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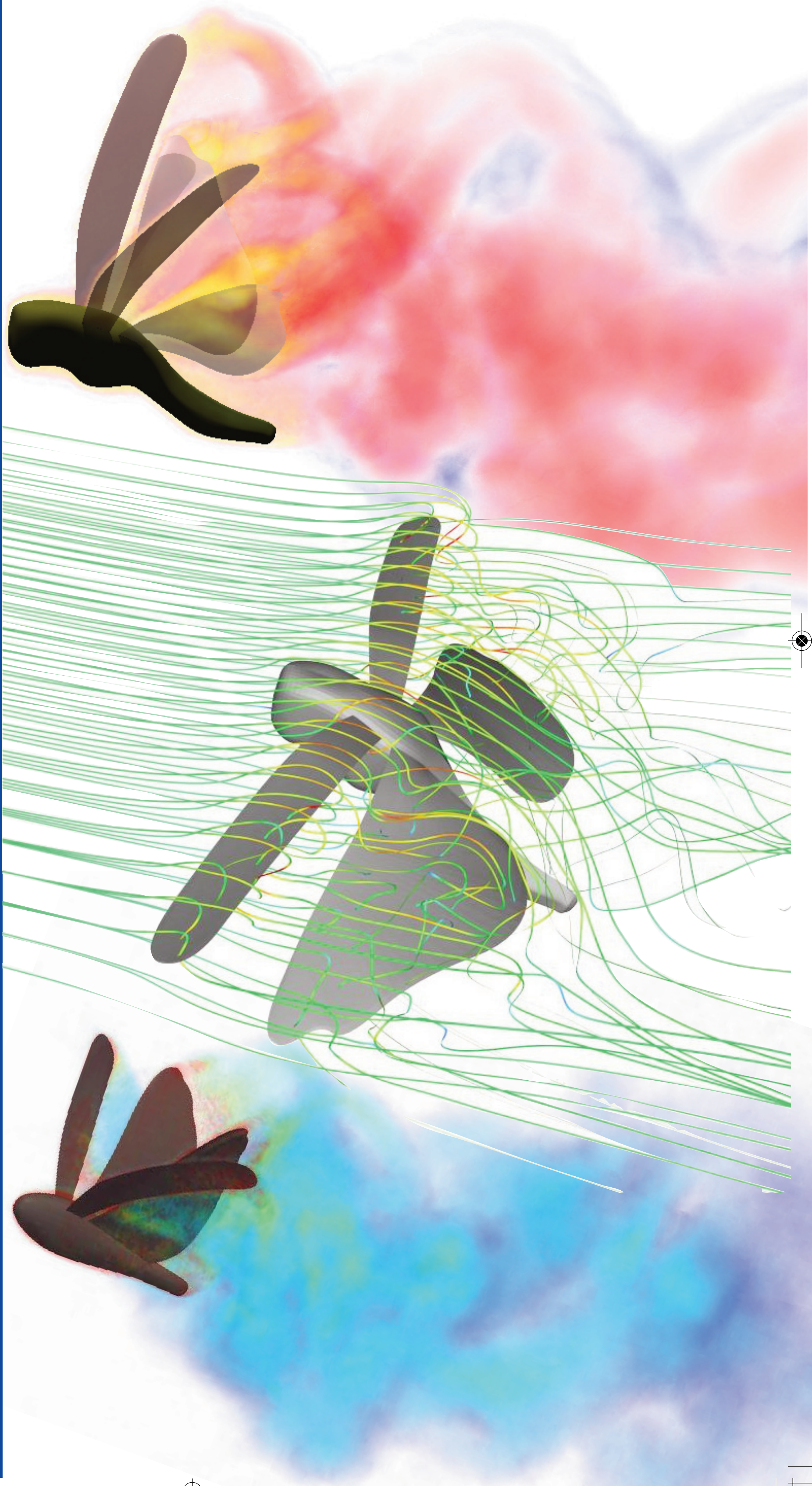

Bulletin for
The International Association
for Computational Mechanics

Nº 32
December 2012

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Published by: The International Association for Computational Mechanics (IACM)
Editorial Address: IACM Secretariat, Edificio C1, Campus Norte UPC, Gran Capitán s/n, 08034 Barcelona, Spain.
Tel: (34) 93 - 405 4697 ***Fax***: (34) 93 - 205 8347
Email: iacm@cimne.upc.edu ***Web***: www.iacm.info

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editorial

A new horizon is appearing in the world of communications and internet that will surely have an influence in the way the Computational Mechanics community will approach the solution to many practical problems in the future.

What if all objects were interconnected and started to sense their surroundings and communicate with each other? The Internet of Things (IoT) will have that sort of ubiquitous machine-to-machine (M2M) connectivity. Since there are estimates that between 50 billion to 500 billion devices will have a mobile connection to the cloud by 2020, here’s a glimpse of our possible future.

Your alarm clock signals the lights to come on in your bedroom; the lights tell the heated tiles in your bathroom to kick on so your feet are not cold when you go to shower. The shower tells your coffee pot to start brewing. Your smartphone checks the weather and tells you to wear your gray suit since RFID tags on your clothes confirm that your favorite black suit is not in your closet but at the dry cleaners. After you pour a cup of coffee, the mug alerts your medication that you have a drink in-hand and your pill bottle begins to glow and beep as reminder. Your pill bottle confirms that you took your medicine and wirelessly adds this info to your medical file at the doctor’s office; it will also text the pharmacy for a refill if you are running low.

Your smart TV automatically comes on with your favorite news channel while you eat breakfast and browse your tablet for online news. