide*, the committee unanimously approved the *Guide* in a ballot concluded on 13 July 2006. The *Guide* is presently available for public review through ASME. It is hoped the *Guide* can be published near the beginning of 2007.

What the Guide is Not

Perhaps the most common misconception about the *Guide* is that it would provide a definitive step-by-step V&V procedure, immediately applicable by analysts in computational mechanics. This expectation is quite understandable when viewed by an outsider to the V&V community. One reads a title page with words ASME standards committee and verification & validation, and expects a typical ASME standards document. Somehow the reader glosses over the very intentional first word of the title, i.e. *Guide* - something that offers underlying information. Not only the first time reader, but much of the informed V&V computational mechanics

community desires a step-by-step standard. However, it is the view of the committee that such a standard is many years in the future. The next immediate goal for PTC 60, and its AIAA Computational Fluid Dynamics Standards sister committee, is to attempt to define some best practices, which in the future can lead to standards; our ASME sister committee, PTC 61/V&V 20, is already addressing best practices for uncertainty analysis related to some aspects of V&V.

The committee makes no excuses for writing the present *Guide* the way it did. After five years of discussion and debate, the committee recognizes it was a necessary, but difficult, first step. Much of V&V is not a 'hard' science, which is the bread-and-butter of most of computational mechanics, but more a 'soft' science like the philosophy of science, where differing points of view have merit, and need not be evaluated as either right or wrong.

Because the present *Guide* is intentionally a foundational document, and not a typical ASME standard, the committee deviated significantly from the well-developed guidance for writing standards documents, provided by both the ASME Codes & Standards Council and the PTC Committee. Attempting to force this *Guide* into an ASME standard format would detract significantly from its appeal to potential readers. The intended audience for this *Guide* is not the occasional computational mechanics user, e.g. a modern-day draftsman using an automated CAD/FEA package, rather it is computational analysts, experimentalists, code developers, and physics model developers, and their managers, who are prepared to read a technical document with a mixture of discussion concerning mathematics, numerics, experimentation, and engineering analysis processes.

Outline of the Guide

As stated in the *Guide's* Abstract, the guidelines are based on the following key principles:

- Verification must precede validation.
- The need for validation experiments and the associated accuracy requirements for computational model predictions are based on the intended use of the model and should be established as part of V&V activities.
- Validation of a complex system should be pursued in a hierarchical fashion from the component level to the system level.
- Validation is specific to a particular computational model for a particular intended use.
- Validation must assess the predictive capability of the model in the physical realm of interest, and it must address uncertainties that arise from both simulation results and experimental data.

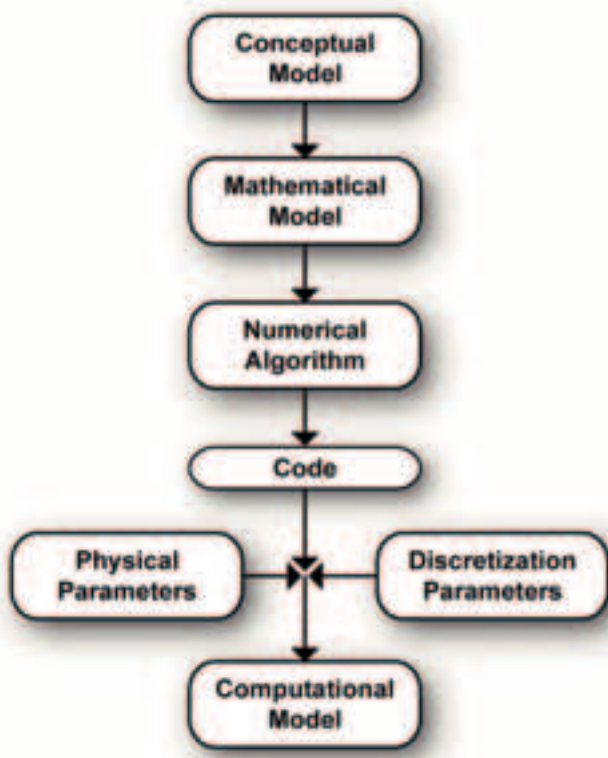
² Hereafter referred to as "solid mechanics" for brevity.

The Guide contains four major sections:

1. *Introduction* - the general concepts of verification and validation are introduced and the important role of a V&V Plan is described.
2. *Model Development* - from conceptual model, to mathematical model, and finally the computational model are the keys stages of model development.
3. *Verification* - is subdivided into two major components: code verification - seeking to remove programming and logic errors in the computer program, and calculation verification - to estimate the numerical errors due to discretization approximations.
4. *Validation* - experiments performed expressly for the purpose of model validation are the key to validation, but comparison of these results with model results depends on uncertainty quantification and accuracy assessment of the results.

In addition to these four major sections a Concluding Remarks section provides an indication of the significant challenges that remain. The document ends with a Glossary, which perhaps should be reviewed before venturing into the main body of the text. The Glossary section is viewed as a significant contribution to the effort to standardize the V&V language so all interested participants are conversing in a meaningful manner.

Figure 1:
The path from Conceptual to Computational Model.



The Model Development Section

The processes of verification & validation start, and end, with modeling and models, for it is a computational model we seek to verify & validate for making predictions within the domain of intended use of the model. Three types of models, from the general to the specific, are described. The logic flow from the most general Conceptual, to Mathematical, to the most specific Computational Model, is illustrated in *Figure 1*.

Before modeling begins, a reality of interest is identified, i.e. what is the physical system to be modeled. The reality of interest is typically described in the problem statement presented to the analyst, e.g. "We need to know the wing tip deflection of the ABC experimental aircraft under a distributed load of X Newtons/meter," in this case the reality of interest is the aircraft wing.

The most general form of the model addressed in the *Guide* is the *Conceptual Model* - "the collection of assumptions and descriptions of physical processes representing the solid mechanics behaviour of the reality of interest from which the mathematical model and validation experiments can be constructed." Continuing the aircraft wing example, the conceptual model could be a cantilever beam of variable cross section made of a laminated composite material, and loaded uniformly along the length.

With the Conceptual Model defined, the analyst next defines the Mathematical Model - "The mathematical equations, boundary values, initial conditions, and modeling data needed to describe the conceptual model." For the aircraft wing example, the analyst might select a Bernoulli-Euler beam theory with fixed-free boundary conditions, i.e.

$$\begin{aligned}
 [EI(x)y''']' &= w(x) \quad 0 < x < L \\
 y(0) = y'(0) &= y''(L) = y'''(L) = 0
 \end{aligned}$$

The variable cross section geometry of the wing is reflected in the function $I(x)$, for simplicity in this example an elastic material response is assumed, and $w(x) = \text{constant}$, represents the uniform load along the span.

The final model in the sequence is the *Computational Model* - "The numerical implementation of the mathematical model, usually in the form of numerical discretization, solution algorithm, and convergence criteria." This is the stage of modeling most familiar to numerical analysts, as this is where the analyst forms the "input file" used to describe the particulars of the model in terms the numerical solution software (code) interprets as the model to be solved.

At this point the computational model can be exercised (run) and the results compared to available experimental data for validation of the model. It is frequently the case that the results do not compare as favourably as

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requested in the original problem statement. *Assuming* a high degree of confidence in the experimental data, the analyst has two basic choices for revising the model: changing the model form or calibrating model parameters.

Changing the model form can apply to either the Conceptual or Mathematical model. As an example of a change in the Conceptual model, perhaps the fixed-end cantilever beam assumption was too restrictive and this boundary condition needs to be replaced with a deformable constraint to reflect the wing's attachment to the fuselage. An example of a change in the Mathematical Model is perhaps the long-and-slender beam assumptions of Bernoulli-Euler beam theory are deemed inappropriate and a Timoshenko beam theory is adopted as the revised Mathematical Model.

Perhaps the most misunderstood, and thus most abused, form of model revision is model *Calibration* - "the process of adjusting physical modeling parameters in the computational model to improve agreement with experimental data." A trivial example of calibration is the selection of Young's modulus for a linear elastic constitutive model based on laboratory uniaxial stress data. For the present aircraft wing example, assume it was decided to revise the conceptual model and include a flexible boundary condition to replace the fixed-end assumption. The analyst is then faced with replacing a very complex connection of wing-to-fuselage with a simplified equivalent shear and moment resistance for a beam model. One approach could be to construct a laboratory model of the connection and measure the shear and moment resistance. A separate computational model would be constructed of this laboratory experiment, and the shear and moment resistance calibrated to the laboratory results. These end-reaction calibration values would then be used in the revised mathematical model of the wing, and validation comparisons revisited. It is important to note that the model used in the validation comparison was not calibrated to the validation data, as this results in a calibrated rather than validated model. Rather a sub-system calibration experiment was designed and executed to determine the unknown model parameters.

The Introduction Section

With the above three types of models described, i.e. Conceptual, Mathematical, and Computational, the concepts of verification & validation, and how they fit into an overall V&V Plan, are described.

Beginning with the definitions of verification and validation:

- *Verification*: The process of determining that a computational model accurately represents the underlying mathematical model and its solution.
- *Validation*: The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.

A careful examination of the verification definition indicates there are two fundamental parts of verification:

1. Code Verification - establish confidence, through the collection of evidence, that the mathematical model and solution algorithms are working correctly.
2. Calculation Verification - establish confidence, through the collection of evidence, that the discrete solution of the mathematical model is accurate.

Neither part of verification addresses the question of the adequacy of the selected Conceptual and Mathematical models for representing the reality of interest. Answering this question is the domain of validation, i.e. are the mechanics (physics) included in the Conceptual and Mathematical models sufficient for answering the questions in the problem statement.

Put most simply, verification is the domain of mathematics and validation is the domain of physics.

The manner in which the mathematics and physics interact in the V&V process is illustrated in the flow chart shown in *Figure 2*. After the selection of the Conceptual model, the V&V process has two branches: the left branch contains the modeling elements and the right branch the physical testing (experimental) elements.

This figure is intentionally designed to illustrate the paramount importance of physical testing in the V&V process, as ultimately, it is only through physical observations (experimentation) that assessments about the adequacy of the selected Conceptual and Mathematical models for representing the reality of interest can be made. Close cooperation among modelers and experimentalist is required during all stages of the V&V process, until the experimental outcomes are obtained. Close cooperation is required because the two groups will have quite different views of the Conceptual model, i.e. the mathematical and physical model will be different. As an example consider the fixed-end (clamped) boundary for the aircraft wing illustration. Mathematically this boundary condition is quite easy to specify, but in the laboratory there is no such thing as a 'clamped' boundary. In general, some parts of the Conceptual model will be relatively easy to include in either the mathematical or physical model, and others more difficult. A dialogue between the modelers and experimentalist is critical to resolve these differences. To aid in this dialogue, the 'cross-talk' activity labelled as "Preliminary Calculations" in *Figure 2* is intended to emphasize the goal that both numerical modelers and experimentalist attempt to model the same Conceptual model.

*“Put most simply,
verification is the domain
of mathematics
and validation is the domain of physics.”*

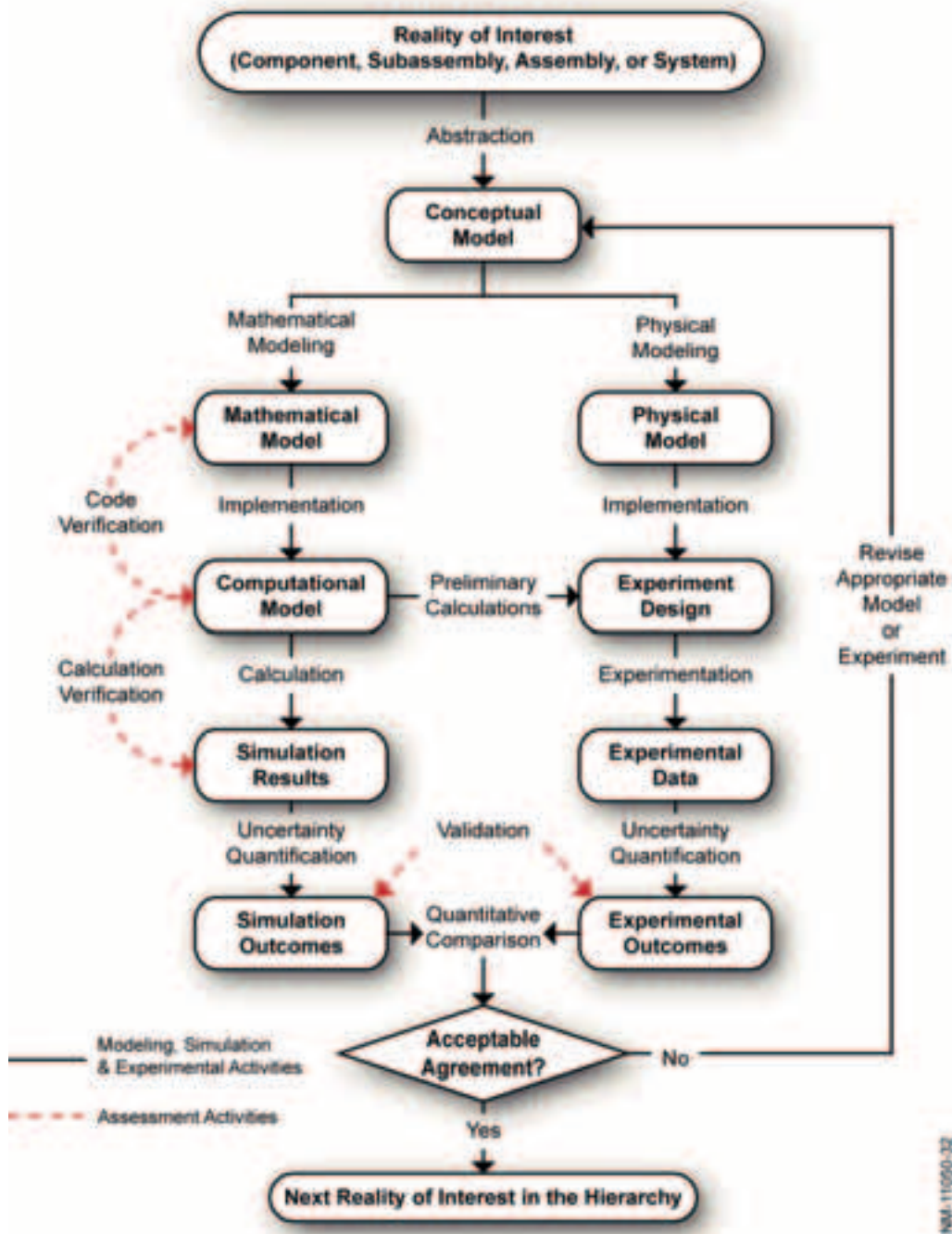
Of equal importance is the idea that the experimental outcomes should not be revealed to the modelers until they have completed the simulation outcomes. The chief reason for segregation of the outcomes is to enhance the confidence in the model's predictive capability. When experimental outcomes are made available to modelers prior to establishing their simulation outcomes, the human tendency is to 'tune' the model to the experimental outcomes to produce a favourable comparison. This tendency decreases the level of confidence in the model's ability to predict, and moves the focus to the model's ability to mimic the provided experimental outcomes.

Lastly, the role of uncertainty quantification (UQ), again for both modelers and experimentalists, is emphasized.

It is common to perform more than one experiment and produce somewhat different results. It is the role of UQ to quantify "somewhat" in a meaningful way. Similarly, every computation involves both numerical and physical parameters that have ranges, and likely distributions, of values. Uncertainty quantification techniques attempt to quantify the affect of these parameter variations on the simulation outcomes.

Figure 2 can also serve as the starting point for forming a V&V Plan, i.e. what are the goals and expected outcomes of the V&V effort and how will the available resources be allocated. Critical assessment of the resource allocation will often affect the goals of a V&V Plan, but it is better to have such an estimate of this impact before embarking on a V&V effort, than to

Figure 2
Verification & Validation activities and outcomes.



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come to this realization after the resources have been expended without a V&V Plan. The three key elements of the V&V Plan that will help in estimating the resource allocations are:

1. *System Response Features* - the features of interest to be compared and how they are to be compared (metrics).
2. *Validation Testing* - set of experiments for which the model's predictive capability is to be demonstrated for the model to be accepted for its intended use.
3. *Accuracy Requirements* - specification of accuracy requirements allows the "acceptable agreement" question to be answered quantitatively.

The V&V Plan is of paramount importance to the V&V process. It is the basis for developing the models, assessing the models, and establishes the criteria for accepting the models as suitable for making predictions. Simply put, the specification in the V&V Plan answers the question "What is a validated model?"

Finally, the role of documentation throughout the V&V planning process cannot be over emphasized. Eventually the body of evidence comprising the V&V process will need to be presented to an appropriate authority, e.g. management, for their evaluation and subsequent decision-making process. The documentation should try to anticipate and provide answers to the questions raised by such an authority. The documentation also has potential value in the future, e.g. when decisions are revisited or when past knowledge needs to be reused or built upon.

The Verification Section

The *Guide* emphasizes that Verification must precede Validation. The logic is that attempting to validate a model using a code that may still contain (serious) errors can lead to a false conclusion about the validity of the model.

As mentioned above, there are two fundamental parts of verification:

1. *Code Verification* - establish confidence, through the collection of evidence, that the mathematical model and solution algorithms are working correctly.
2. *Calculation Verification* - establish confidence, through the collection of evidence, that the discrete solution of the mathematical model is accurate.

Code Verification

In general, Code Verification is the domain of software developers who hopefully use modern Software Quality Assurance techniques along with testing of each released version of the software. Users of software also share in the responsibility for code verification, even though they typically do not have access to the software source. The large number of software users, typical of

most commercial codes, provides a powerful potential code verification capability, if it is used wisely by the code developers.

Among the code verification techniques, the most popular method is to compare code outputs with analytical solutions; this type of comparison is the mainstay of regression testing. Unfortunately, the complexity of most available analytical solutions pales compared to even rather routine applications of most commercial software. One code verification method with the potential to greatly expand the number and complexity of analytical solutions is what is termed in the V&V literature as manufactured solutions.

The basic concept of a manufactured solution is deceptively simple. Given a partial differential equation (PDE), and a code that provides general solutions of that PDE, an arbitrary solution to the PDE is manufactured, i.e. made up, then substituted into the PDE along with associated boundary and initial condition, also manufactured. The result is a forcing function (right-hand side) that is the *exact* forcing function to reproduce the originally selected (manufactured) solution. The code is then subjected to this forcing function and the numerical results compared with the manufactured solution. If the code is error free the two solutions should agree.

As an illustration of a manufactured solution, consider again the ordinary differential equation (ODE) for a beam given previously in the Model Development section,

$$EIy^{IV} = w(x)$$

where for simplicity of this illustration a constant cross section has been assumed. The following manufactured solution is proposed:

$$y(x) = A \sin \frac{\alpha x}{L} + B \exp \left(\frac{x}{L} \right) + C$$

Where the four constants, i.e. A, α, B, C , are determined from the boundary conditions. Substitution of the manufactured solution into the ODE results in the expression for the forcing function $w(x)$ as

$$\frac{w(x)}{EI} = A \left(\frac{\alpha}{L} \right)^4 \sin \frac{\alpha x}{L} + \frac{B}{L^4} \exp \left(\frac{x}{L} \right)$$

The above forcing function would be prescribed as input to the discrete beam element code, and the code's discrete solution for $y(x)$ compared with the selected manufactured solution.

Calculation Verification

The above illustration of a manufactured solution used as part of code verification is only half of the verification effort. The other half is what is termed calculation verification, or estimating the errors in the numerical solution due to discretization. Calculation verification, of necessity, is performed after code verification, so that the two error types are not confounded.

In the above beam example, a poor comparison of the numerical and analytical solutions would tend to indicate an error in the numerical algorithm. However, any comparison of the numerical and analytical results will contain some error, as the discrete solution, by definition, is only an approximation of the analytical solution. So the goal of calculation verification is to estimate the amount of error in the comparison that can be attributed to the discretization.

The discretization error is most often estimated by comparing numerical solutions at two or more discretizations (meshes) with increasing mesh resolution, i.e. decreasing element size. The objective of this mesh-to-mesh comparison is to determine the rate of convergence of the solution. In the above beam example, if the numerical algorithm for integrating the ODE was the trapezoidal rule, then the error in the numerical solutions should converge at a rate proportion to the square of the mesh size, i.e. second-order convergence for the trapezoidal rule.

The main responsibility for Calculation Verification rests with the analyst, or user of the software. While it is clearly the responsibility of the software developers to assure their algorithms are implemented correctly, they cannot provide any assurance that a user-developed mesh is adequate to obtain the available algorithmic accuracy, i.e. large solution errors due to use of an coarse (unresolved) mesh are attributable to the software user.

The lack of mesh-refinement studies in solid mechanics may be the largest omission in the verification process. This is particularly distressing, since it is relatively easy to remedy.

The Validation Section

The validation process has the goal of assessing the predictive capability of the model. This assessment is made by comparing the predictive results of the model with validation experiments. If these comparisons are satisfactory, the model is deemed validated for its intended use, as stated in the V&V Plan. There is perhaps a subtle point here to be emphasized. The original reason for developing a model was to make predictions for applications of the model where no experimental data could, or would, be obtained. However, in the V&V Plan it was agreed that if the model could adequately predict some related, and typically simpler, instances of the intended use, where experimental data would be

obtained, then the model would be validated to make predictions beyond the experimental data for the intended use. Simply put, if the model passes the tests in the V&V Plan, then it can be used to make the desired predictions with confidence. The V&V Plan is of paramount importance to the V&V process.

When it is said that the model is validated for the intended use, it is not just the Computational model, which likely will have to change for the predictions of interest, but the Mathematical and Conceptual models upon which the Computation model was built that have been validated. It is through the validation of the Conceptual model that confidence is gained that the correct physics (mechanics) were included in the model development.

The key components of the validation process are the:

- *Validation Experiments* - experiments performed expressly for the purpose of validating the model.
- *Accuracy Assessment* - quantifying how well the experimental and simulation outcomes compare.

The goal of a validation experiment is to be a physical realization of an initial boundary value problem, since an initial boundary value problem is what the computational model was developed to solve. Most existing experiments do not meet the requirements of a validation experiment, as they were typically performed for purposes other than validation. Certainly appropriate existing experimental data should be used in the validation process, but the resulting confidence in the model's ability to make predictions, based on these experimental results, is diminished, relative to validation experiments. The reduced confidence arises from the necessity of an analyst needing to select physical and numerical parameters required for the model that were left undefined in the experiment. As an example, an experiment may report that a steel plate was tested and the steel used was designated A36 steel, indicating the manufacturer's minimum specification for a yield strength of 36,000 psi. In fact the yield strength of the specimen tested could be significant greater than that minimum.

The important qualities of a validation experiment include:

- *Redundancy of the Data* - repeat experiments to establish experimental variation.
- *Supporting Measurements* - not only are measurements of the important system response quantities of interest recorded, but other supporting measurements are recorded. An example would be to record the curvature of a beam to support a strain gauge measurement.
- *Uncertainty Quantification* - errors are usually classified as being either random error (precision) or systematic error (bias).

Once the experimental and simulation outcomes are obtained, the accuracy assessment phase of the validation process can begin. If possible, the comparison of

the experimental and simulation outcomes should be made by an interested third party, as this helps to remove a bias that favors either the experimental or the simulation results. In addition to deciding what response quantities should be compared, the V&V Plan should state how the quantities are to be compared.

Validation metric is the term used describe the comparison of validation experiment and simulation outcomes. These metrics can range from simple binary metrics, e.g. was the material's yield strength exceeded, to more complex comparisons involving magnitude and phase difference in wave forms, e.g. deceleration history in a vehicle crash. Whatever the form of the validation metric, the result should be a quantitative assessment of the agreement between the experiment and simulation. Hopefully, this quantification will also include an estimate of the variability in the agreement and a confidence statement about the variability, e.g. the relative error between the experiment and simulations was 18% plus or minus 6% with a 85% confidence level. This three-part comparative statement is provided to the decision maker, along with all the supporting V&V documentation, to aide in their decision making process about the validity of the model for the intended use.

The Conclusion Section

Some of the remaining important V&V activities requiring guidance from the community:

- *Verification* - this 'poor' sister of validation needs more attention from the V&V research community. Reliance on regression testing for code verification provides minimal confidence when using today's complex multi-physics and multi-scale software. Methods, and their implementation as tools, for verification of increasing software complexity are needed.
- *Quantification of the Value of V&V* - if program managers are asked to spend resources on V&V, they needed some measure of the value they are receiving for the resources expended.
- *Incomplete V&V* - if the V&V process is terminated before a successful conclusion, what is the best path forward for the decision maker?
- *Validation Experimentation* - most experiments consume large amounts of resources, the value of these experiments to the V&V process needs to be quantified to enable decision makers to appropriately allocate resources for this important activity.
- *Uncertainty Quantification* - meaningful comparisons of simulations with experiments requires an estimate of the uncertainty in both sets of results, and a comparative assessment of these two uncertain outcomes.
- *Predictive Confidence* - when validated models are applied beyond the limited range of validation experiments, how can the confidence in these results be quantified? ●

Committee Roster for PTC 60/V&V 10

The following is a list of members the ASME Committee on Verification & Validation in Computational Solid Mechanics who participated in writing, and voting approval, of the Guide.

Officers

L. E. Schwer, Chair
H. U. Mair, Vice Chair
R. L. Crane, Secretary

Committee Personnel

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J. A. Cafeo, *General Motors Corporation*
R. L. Crane, *The American Society of Mechanical Engineers*
S. W. Doebling, *Los Alamos National Laboratory*
J. H. Fortna, *ANSYS*
M. E. Giltrud, *Defence Threat Reduction Agency*
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Y. Zhao, *St. Jude Medical*

The Committee acknowledges the contributions of the following individuals associated with the Committee:

G. Gray, Former Member,
Los Alamos National Laboratories
F. Hemez, Alternate,
Los Alamos National Laboratories
R. Lust, Alternate,
General Motors Corporation
C. Nitta, Alternate,
Lawrence Livermore National Laboratory
V. Romero, Alternate,
Sandia National Laboratories
J. M. Burns, Liaison Member,
Burns Engineering
W. G. Steele, Jr., Liaison Member,
Mississippi State University

2006 Prince Philip Medal awarded to Professor Olek Zienkiewicz

The **Royal Academy of Engineering** presented its solid gold Prince Philip Medal to **Professor Olek Zienkiewicz CBE FREng FRS**, widely regarded as the “*Father of the Finite Element Method*”, for outstanding contributions spanning the wide field of mechanics and engineering.

Professor Zienkiewicz received the Prince Philip Medal from HRH Duke of Edinburgh at Buckingham Palace on 16 June 2006 at a glowing ceremony attended by his wife, Helen and his daughter.

The Prince Philip Medal, instigated in 1989, is awarded periodically to an engineer of any nationality “who has made an exceptional contribution to engineering as a whole through practice, management or education.”

Olek Zienkiewicz is Emeritus Professor and former Director of the Institute for Numerical Methods in Engineering at the University of Wales, Swansea. He holds the UNESCO Chair of Numerical Methods in Engineering at the Technical University of Catalunya in Barcelona and is a past holder of the Joe C Walter Chair of Engineering at the University of Texas, Austin.

Born in Surrey in 1921, he attended primary and secondary schools in Poland and obtained his BSc, PhD and DSc at Imperial College. Since his first paper in 1947 dealing with numerical approximation to the stress analysis of dams, he has published nearly 600 papers and written or edited more than 25 books. He was one of the early pioneers of the Finite Element Method and was the first to realise its potential for the solution to problems outside the area of solid mechanics. His own

contribution to the Method’s development made it the widely applicable tool of computational mechanics and engineering that it is today. His books on the Finite Element Method were the first to present the subject and to this day remain the standard reference texts.

In his research career, he has personally supervised over 70 PhD students, many of whom today hold leading positions in academia and industry. He also founded the first journal dealing with computational mechanics in 1968 (International Journal of Numerical Methods in Engineering) which is still the major journal for the field of Numerical Computations. He has served as a member of Council of the Institution of Civil Engineers and was the Chairman of the Analysis and Design Committee of the International Congress for Large Dams.

Professor Zienkiewicz has received honorary degrees from Ireland, Belgium, Norway, Sweden, China, Poland, Scotland, Wales, France, England, Italy, Portugal, Hong Kong, Hungary and the United States. He has been the recipient of many awards, including the title of Commander of the British Empire, the prestigious Royal Medal of the Royal Society from HM Queen Elizabeth II, the Carl Friedrich Gauss Medal of the West German Academy of Science, the Nathan Newmark Medal of the American Society of Civil Engineers, the Newton-Gauss Medal of the International Association for Computational Mechanics, the Gold Medal of the Institution for Mathematics and its Applications, a Gold Medal from the Institution of Structural Engineers and the Timoshenko Medal of the American Society of Mechanical Engineers. He was



elected to the Royal Society and The Royal Academy of Engineering in 1979 and is a Foreign Member of the United States National Academy of Engineering, the Polish Academy of Science, the Italian National Academy of Sciences and the Chinese National Academy of Sciences.

The Prince Philip Medal, instigated in 1989, is awarded periodically to an engineer of any nationality “*who has made an exceptional contribution to engineering as a whole through practice, management or education.*” The list of previous winners is short but very eminent and includes:

- **Professor James Dooge** *FREng* (2005), retired Chair in Civil Engineering, University College Dublin, one of the most eminent engineers to have come out of Ireland for his contribution to professional practice in hydraulic engineering and hydro-electric design, and who led many advances in the application of linear systems theory to hydrology;

- **Professor William Bonfield** *CBE, FREng, FRSA*, (2004) Professor of Medical materials at the University of Cambridge, for his outstanding achievements in developing and taking right through to commercialisation and clinical use the world leading ‘artificial bone’ material;

- **Professor David Rhodes** (2003), Executive Chairman of Filtronic plc, in recognition for his outstanding research expertise in communications technology which he developed into a highly successful world-wide company;

- **Philip Ruffles** *CBE RDI FREng FRS* (2001) for his key role behind Rolls-Royce’s award-winning Trent family of engines, which have captured over half the global market;

- the Academy’s President **Sir Alec Broers** *FREng FRS* (now Lord Broers), Vice-Chancellor of the University of Cambridge (2000) both for pioneering miniature electronic circuits on silicon chips and for building the university’s links with industry;

- **Sir John Browne** *FREng*, Chief Executive of BP Amoco plc, in 1999 for his engineering and managerial achievements in creating Britain’s biggest company;

Founded in 1976, The Royal Academy of Engineering promotes the engineering and technological welfare of the country. Our fellowship - comprising the UK’s most eminent engineers - provides the leadership and expertise for our activities, which focus on the relationships between engineering, technology, and the quality of life. As a national academy, we provide independent and impartial advice to Government; work to secure the next generation of engineers; and provide a voice for Britain’s engineering community. ●



Figure 1:
Prof. Zienkiewicz receiving the award from Prince Philip



Figure 1:
Prof. Zienkiewicz joined by his wife, Helen and daughter Krysia at Buckingham Palace

2006 WCCM-VII

A Successful International Event



Figure 1: W. K. Liu, W. Ju and their spouses at the reception



Figure 2: W.K. Liu, J.T. Oden, T. Belytschko, & C. Farhat at the reception



Figure 3: J. Fish, R. Ohayon, and delegate at the reception



Figure 4: B. Schrefler and C. K. Choi at the reception

The 7th World Congress on Computational Mechanics (WCCM-VII) was successfully held at the Hyatt Regency Century Plaza Hotel in Los Angeles, California, USA, during July 16-22, 2006. The WCCM-VII was co-organized by Northwestern University and UCLA, and was under the auspices and guidance of the International Association for Computational Mechanics.

The WCCM-VII's technical themes — computational mathematics, computational bioscience, computational nanotechnology, computational materials science, and high performance computing — showcased the many applications of computation mechanics to scientific research and industrial development.

Nearly 1,900 people from 59 countries around the world attended this Congress. As the largest worldwide scientific event held to date in the discipline of computational mechanics, the Congress offered 130 minisymposia and 460 technical sessions over the course of the seven-day event. More than 2,000 technical abstracts were included in the WCCM-VII Congress Proceedings. Furthermore, 10 plenary lectures and 17 semi-plenary lectures



Figure 5: C. Rigmailden and E. Taciroglu at the reception



Figure 7: Opening Remarks: T. Belytschko, J. S. Chen, V. Dhir, W. K. Liu & E. Oñate

were delivered by the most distinguished international scholars in computational mechanics; and two short courses on the emerging fields of computational mechanics were also held in this Congress. In addition to the extensive technical presentations and discussions, a total of 14 exhibitors participated in the exhibition of the state-of-the-art technologies, softwares and scientific applications in computational mechanics. The deputy mayor of the City of Los Angeles and the Dean of engineering of UCLA also participated in the Congress event.

Many sponsors contributed to the success of WCCM-VII. The US Association for Computational Mechanics and National Science Foundation provided sponsorships to student travel, student paper competition, and workshops. Other sponsors include: Sandia National Laboratories, Holman's, Hewlett Packard, ADINA, EDS, GEI, Wiley, Taylor & Francis, COMSOL, Springer, Oxford, Elsevier, Begell House, and GiD. ●

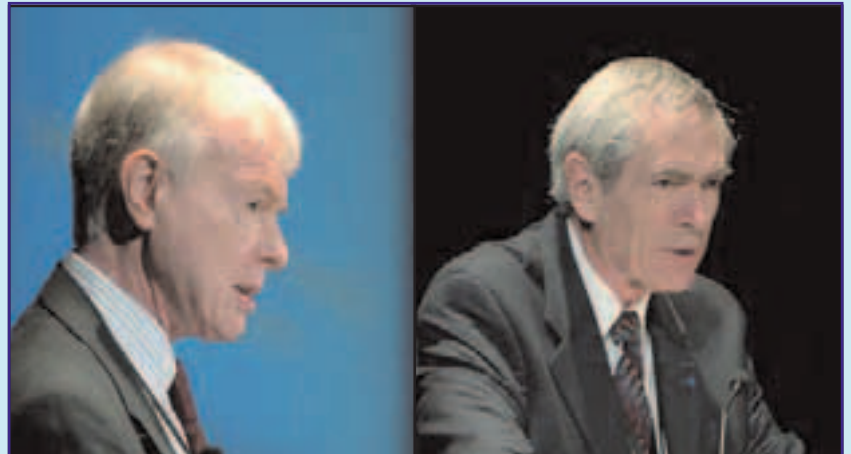


Figure 8: Opening Plenary Lecture hosted by J.T. Oden (right) and delivered by T. Hughes (left)



Figure 9: T. Belytschko, Deputy Mayor of the City of Los Angeles & E. Oñate at the banquet dinner



Figure 6: Reception - Reflection Pools & Gardens of Hyatt Regency Century Plaza Hotel



Figure 10: Banquet dinner in the Los Angeles Ballroom



news

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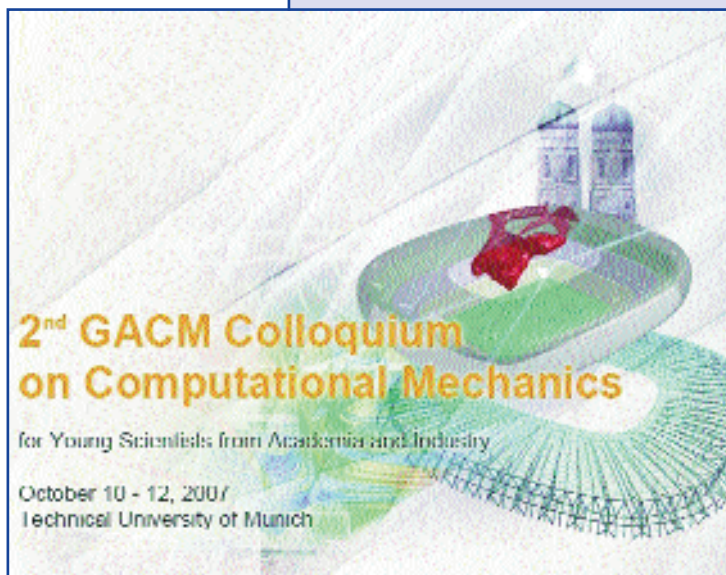
Decisions taken in the first round of the German Excellence Initiative

The final decision in the first round of the so-called German Excellence Initiative (cf. expressions No 18) is taken. It has been elaborated by an international scientific committee, especially formed for this purpose, under the guidance of the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and a governmental institution called "Wissenschaftsrat" (scientific council), on the basis of 88 proposals from universities throughout the country. After negotiations with representatives from the German government, the decision has been published on October 13th in a press release by the DFG (http://www.dfg.de/aktuelles_presse, in German). Institutions that have not been successful in this first round still have a second chance in fall 2007, when a similar decision is taken, equipped with comparable funds.

According to the DFG, a total of 22 German universities are provided with extra money for the implementation of graduate schools and so-called excellence clusters, as well as for the realization of future concepts for the upgrading of top level research in particular projects. The University of Karlsruhe and two universities in Munich (the "TUM" and the "LMU") are the only ones that succeeded with applications in all three categories – a prerequisite for the nonofficial label of an "Elite University" which is generally expected to have a certain impact on future decisions of students, scientists and sponsors from industry.

Available funds for this first round amount to 873 Million euros for the period from 2006 to 2011. Evaluation criteria have focused on scientific excellence rather than proportional political or regional distribution. Nevertheless, the fact that all aforementioned "Elite Universities" are located in the south of Germany – two of them in the same city – has prompted a controversial echo. There is a strong hope, though, in the scientific community that this will not remain a singular decision but the process will lead to a sustainable competition between the leading institutions on the basis of scientific criteria. ●

2nd GACM Colloquium



Following the great success of the 1st GACM Colloquium for **Young Scientists**, hosted by the Department of Civil Engineering at Ruhr-Universität Bochum in October 2005 (expressions No 19), the 2nd event of this series will be held in Munich.

The chairmen are W.A. Wall, K.-U. Bletzinger, H.-J. Bungartz and E. Rank, all from the Technical University of Munich (TUM) and G. Müller from the company CADFEM.

The local organizing committee consists of V. Gravemeier (TUM) and M. Hörmann (CADFEM).

Outstanding Program for Young Scientists in Germany:

First Research Group in Computational Mechanics

Responding to the current situation for young scientists in Germany, characterized by a considerable “brain drain” and relatively late scientific autonomy, among other things, the German Research Foundation (DFG) promotes outstanding young scientists in the Emmy Noether Program since 1999. The ambition of the program, which has already established a very high reputation, is to enable an early scientific autonomy and a speedy qualification of the young scientists for leading positions in science in Germany.

The members of the program are elected based on their hitherto existing scientific career and a sound standing research proposal. Having been elected to the program, the promoted young scientist is granted the resources required for establishing a research group he will be in charge of and the realization of the requested research projects for up to five years.

About 350 Emmy Noether Research Groups have been launched since the initiation of the program, mainly settled in the natural sciences, medicine, and computer science, and only few in engineering. To our knowledge, the first Emmy Noether Research Group in the field of computational mechanics has recently been granted. GACM member Dr. Volker Gravemeier, Research Associate at the Chair for Computational Mechanics, Technical University of Munich, was elected in August 2006 to be a member of the Emmy Noether Program. His project is entitled „Computational multiscale methods for turbulent combustion in complex geometries“, and his group will be located at the Technical University of Munich.

Volker Gravemeier received his PhD from the University of Stuttgart in 2003. In 2004, he was a Feodor Lynen scholarship holder of the Alexander von Humboldt-Foundation and Postdoctoral Fellow of the Center for Turbulence Research (CTR), Stanford University and NASA Ames Research Center. Since 2005, he works together with Professor Wolfgang A. Wall at the Chair for Computational Mechanics. ●



Figure 1:
*Volker Gravemeier,
Emmy Noether
Awardee
from the Chair of
Computational
Mechanics,
Munich*

on Computational Mechanics to be held in Munich

The Colloquium will provide a forum for **young scientists** both from academia and industry engaged in research on computational mechanics and computer methods in applied sciences to present and discuss results emanating from recent research efforts and non-standard industrial applications. Particular emphasis will be given on the exchange of ideas among various fields in Computational Mechanics to support further progress of ongoing research and the initiation of new promising research directions. The main focus of the colloquium is on innovative theoretical and methodical developments as well as new fields of application for Computational Mechanics.

In the spirit of the previous event – from young scientists for young scientists – the new computational mechanics generation is not only invited to contribute papers, but also encouraged to propose and organize their own minisymposia.

Important dates:	<i>December 15, 2006</i>	minisymposia proposals
	<i>March 31, 2007</i>	one-page abstracts
	<i>May 1, 2007</i>	abstract acceptance
	<i>June 1, 2007</i>	early registration ●

For additional information, visit www.lnm.mw.tum.de/gacm07/



Figure 2:
*The Department of Mechanical
Engineering at the TUM-Campus*



CHILEAN SOCIETY FOR COMPUTATIONAL MECHANICS

The fourth consecutive annual meeting of the Chilean Society for Computational Mechanics (its Spanish acronym is SCMC) has been organized in Concepción, Chile, by the Mechanical Engineering and the Civil Engineering Departments of the Universidad de Concepción (UdeC). It was the **V Workshop on Computational Mechanics (JMC 2006)**. It was hosted by the University where the SCMC was born during the first version of this workshop in 1995. During the opening ceremony, the Dean of the Faculty of Engineering at UdeC, Prof. Joel Zambrano Valencia, welcome the participants and, on behalf of the SCMC, Mrs. Marcela Cruchaga acknowledged the hospitality of the UdeC. She also thanked to the Organizer Committee the effort devoted to coordinate the Workshop, in particular, to Prof. Emilio Dufeu. The Workshop was rich in Invited Speakers: Prof. Pierre Beckers from Liège (Belgium), Prof. Juan Carlos Heinrich from New Mexico (USA) and Prof. Ezra Bar-Ziv from Israel.

Figure 1:
*Prof. Pierre Beckers (Invited Speaker),
Profs. Luis Quiroz and Emilio Dufeu (Members of the
Organizer Committee), Prof. Joel Zambrano Valencia
(Dean of the Faculty of Engineering at UdeC) and
Prof. Juan Carlos Heinrich (Invited Speaker)*



Figure 3:
*Participants of the V Workshop on Computational Mechanics (JMC 2006)
hosted by the Universidad de Concepción (UdeC) at Concepción - Chile, August 25th 2006.*



Figure 2:
*Prof. Oscar Fariás Fuentes (UdeC),
Prof. Ezra Bar-Ziv (Invited Speaker),
Prof. Carlos Rodriguez (UdeC) and
Prof. Marcela Cruchaga (U. de Santiago de Chile,
President of SCMC)*

36 works have been submitted to be presented during the meeting and 16 full written papers were published in the journal of the SCMC ("Cuadernos de Mecánica Computacional", ISSN 0718-171X). As in its previous versions, the organizers of this meeting have encouraged the participation of under and post-graduate students and young researchers giving the opportunity to present their first works. Developments and applications from different areas of Engineering and Sciences have been presented. The SCMC invites to the readers to visit its new web page <http://www.scmc.cl>. The visitor of the web will find information about the SCMC and the workshops including a summary, a list of works and photos as well as news of the Workshop 2007 (JMC 2007) to be hosted by the Universidad de Chile at Santiago the Chile where the Computational Mechanics community is cordially invited to come. ●



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Following the effort on the reorganization and revitalization of our Association, several important events have been sponsored or supported by ABMEC on recent and on the coming year. In the following we present briefly the announcement of some of the **Forthcoming Events** and the description of some recently organized events.

CMNE / CILAMCE 2007 is a joint organization of the Portuguese (APMTAC), Spanish (SEMNI) and Brazilian (ABMEC) Associations for Numerical and Computational Methods in Engineering and will congregate the Iberian Latin American community in Porto, Portugal, from **13 to 15 of June, 2007**. CMNE is the Congress on Numerical Methods in Engineering jointly organized by the Portuguese and Spanish Associations, alternating the country at each edition. The first congress of this new series took place in Madrid (2002), followed by those of Lisbon (2004) and Granada (2005). The 4th edition of the congress in this series will be together with the 28th CILAMCE (Iberian Latin American Congress on Computational Methods in Engineering). The congregation in Porto of these two congresses in 2007 will reinforce the scientific relations and future cooperation between the scientific communities in both sides of the Atlantic. Abstracts must be submitted electronically before November 15, 2006. For further details see: <http://numiform.inegi.up.pt/CMNE/>. ●

The first Biomechanical Engineering National Meeting is an initiative of the Bioengineering Committee of the Brazilian Association for Engineering and Mechanical Sciences (ABCM), supported by the Brazilian Association for Numerical Methods in Engineering (ABMEC), to promote the integration and exchange of experiences among the different Brazilian research groups in the area of Engineering Biomechanics. Professionals and students from Health Sciences (medicine, physiotherapy, dentistry, etc) are most welcome, contributing to the discussion of bioengineering problems with their engineering colleagues. The event will take place in Itaipava, Petropolis, RJ - Brazil, from **May 30 to June 1, 2007**. The following invited speakers have confirmed presence: Raul Gonz ales Lima, EPUSP-Brazil, Id agine Cestari, INCOR- Brazil, S ergio Oller - UPC, Barcelona, Raul Feij o, LNCC-Brazil. The official language will be Portuguese. For further details see: <http://eneb-abcm.tripod.com/>. ●

VECPAR'06

ABMEC sponsored the *7th International Meeting on High Performance Computing for Computational Science and Engineering* from **July 11-13**, in Rio de Janeiro, Brazil.

The conference is a multidisciplinary meeting and offers an opportunity for gathering of an enlarged scientific community made up of mathematicians, physicists, engineers, i.e. all branches of science reverting to computer simulations for analysis of complex systems and phenomena.

VECPAR'06, the seventh edition the VECPar series of conferences, organized jointly by the Federal University of Rio de Janeiro and the Institute of Pure and Applied Mathematics. VECPar'06 hosted 5 invited speakers, Omar Ghattas, from ICES - University of Texas at Austin, Bruce Hendrickson, from Sandia National Laboratory, Christopher R. Johnson from the University of Utah, Kenichi Miura, from the National Institute of Informatics, Japan and Marcos Donato, from Petrobras, Brazil. Circa of 61 papers were presented on different topics with over 100 participants. Pos-conference activities included two workshops, the 'Workshop on Computational Grids and Clusters: Models, Middlewares, Testbeds, Architectures', the 'International Workshop on High-Performance Data Management in Grid Environments'. In Parallel with these activities, it was also organized the Grid Computing School.

Please visit <http://vecpar.fe.up.pt/2006/index.html> for the full program, papers & photos. ●



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CILAMCE

CILAMCE (Iberian Latin American Congress on Computational Methods in Engineering) is the official annual conference of ABMEC and it is a prestigious conference that has been organized since 1977 with 27 editions

Highlights of CILAMCE 2005

The 26th edition was held in **Guarapari**, Espírito Santo, Brazil, **October 19th to 21st, 2005**. It was organized by the Federal University of Espírito Santo (UFES) and the chairmen of the conference were Professors Andréa Maria P. Valli and Neyval C. Reis Jr.



Guarapari is a beach resort in the coast of Espírito Santo State. Its famous beaches attract tourists from all over the world. One of the better known beaches is Praia da Areia Preta (Black Sand Beach) for its medicinal properties due to its radioactive sands.

The Research Beginners on Computational Mechanics mini-symposium, which was created to stimulate the participation of undergraduate students, had its second year edition and the prize for the best three papers had the following winners:

Diogo T. Cintra, Humberto de Carvalho Júnior, José R. M. Barbosa Júnior and João P. N. de Araújo (UFAL) and *Filipe X. C. Andrade* from (UDESC).

Participants: There were researchers from 17 countries (Americas, Europe and Asia) and from 18 states of Brazil. Besides, we had around 400 participants. Initially over 1000 abstracts were submitted, then over 500 full papers were submitted and after the three stages reviewing process 482 papers were accepted to be presented in the conference and published in the conference proceedings.

Scientific Programme: 6 invited plenary lectures and several invited mini-symposia keynote lectures performed by acknowledged experts, 30 thematic mini-symposia with contributed papers, encompassing most Engineering and Applied Sciences fields and one "Research Beginners" mini-symposium.

Plenary Lectures:

Abimael F. D. Loula, Laboratório Nacional de Computação Científica, "Stabilized Finite Element Methods for Helmholtz Problem";

Eduardo A. de Souza Neto, University of Wales Swansea, "On the Multi-Scale Constitutive Modeling of Solids under Large Strains";

Isaac Harari, Tel Aviv University, "Spatial Stability of Semidiscrete Formulations for Transient Computation";

J. N. Reddy, Texas A&M University, "Computational Models of Materials and Mechanics";

José Luis Drummond Alves, Universidade Federal do Rio de Janeiro, "Computational Solid Mechanics with Finite Elements and Discrete Elements";

Philippe Remy Bernard Devloo, Universidade Estadual de Campinas, "Evolution of Scientific Software".

The Congress banquet and ball happened at an old stone mine, a nice and somewhat mystic place surrounded by huge cliffs. After the student award session, we had folk dance presentations, dinner and a plenty of drinks and a dancing throughout the whole night. ●



Figure 1:
Plenary Section -
Prof. Eduardo A.
de Souza Neto.



Figure 2:
Dinner and ball at an old rock mine

2005 and 2006 Overview

up to now (eighteen times in Brazil and nine times abroad). Following the success of its previous editions we had the 26th and 27th Congresses in year 2005 and 2006, respectively. Over the last three editions, a selection

of the best papers of the conference has been considered for publication on special editions of two International Journals: Communications in Numerical Methods in Engineering and Latin American Journal of Solids and Structures.

Highlights of CILAMCE 2006

The 27th edition was held in in **Belém**, capital of the State of Pará, Brazil, from **September 3 to 6, 2006**. It was hosted by the Graduate Program in Civil Engineering at the Federal University of Pará, and the Chaimen were Professors Remo M. de Souza and Regina A. C. Sampaio.

Belém is located in the Guajará bay, in the delta of the Amazon River, close to "Ilha do Marajó", the largest fluvial island in the world. Belém prides itself on being the gateway to the Amazon Region and the cultural and commercial center of Northern Brazil. While the newer part of the city contains many modern buildings and skyscrapers, the colonial section still retains the charm of ancient churches and other historical buildings with their traditional Portuguese blue tiles.

The Research Beginners on Computational Mechanics mini-symposium had its third year edition and the prize for the best five papers had the following winners: *Tiago A. Queiroz* (UFGO), *Renato S. Motta* (UFPE), *Clayton T. Aquino* (UFAL), *Israel B. Sardinha* (UFPA), *Maria C. R. Sena* (UFAL)

Participants: There were researchers from 15 countries (Americas, Europe and Asia) and from 20 states of Brazil. Besides, we had around 450 participants. Initially around 1000 abstracts were submitted, then 546 full papers were submitted and after the three stages reviewing process 489 papers were accepted to be presented in the conference and published in the conference proceedings.

Scientific Programme: 6 invited plenary lectures and several invited mini-symposia keynote lectures performed by acknowledged experts, 30 thematic mini-symposia with contributed papers, encompassing most Engineering and Applied Sciences fields and one "Research Beginners" mini-symposium.

Plenary Lectures: *Djorge D. Peric*, University of Wales Swansea, "Some Advances on Fluid-Structure Interaction Problems"; *Emilio C. Nelli Silva*, Universidade de São Paulo, "Design of Smart Materials and Structures Using Topology Optimization"; *Filip C. Filippou*, University of California at Berkeley, "Advances in Nonlinear Structural Analysis"; *Gernot Beer*, Technische Universität Graz, "Efficient Numerical Simulation of problems in Geomechanics"; *Paulo R. M. Lyra*, Universidade Federal de Pernambuco, "Unstructured Grid Algorithms and Auxiliary Tools for CFD Applications"; *Victorio Sonzogni*, Universidad Nacional del Litoral, "Parallel Computing in Engineering, Domain Decomposition Methods and Some Developments on a Beowulf Cluster".

The Congress banquet and ball happened at the home of the Gems Museum of Pará. After the student award session, we had the dinner accompanied by music and dancing including a variety of rhythms and an extremely enjoyable night. ●



Figure 1:
Opening Ceremony



Figure 2:
"Carimbó" folk dance at Hilton Hotel.

Other Recently Supported Events

● **SIMMEC 2006:** *7th Computational Mechanics Symposium*, held in Araxá/MG-Brazil, May 31 to June 02, (<http://www.cefetmg.br/simmec2006/>);

● **2nd LNCC Meeting on Computational Modelling:** held at LNCC, Petrópolis/RJ-Brazil August 8 to 11 (<http://www.lncc.br/comprode>);

● **Variational Formulations in Mechanics: Theory and Applications**

A Workshop dedicated to the 60th Birthday of Professor Raúl A. Feijóo, held at LNCC, Petrópolis/RJ-Brazil, September 3 to 5 (<http://www.lncc.br/variational>). ●



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The Israel Association for Computational Methods in Mechanics (IACMM) has held three IACMM Symposia since our last report (see IACM Expressions No. 18). In this issue we shall report on these recent events.

The 18th IACMM Symposium was held in April 2005 at the Department of Civil and Environmental Engineering, Technion - Israel Institute of Technology. The local organizer was Prof. Moshe Eisenberger. The Symposium opening keynote lecture was given by Prof. Uri Kirsch from the hosting department (Fig. 4). Prof. Kirsch is a world renowned researcher in structural and multidisciplinary optimization. He talked about a recent optimization method called Combined Approximation which was developed by Prof. Kirsch's group (and hence is also known as the Kirsch method). This method is based on a perturbation technique, and attempts to overcome the all too known difficulty of expensive re-analysis in optimization schemes.

Among the other ten lectures that were given in this Symposium, we mention the interesting talk presented by Moshe Zelkha, a Technion graduate student, who described his work with Prof. Robert Levy, also from the hosting department, and Dr. Erez Gal from Ben Gurion University in the Negev. This research group developed a simple computational model for wrinkles in geometrically-nonlinear membranes. Comparison of the numerical results to laboratory experiments generally shows very good agreement (Fig. 5).

The 19th IACMM Symposium was held in Oct. 2005 at the Tel-Aviv Jaffa Academic College. The local organizers were Prof. Boris Epstein and Dr. Hillel Tal-Ezer. The Symposium included a keynote lecture given by John C. Vassberg from Boeing - Phantom Works in CA, USA. In his talk, Dr. Vassberg described his joint work with Prof. Antony Jameson from Stanford University on recent advances in aerodynamic shape optimization. The talk consisted of a review and comparison of various existing methods and then focused on Adjoint Equation Gradient type methods.

The other ten lectures in the 19th Symposium included a few lectures given by graduate students. Eran Grosu from the Dept. of Mechanics, Materials and Systems at Tel Aviv University described his research work with Prof. Isaac Harari on the satisfaction and violation of the principle of causality by time integration schemes in elastodynamics. Nathan Perchikov, from the same department, talked about his work with Prof. Moshe Fuchs on optimal topological design of stiffened plates. Zvika Assaf described research work with Dr. Dror Rubinstein and Prof. Itzhak Shmulevich from the Dept. of Civil and Environmental Engineering at the Technion, on a Discrete Element Method (DEM) for granular material with friction. The application of this work is to agricultural processes involving terramechanics in soil (Figs. 6 and 7).



Figure 1:
Audience in the
20th IACMM
Symposium.



Figure 2:
Dr. Abigail Wacher
Keynote Lecturer
Symposium.



Figure 3:
Prof Stefan Hartmann
at the 20th IACMM



Figure 4:
Prof. Uri Kirsch, Keynote
lecturer at the 18th
IACMM Symposium.

The 20th IACM Symposium was held in March 2006 at Tel Aviv University. The local organizers were Dr. Slava Krylov and Dr. Alexander Gelfgat. The Symposium drew varied audience from industry and academia (Fig. 1). The Symposium included two keynote lectures. The first one was given by Dr. Abigail Wacher, from the Department of Aerospace Engineering at the Technion (Fig. 2), who talked about the method of Weighted Moving Finite Elements.

The second keynote lecture was given by Prof. Stefan Hartmann from the University of Kassel in Germany (Fig. 3), who talked about recent advances in computational viscoelasticity. After seven more lectures on various subjects of computational mechanics, the Symposium ended with a "tutorial session" given by Prof. Pinhas Bar-Yoseph from the Dept. of Mechanical Engineering at the Technion on Discontinuous Galerkin Methods.

The 20th Symposium was particularly festive and included a short ceremony to celebrate 20 successful IACMM Symposia to date. ●



Figure 5:
Wrinkles in a membrane - comparison of computational results and a "qualitative experiment"; from a presentation of Zelkha, Gal and Levy.



Figure 6:
Simulation of digging in soil; from a presentation of Assaf, Rubinstein and Shmulevich in the 19th IACMM Symposium.

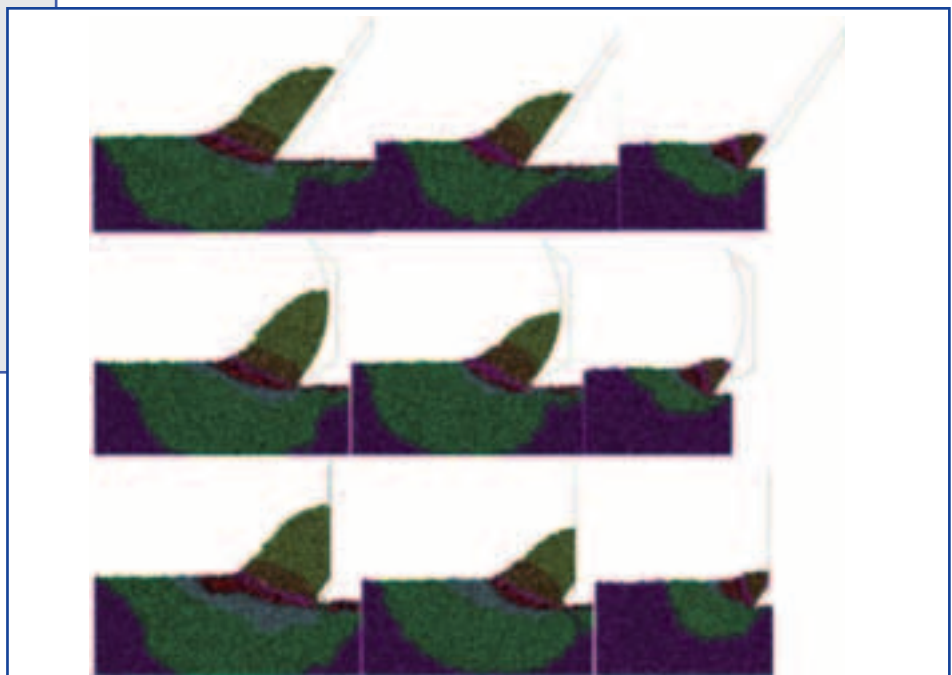


Figure 7:
Model of a bulldozer blade
as a part of the
cross-section shape optimiza-
tion; from a presentation of
Assaf, Rubinstein and
Shmulevich in the 19th IACMM
Symposium.

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Student Presentation Competition

held during
The Seventh World Congress on Computational Mechanics
July 2006

The Seventh World Congress on Computational Mechanics, held in Los Angeles, California in July 2006 was a great success. All of the organizers are to be congratulated; special recognition is given to Conference Chairs Profs. Wing Kam Liu and Ted Belytschko of Northwestern University and to Profs. J.S. Chen and J.W. Ju of UCLA.

USACM was pleased to offer travel grants to twenty young faculty, post-doctoral fellows and graduate students to help support their expenses to attend the World Congress. In addition, 25 people received support to attend the Multiscale Computational Methods and Applications short course, sponsored by the National Science Foundation.

During the World Congress, the USACM sponsored a Student Presentation Competition. This inaugural event was organized by Professor John Dolbow of Duke University and by Dr. Len Schwer of Schwer Engineering & Consulting Services.

The competition consisted of presentations of original student work, in the six specialty committee areas of the USACM, during the World Congress, and judging of the presentations by members of the specialty committees. *The six specialty areas are:* Biotechnology; Integration of Computational Mechanics with Manufacturing; Material Modeling; Meshfree Methods; Nanotechnology; Verification & Validation.

The purpose of the specialty committee is to provide a focus on these areas of computational mechanics through organization of specialty minisymposia during USACM & IACM Congresses, and other activities the committees develop in their areas.

Twenty six students participated in the competition; all received certificates of recognition. Seven monetary awards were given, including a tie in the Integration of Computational Mechanics with Manufacturing specialty area.

The seven awardees are:

Christopher Blakely, University of Maryland at College Park;
Martijn Hans Albert Bonte, University of Twente;
Khairul Chowdhury, Texas A&M University;
Sivom Manchiraju, Ohio State University;
Roger Sauer, University of California at Berkeley;
Mohit Tandon, University of Utah;
Irene Vignon-Clementel, Stanford University.

The Ninth US National Congress on Computational Mechanics (USNCCM9) will be held in San Francisco, California July 22 – 26, 2007. The Congress chairs are Profs. Panos Papadopoulos, Tarek Zohdi, and Robert Taylor (honorary), of the University of California-Berkeley.

More information about the Congress can be found in this issue of iacm expressions; for complete details, visit the website:

<http://www.me.berkeley.edu/compmat/USACM/main.html>

Conference fellowships will be awarded. The Student Presentation Competition also will be held during USNCCM9. ●



9th US National Conference on Computational Mechanics

Hyatt Regency
San Francisco, California, USA

Technical Program
Pre- & Post-Congress Short Courses

July 23-26, 2007
July 22 & 26, 2007

Hosted by:
University of California, Berkeley
Co-chairs: P. Papadopoulos, T. I. Zohdi



Web site: <http://me.berkeley.edu/compmat/USACM/main.html>

NEWS

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Figure 1:

One scene from the banquet attraction at EPMESC X

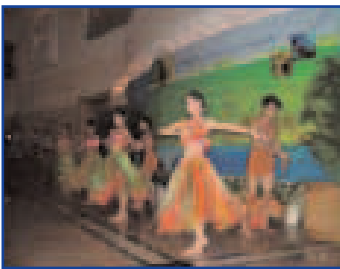
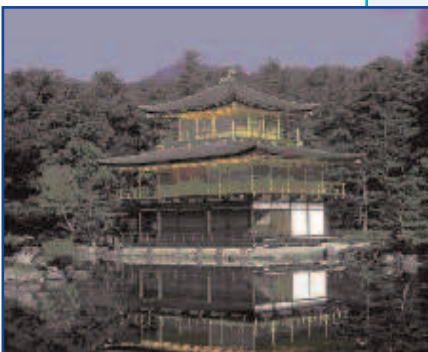


Figure 1:
Kinkaku-ji



EPMESC X

21-23 August 2006 - Sanya, China

The General Chairman of the Conference: Prof. M.W. Yuan (China)

The 10th International Conference on Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC X) was held during **August 21-23, 2006** in Sanya, Hainan Island, China.

Sanya is the southern most city in China with the best ecological environment and no pollution since there are no industries. It is a beautiful city with blue sky, white cloud, peaceful sea and long beach with white sand, shells and pearls.

After an initial call for papers, more than 190 abstracts from 20 countries were received. Finally, 108 delegates from 17 countries and regions- China, Macau, Hong Kong, Taiwan, Korea, Japan, Singapore, Australia, Portugal, USA, UK, Germany, Austria, France, Poland, Israel - participated in the conference. Professor Valliappan (Australia), Professor Eduardo Oliveira (Portugal) and Professor Lu Vai Pan (Macau) delivered the opening addresses and welcomed the delegates. 3 Plenary lectures and 13 Semi-plenary lectures were delivered by distinguished experts in computational mechanics. 83 technical papers were presented in 4 parallel sessions.

EPMESC series of conferences has been an excellent avenue for exchanging progress and achievement in computational mechanics research. Further, it has been a good platform for young researchers and graduate students to present their research work, gain experience in the art of delivery of lectures, meet and exchange ideas with a number of senior researchers from around the world.

One of the highlights of EPMESC series is the 'student paper competition' from graduate students in the world. During this conference, 16 doctoral candidates provided their research results both in written form and oral presentation. A panel of experts reviewed their papers and judged their oral presentation. Three winners - K.I.Hoi and H.K.Tam from University of Macau and Wei Li from Tsinghua University, China- were declared by the panel of experts.

The proceedings of the conference have been edited by Z.H.Yao, M.W.Yuan and Y.Q.Chen and published by Tsinghua University and Springer. Following this successful conference, the next EPMESC conference will be held in conjunction with APCOM'07 in Kyoto, Japan during December, 2007. ●

APCOM'07

in conjunction with EPMESC XI

Third Asian-Pacific Congress on Computational Mechanics in conjunction with Eleventh International Conference on Enhancement and Promotion of Computational Methods in Engineering and Science in **Kyoto, Japan - December 3-6, 2007**

The Asian-Pacific Association for Computational Mechanics (APACM) and the Conference Board for the Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC) are pleased to announce that the Third Asian-Pacific Congress on Computational Mechanics (APCOM'07) in conjunction with the Eleventh International Conference on Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC XI) will be held in Kyoto, Japan during December 3-6, 2007. The joint congress will feature the latest developments in all aspects of computational mechanics, with many other emerging computation-oriented areas in engineering and science. In addition to plenary

lectures and minisymposia that highlight the latest trends in computational mechanics, numerous vender exhibits are planned.

The Tenth East Asia-Pacific Conference on Structural Engineering and Construction (EASEC-10) 3-5 August 2006 - Bangkok

The General Chairman of the Conference: Prof. Worsak Kanok-Nukulchai (Thailand)

Joining nationwide grand celebration of the 60th Anniversary of Accession to the Throne of H.M. the King of Thailand, more than 700 delegates attended EASEC-10 Conference organized under the Auspices of the IACM's Asia-Pacific Association of Computational Mechanics (APACM)



The first East Asia-Pacific Conferences on Structural Engineering and Construction (EASEC) was inaugurated in Bangkok in 1986 by Asian Institute of Technology (AIT) and The University of Tokyo. The conferences were subsequently hosted by various cities in Asia normally in 2-year interval. Over the last 20 years, EASEC has taken its place as the only forum in Asia Pacific where academicians, researchers and professional structural and construction engineers gathered to exchange views, expertise, and research innovations. EASEC conferences served as a gateway for the region to reach the world at its own backyard. This has stepped up scholarly exchanges and cooperation at global magnitude with strong regional focus and dimension.

EASEC-10 returned to Bangkok to celebrate the 20th anniversary on 3-5 August 2006 under the organization of Asian Institute of Technology under the auspices of Asia-Pacific Association of Computational Mechanics (APACM) and the International Association of Computational Mechanics (IACM). The conference was supervised by the EASEC International Steering Committee chaired by Prof. Worsak Kanok-Nukulchai, a Fellow of IACM. Using the theme "Reaching the World", EASEC-10 embraces the idea of strong participation of professionals from all corners of the world, to jointly explore the opportunities presented to us by the globalization process.

The opening ceremony was presided by Prime Minister of Thailand, Dr Thaksin Shinawatra, who congratulated the EASEC for its past achievements, and wished over 700 participants the opportunity to exchange views and experiences on the latest technology in structural engineering and construction. EASEC-10 recorded as the largest one in its history with 649 papers from 41 countries, including Japan (108), China including Chinese Taipei (76), India (66), Thailand (50), Australia (36), Korea (25) and the rest. In addition, 6 minisymposia were independently organized, namely (1) Hazard Mitigation and Infrastructure Renewal Related to Natural Disasters; (2) Engineering Software Development and Computations; (3) Blast Analysis and Design; (4) The Scaled Boundary Finite Element Method; (5) Third Asian Workshop on Meshless Methods; and (6) The Pishidi Karasudhi Symposium. Particularly, the Third Asian Workshop on Meshless Methods was attended by many invited speakers including G. Yagawa, H. Noguchi, G.R. Liu, J. T. Katsikadelis, C. Fan, S. Hagihara, and W. Kanok-Nukulchai. The next EASEC conference is scheduled to be hosted by Prof. Y. B. Yang in 2008. ●

APCOM'07-EPMESEC XI will be held at the Kyoto International Conference Hall, conveniently located in downtown Kyoto, within 25 min by subway from Kyoto Central Station. Kyoto was the capital of Japan for over 1000 years from 794 to 1868AD. In addition to beautiful imperial villas, Kyoto is home to about 400 Shinto shrines and 1,650 Buddhist temples which are dotted around the city.

A collection of topical minisymposia forms the backbone of the Congress' technical program. The Technical Program Chairs invite proposals for minisymposia from the Computational Mechanics, Engineering and Science communities. There should be at least two organizers for each minisymposium, and it is desirable that they represent more than one institution. All proposals must be submitted electrically via the Congress web-site. All technical papers, including keynote, invited and contributed presentations, will be presented within one of the Congress' minisymposia. We also call for papers for the VISUALIZATION CONTEST and the STUDENTS AWARDS. The Technical Program Chairs cordially invite excellent exhibitors from both the industrial and academic communities. This is a great opportunity to introduce advanced research and products to the attendants through exhibits and demonstrations.

For further information please visit : <http://www.apacm.org/apcom07-epmescXI>

Important Dates :

Online submission of minisymposia proposals October 15, 2006

Final selection of minisymposia February 1, 2007

Deadline for abstract submissions May 1, 2007

Deadline for submission of full length papers August 1, 2007

Deadline for minisymposia proposals January 1, 2006

Online submission of abstracts December 1, 2006

Final selection of abstracts July 1, 2007

Deadline for early registration October 1, 2007 ●



The Japan Association for Computational Mechanics Report

in association with
APACM

For all inclusions
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Technology
Tel: +81-5734-2165
Fax: +81-5734-2165
yabe@mech.titech.ac.jp

JACM was established in 2002 and is a union of researchers and engineers working in the field of computational mechanics in Japan.

JACM is a rather loosely coupled umbrella organization covering almost all computational mechanics related societies* in Japan through communication with e-mail and web page (<http://www.mech.titech.ac.jp/~ryuutai/jacmeng.html>). The JACM organized 17 minisymposia that include 184 papers at WCCM Beijing 2004 and 8 minisymposia and 100 papers at WCCM Los Angeles 2006 and is currently organizing APCOM 2007.



Kozo Fujii,
The JACM Award for Computational Mechanics



The JACM meeting was held on the occasion of WCCMVII at **Los Angeles** on **July 18, 2006** (Figure 1). More than 30 members get together to discuss the future prospect of JACM and organization of APCOM2007. The JACM awards were presented to 4 members shown below.

*JACM is a union of the following societies : Name, (Estimated Number of CM researchers [Number of Members]).



Tomonari Furukawa
The JACM Award for Young Investigators in CM



The Japan Society of Mechanical Engineers, Computational Mechanics Division (5300 [5300]), Japan Society of Fluid Mechanics (1000 [1400]), The Japan Society for Simulation Technology (600 [600]), The Japan Society for Industrial and Applied Mathematics (800 [1900]), The Society of Materials Science, Japan (500 [3000]), Atomic Energy Society of Japan (400 [7000]), The Society of Chemical Engineers, Japan (500 [7900]), The Japan Institute of Metals (800 [8000]), Japan Society for Aeronautics and Space Sciences (500 [4200]), Japan Association for Earthquake

Engineering (200 [1000]), The Japan Society for Technology of Plasticity (500 [4100]), The Visualization Society of Japan (300 [1500]), Japan Society for Fuzzy Theory and Intelligent Informatics (200 [1000]), The Society of Rheology, Japan (200 [1000]), The Japan Society of Thermophysical Properties (100 [520]), Architectural Institute of Japan (400), The Society of Rubber Industry, Japan (300 [2700]), The Japan Society of Applied Electromagnetics and Mechanics (100 [550]), Japanese Society for Medical and Biological Engineering (300 [3100]), The Japan Society of Polymer Processing (150 [1500]), Information Processing Society of Japan, The Japan Fluid Power System Society, The Japan Society of Plasma Sciences and Nuclear Fusion Research. ●

Figure 1:
Photo at JACM meeting
Los Angeles
July 2006



in association with
APACM

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<http://www.jsc.es.org/>

The Japan Society for Computational Engineering and Science (JSCES) has hosted eleven conferences over the past 10 years. Each of these consists of three full days of lectures given mainly by Japanese researchers, as well as graduate students and young practitioners, and includes a few plenary lectures given by eminent international researchers. All the conferences were quite successful in terms of attendance as well as quality of the presentations and have become an established setting for the exchange of ideas in the field of computational engineering and science and for the dissemination of the advances in this field.

The eleventh Conference on Computational Engineering and Science was held on **June 12-14, 2006**, at the Convention Center of **Osaka University**. More than 350 delegates attended the conference and 260 papers were presented. The conference had 27 parallel sessions in total, each of which is organized by prominent researchers in each field of computational engineering and science. The conference invited Prof. Gregory M. Hulbert (University of Michigan) as a plenary lecturer who gave a talk entitled "Design and Analysis of New Classes of Structural Vibration Control".

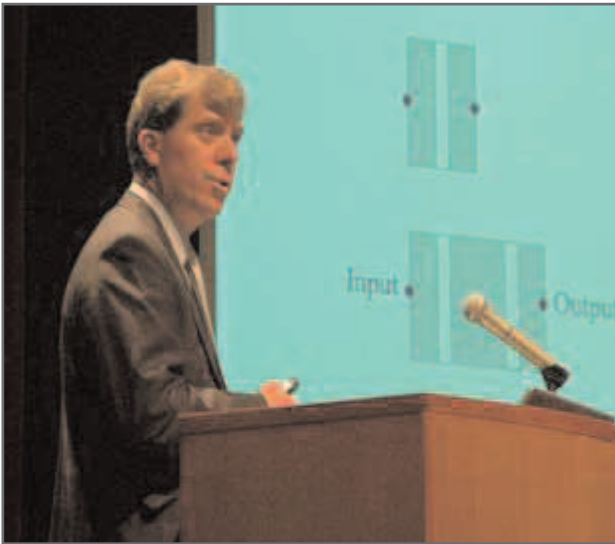


Figure 1:
 Plenary lecture by
 Prof. Greg Hulbert

The conference was accompanied by the First Korea-Japan (KJ) Joint Workshop on Computational Engineering, which the JSCES regards as a special event to celebrate the 11th founding anniversary, under the joint sponsorship with the Computational Structural Engineering Institute of Korea (COSEIK). The opening remark by Prof. K. Fujii (Japan Aerospace Exploration Agency), the President of the JSCES, was followed by twelve 25-minute talks interchangeably given by Korean and Japanese young scientists, and then the closing remark by Prof. Y.S. Yang (Seoul National University), the former President of COSEIK. The conference along with the KJ workshop was quite successful. The effort will continue and we will have another workshop in Tokyo, May 2007.

The JSCES was founded in 1995 by the first president T. Kawai and co-founders, who organized the third WCCM 1994 in Chiba. The JSCES, which is an IACM affiliated society in Japan, has currently about 900 members, all of which are automatically registered as international members of the IACM. The JSCES has continuously supported and will continue to support the IACM activities, such as several WCCM's and other regional and national congresses held over the past eleven years. Please visit our web site (<http://www.jsc.es.org/>) to look over other activities including publications of a quarterly magazine and an internet journal. ●



Figure 2:
 Group shot
 of participants from
 the First Korea-Japan
 (KJ) Joint Workshop on
 Computational
 Engineering

2nd International Congress on Computational Mechanics and Simulation

For all inclusions
under IndACM, please
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Prof. Tarun Kant

Tel: +91-22-2576-7310
Fax: +91-22-2576-7302
Email: tkant@iitb.ac.in

<http://indacm.civil.iitb.ac.in>



(ICCMS-06)



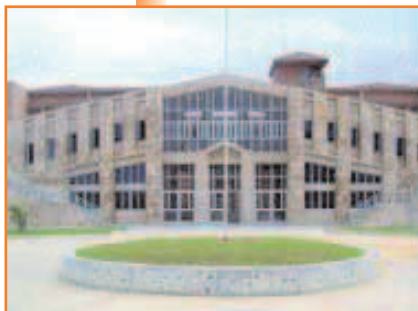
The Indian Institute of Technology (IIT) Guwahati and The Indian Association for Computational Mechanics (IndACM, <http://indacm.civil.iitb.ac.in>) are organizing the 2nd International Congress on Computational Mechanics and Simulation (ICCMS-06) during **8-10 December 2006**, at **IIT Guwahati**.

This international congress is expected to provide a meeting ground for researchers, practitioners and specialists in frontier areas of contemporary interest in the broad field of Computational Mechanics and Simulation. Dr. Damodar Maity from Civil Engineering Department and Dr. S. K. Dwivedy from Mechanical Engineering Department are the conveners of this congress. The organizers had already received a very enthusiastic and huge response to the Congress (ICCMS-06) from both India and abroad.



The details of the congress are available at:
<http://www.iitg.ac.in/iccms06>.

The theme of the congress is broadly categorized into Computational Solid Mechanics, Computational Fluid Dynamics, Computational Multi-Physics Dynamics.



The topics which will be covered in the congress include Composite structures, Fracture and Damage Mechanics, Earth Mechanics, Soil-structure interaction, Smart structures, Micro and nano-mechanics, Robotics, Bridge Structures, Material Modeling, Flows with Moving Boundaries, Turbulence Modeling, Free Surface Flows, Biological Fluid Dynamics, Weather Forecasting, Fluid-structure interaction, Transient dynamic problems, Electro-mechanics/magnetics, Porous Media Mechanics, New computational techniques, High performance computing, Nonlinear mechanics, Piezoelectric Mechanics. ●

Dr Damodar Maity



Dr SK Dwivedy



conference

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Challenges in Computational Mechanics

10 - 12 May 2006

Cachan - France

A Workshop entitled " Challenges in Computational Mechanics " was held at the Ecole Normale Supérieure de Cachan, **10-12 May 2006**, in honour of **Pierre Ladevèze** for its 60th birthday.

The conference was preceded by a Ceremony of Doctor Honoris Causa Graduation of Professor J. Tinsley Oden who gave a conference entitled :

"The Place of Computer Simulation in Science : the Third Pillar"

The chairmen would like to express to all the invited speakers:

P. Beckers, T. Belytschko, H. Ben Dhia, A. Benallal, M. Bonnet, P.-A. Boucard, Ph.

Bouillard, J.L. Chenot, F. Chinesta, G. Coffignal, A. Combescure, A. Corigliano, R. de Borst, Ph. Destuynder, F. Dias, P. Diez, D. Dureisseix, C. Farhat, F. Feyel, J. Fish, M. Geers, M. Gérardin, R. Ghanem, A. Huerta, T. Hughes; A. Ibrahimbegovic, S. Idelhson, D. Leguillon, W.K. Liu, H. Mang, H. Matthies, JF Molinari, A. Needleman, Q.S. Nguyen, R. Ohayon, X. Oliver, E. Oñate, R. Owen, M. Papadarakakis, G. Stavroulakis, D. Peric, S. Prudhomme, E. Ramm, C. Rey, D. Rixen, E. Sanchez-Palencia, B. Schrefler, J. Simmonds, E. Stein, T. Strouboulis, P. Wriggers

Our sincere gratitude for having made this event a very warmful and stimulating conference.



Figure 1:
Pierre Ladevèze, J. Tinsely Oden and Claire Dupas (Head of ENS Cachan)



Figure 2:
Conference Banquet

Figure 3:
Photos of the invited Speakers (after the banquet!)



The support of the following industrial sponsors:

AIRBUS - CNES - CNRS- EADS - EADS CCR -- FONDATION D'ENTREPRISE EADS - IFP

and institutional ones:

ENS Cachan- AFM - -CSMA - LMT CACHAN - IFREMER MINISTERE DE LE RECHERCHE- REGION ILE DE Franceis also warmly acknowledged.

The Workshop was divided into several sessions:

Perspectives for Computational Mechanics, Computational Mechanics of complex systems, Mixed approach & adaptativity, Computational Fluid Mechanics, Verification & adaptativity, Computational solid dynamics, Modelling instabilities in solid mechanics, Response & forming of structural components, Materials & design tools for civil engineering, Multiscale approaches for crack propagation, Solid/Fluid Interaction Mechanics, Large & Multiscale Computations, Meso-scale computation,

A round panel session has given the opportunity to top level managers to share their views on "Aeronautical and Aerospace challenges in Computational Mechanics" . This session was introduced by a talk of Pierre Ladevèze on "Research Challenges for Robust Design". ●

**O. ALLIX
N. MOES
U. PEREGO**

9th US National Congress on Computational Mechanics July 22 - 26, 2007



**Pre- & Post-Congress Short Courses
July 22 & 26, 2007**

Hyatt Regency San Francisco

Biennial Congress of the **U.S. Association for Computational Mechanics**, an affiliate of the International Association for Computational Mechanics, Hosted by the University of California, Berkeley.

IMPORTANT DATES:

- Deadline for minisymposia proposals
January 15, 2007
- Final selection of minisymposia
February 1, 2007
- Website open for abstract submission
February 1, 2007
- Deadline for abstract submissions
April 1, 2007
- Final selection of abstracts
April 15, 2007
- Deadline for print-ready abstracts
June 1, 2007
- Deadline for early registration
June 1, 2007
- USNCCM IX technical program
July 23-26, 2007
- Pre- and post-conference short courses
July 22 & 26, 2007

<http://me.berkeley.edu/compmat/USACM/main.html> ●

ICCMS - 06 2nd International Congress on Computational Mechanics & Simulation

Indian Association for Computational Mechanics (IndACM) in collaboration with Indian Institute of Technology Guwahati announces International Congress on Computational Mechanics and Simulation (**ICCMS- 06**) to be held in **IIT Guwahati between 8-10 December 2006**. IndACM was founded on 1 January 2000 to bring together this community to have meaningful interaction to further the growth of computational mechanics in different disciplines. To achieve this objective ICCMS-04 was to provide a forum for scientists, engineers and designers in universities, laboratories and industry to share their research findings to further the cause of computational mechanics. We would like to invite you to submit your abstracts and register online at: <http://www.iitg.ac.in/iccms06/> ●

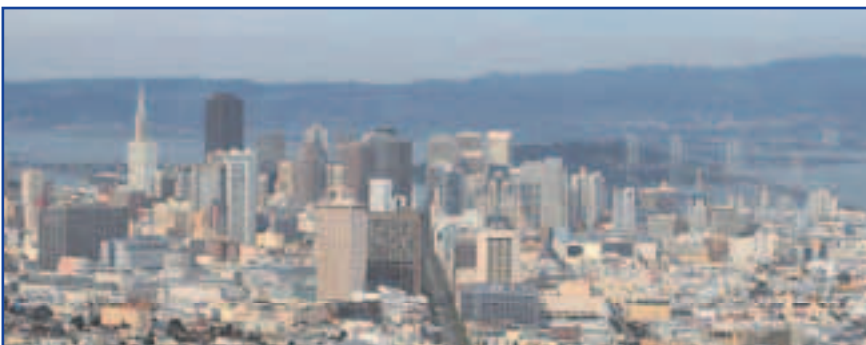
*The International Congress on
Simulation Technology for the
Engineering
Analysis Community*

NAFEMS World Congress 2007

www.nafems.org/congress

NAFEMS is an independent not-for-profit body with the sole aim of promoting the effective use of engineering simulation methods such as finite element analysis, multibody system dynamics and computational fluid dynamics.

This conference will bring together world leading industrial practitioners, consultancies, academic researchers and software developers with a common interest in engineering analysis. Simulation is now established in many engineering companies as part of their product development process. Whilst the conference will cover many aspects of the use of simulation, a particular focus will be how the appropriate deployment of simulation can lead to a further competitive advantage through helping to stimulate innovation. ●



**1st African Conference on
Computational Mechanics
AfrCCM'09**

12-15 January 2009

**An IACM and ECCOMAS
supported event**

The aim of this bi-annual conference, to be held in Sun City Resort, South Africa, is to bring together international researchers engaged in the broad field of computational mechanics and to stimulate research in Africa. Conference topics are to cover all areas of computational engineering and science.

As this is the first conference of its kind in Africa, a special Nelson Mandela Medal will be awarded in recognition of the African who has made the largest contribution to Computational Mechanics internationally over the past decade. The O.C. Zienkiewicz cash award will also be given to the best paper presented at the conference. A number of international leading researchers will be invited to deliver key note lectures as well as individual researchers to organise mini-symposia. ●

<http://www.afrcm.com/>

**19th International Conference on
Structural Mechanics in Reactor
Technology**

SMiRT19

*Toronto, Canada
August 12-17, 2007*

The International Association of Structural Mechanics in Reactor Technology (IASMiRT) along with the American Association of Structural Mechanics in Reactor Technology (AASMiRT), the Center for Nuclear Power Plant Structures, Equipment and Piping (C-NPP-SEP) at North Carolina State University, and the Canadian Nuclear Society (CNS) invite you to Toronto to contribute to and participate in this 19th SMiRT Conference.

As the workforce in the nuclear industry matures, it is important for us to reach out to younger engineers and scientists. SMiRT 19 will provide an excellent opportunity for this dialog. SMiRT 19 will continue this tradition, bringing together experts and practitioners from around the world to share their knowledge of technology that is most relevant at this time ●

www.engr.ncsu.edu/smirt-19

NUMIFORM 2007

International Conference in

Numerical Methods in Industrial Forming Processes

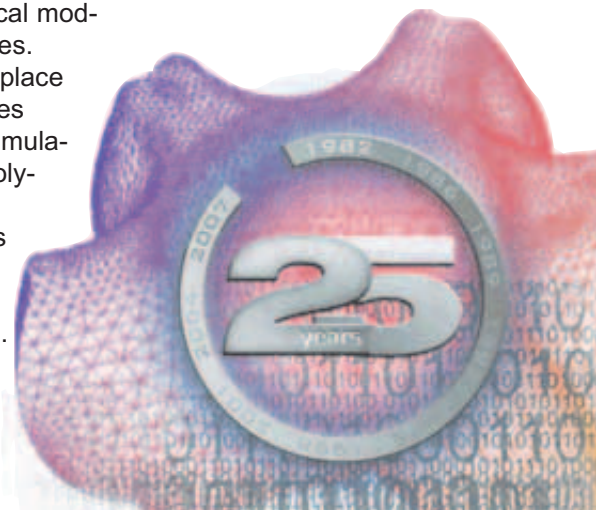
**June 17-21, 2007
Faculty of Engineering,
University of Porto
Portugal**

On behalf of the Organizing Committee of **NUMIFORM 2007** Conference, that will be held in **Porto, Portugal, 17-21 June 2007**, we would like to remind you that the abstracts should be sent by 30th September 2006.

Abstract instructions and Conference topics are available online at the NUMIFORM 2007 website:

www.fe.up.pt/numiform07

The prestigious NUMIFORM series of international conferences was founded in the early eighties with a vision of promoting discussion of state of the art and future directions in numerical modelling of metal forming processes. NUMIFORM conferences take place every three years and addresses computational modelling and simulations of traditional metal and polymers processing methods, as well as of advanced materials and emerging technologies at different scales. Next we will celebrate the 25th anniversary of this conference.



CHANGES IN THE EXECUTIVE COUNCIL OF THE IACM

The following decisions were taken at the meetings of the Executive Council and the General Assembly of the IACM which took place during the 7th World Congress on Computational Mechanics held at the city of Los Angeles in USA on July 16-21, 2006.

The current President, Vice-Presidents and Secretary General of IACM were re-elected for a four-year period.

The names are:

President of IACM: Prof. E. Oñate, *Technical University of Catalunya, Spain*

Vice-Presidents of IACM:America: Prof. T. Belytschko *Northwestern Univ., USA*

Secretary-General: Prof. S. Idelsohn *CIMNE, Spain*

Asian-Pacific: Prof. S. Valliappan *University of Sydney, Australia*

Europe-Africa-Middle East: Prof. H. Mang *Technical University, Viena, Austria*

The following persons were appointed Members, Corresponding Members and Honorary Members of the Executive Council.

New Members of the Executive Council of IACM

Prof. R. Owen, *University of Wales, UK.*

Prof. E. Ramm, *University of Stuttgart, Germany*

Prof. W. Kanok-Nukulchai, *Asian Institute of Technology, Thailand*

New Corresponding Members of the Executive Council of IACM

Prof. R. de Borst, *University of Delft, The Netherlands*

Prof. C. Farhat; *University of Stanford, USA*

Prof. J. Fish, *Rensselaer Polytechnic Institute, USA*

Prof. G. R. Liu, *National University of Singapore*

Prof. C. Mota Soares, *Instituto Superior Tecnico, University of Lisbon, Portugal*

Prof. T. Yabe, *Tokyo Institute of Technology, Japan*

New Honorary Members of the Executive Council of IACM

Prof. E. Arantes e Oliveira, *Instituto Superior Tecnico, Univ. of Lisbon, Portugal*

Prof. C. K. Choi, *Korea Advanced Inst. of Scienc. and Tech.*

Prof. J. Periaux, *CIMNE (Spain) and University of Jyvaskyla (Finland)*

Prof. G. Yagawa, *Toyo University, Japan*

The full list of members of the Executive Council of IACM is listed in page 2 of this Bulletin.

WORLD CONGRESS OF COMPUTATIONAL MECHANICS 2010 IN SYDNEY

The city of Sydney in Australia was selected to be the venue for the 8th World Congress of Computational Mechanics in 2010. The selection was made by the Executive Council of the IACM during a meeting held in the city of Los Angeles on July 2006. The candidate cities to host this event were Seoul (Korea) and Sydney (Australia). Excellent proposals to organise WCCM 2010 were presented by both the Seoul and Sydney teams. After a long debate of the members of the IACM Executive Council and following a secret vote, the city of Sydney was finally chosen by a majority of votes. WCCM 2010 in Sydney will be organised in conjunction with the regular Congress of the Asian-Pacific Association for Computational Mechanics. This experience of joint WCCM-APACM congress was very successful and positive in the organisation of WCCM 2004 in Beijing.

UPDATE OF THE IACM CONSTITUTION

The Executive Council of the IACM has decided to launch the process for the update of the current IACM Constitution. A Committee formed by Profs. T. Hughes, H. Mang, T. Oden and E. Oñate, will be responsible for presenting a proposal of the new IACM Constitution. The text will be submitted to the Executive Council and the General Council of the IACM for discussion and approval.

IACM Awards 2006



Congress Medal



Ivo Babuška
USA

IACM Award



Bernhard Schrafler
Italy

Computational Mechanics Award:



Manolis Papadrakakis
Greece



Peter Wriggers
Germany

Young Investigator Award:



Nicolae Moës
France

IACM Fellows 2006



Olivier Allix
France



Pål Bergan
Norway



Demetrios Beskos
Greece



Arif Masud
USA



Jiun-Shyan Chen
USA



Adnan Ibrahimbegovic
France



Zenon Wazczyzsn
Poland



Worak Kanok-
Nukulchai
Thailand



Paul Steinmann
Germany

master of science in Computational Mechanics

Erasmus Mundus
Master Course

October 2007

A joint initiative of:

UNIVERSITAT POLITÈCNICA
DE CATALUNYA, (BARCELONA, SPAIN)

UNIVERSITY OF WALES SWANSEA, (UK)

ECOLE CENTRALE NANTES, (FRANCE)

UNIVERSITÄT STUTTART, (GERMANY)

In cooperation with CIMNE
www.cimne/cm-master



Structural Membranes 2007

An IACM Special Interest Conference

Organized by:
International Center for Numerical
Methods in Engineering (CIMNE)
Barcelona, Spain

Institute for Static and Dynamics of
Aerospace Structures (ISD)
University Stuttgart, Germany



Textile Composites and Inflatable Structures

17-18 September 2007, Barcelona, Spain

Erasmus
European Contribution to
Conferences in Applied Sciences

<http://www.cimne.com/structure2007>

conference diary planner

3 - 8 January 2007	ICCES07 - Computational & Experimental Engineering and Science Venue: <i>Miami Beach, USA</i> Contact: icces.org/cgi-bin/ices07/pages/index
26 - 28 March 2007	FEF 2007 - 14th International Conference on Finite Elements in Flow Problems Venue: <i>Santa Fe, USA</i> Contact: www.esc.sandia.gov/FEF07/FEFhome.html
2 - 4 May 2007	GPC'2007 Grid and Pervasive Computing Venue: <i>Paris, France</i> Contact: www.ljpn.univ-paris13.fr/~cerin/GPC2007/GPC2007PDF.pdf
14 - 16 May 2007	Fluid Structure Interaction 2007 Venue: <i>New Forest, UK</i> Contact: www.wessex.ac.uk/conferences/2007/fsi07/index.html
21 - 23 May 2007	Coupled Problems 2007 - Conference on Computational Methods for Coupled Problems in Science and Engineering Venue: <i>Ibiza, Spain</i> Contact: http://congress.cimne.upc.es/coupled07
22 - 25 May 2007	NAFEMS World Congress 2007 Venue: <i>Vancouver, Canada</i> Contact: www.nafems.org/congress
28 May - 1 June 2007	Hughes-Belytshko short course on NonLinear Finite Element Analysis Venue: <i>Berlin, Germany</i> Contact: http://www.zace.com/
30 May - 1 June 2007	First Biochemical Engineering National Meeting Venue: <i>Petropolis, Brazil</i> Contact: eneb-abcm.tripod.com/
4 - 6 June 2007	Marine 2007 - Conference on Computational Methods in Marine Engineering Venue: <i>Ibiza, Spain</i> Contact: congress.cimne.upc.es/marine07
13 - 15 June 2007	CMNE/CILAMCE 2007 - Congress on Numerical Methods in Engineering Venue: <i>Porto, Portugal</i> Contact: numiform.inegi.up.pt/CMNE/
13 - 15 June 2007	COMPdyn 2007 - ECCOMAS Thematic Conference Venue: <i>Island of Crete, Greece</i> Contact: 194.42.10.251/compdyn2007/index.html
13 - 15 June 2007	4th M.I.T. Conference on Computational Fluid and Solid Mechanics Venue: <i>Cambridge, MA, USA</i> Contact: www.fourthmitconference.org/
17 - 21 June 2007	NUMIFORM 2007 Venue: <i>Oporto, Portugal</i> Contact: paginas.fe.up.pt/numiform07/
17 - 22 June 2007	IA-FreMCoS Fracture Mechanics for Concrete and Concrete Structures Venue: <i>Catania, Italy</i> Contact: www.framcos6.org
25 - 28 June 2007	ECCOMAS Multibody Dynamics 2007 Venue: <i>Milan, Italy</i> Contact: www.multibody2007.org/
2007	ECCOMAS Thematic Conferences 2007 <i>22 conferences held in different centres in Europe on specific topics in computational science and engineering.</i> Contact: www.eccomas.org
23 - 26 July 2007	9th US National Conference on Computational Mechanics Venue: <i>San Francisco, USA</i> Contact: me.berkeley.edu/compmat/USACM/main.html
5 - 7 September 2007	COMPLAS 2007 - 9th International Conference on Computational Plasticity. Fundamentals and Applications Venue: <i>Barcelona, Spain</i> Contact: www.cimne.com
17 - 19 September 2007	Structural Membranes 2007 - III Int. Conference on Textile Composites & Inflatable Structures Venue: <i>Barcelona, Spain</i> Contact: congress.cimne.upc.es/membranes07
26 - 28 September 2007	ADMOS III - International Conference on Adaptive Modeling and Simulation Venue: <i>Göteborg, Sweden</i> Contact: admos07@cimne.upc.edu
7 - 10 November 2007	ENIEF'2006 - XV Congress on Numerical Methods and their Applications Venue: <i>Santa Fe, Argentina</i> Contact: cimne.org.ar/enief2006
3 - 6 December 2007	APCOM'07 Asian-Pacific Association for Computational Mechanics together with Venue: <i>Kyoto, Japan</i> Contact: www.apacm.org/apcom07-epmesXI
30 June - 5 July 2008	WCCM8 / ECCOMAS Congress 2008 Venue: <i>Lido Island, Venezia, Italy</i> Contact: www.iacm.info / www.eccomas.org
12 - 15 January 2009	AfrCCM'09 - 1st African Conference on Computational Mechanics Venue: <i>Sun City, South Africa</i> Contact: http://www.afrccm.com/

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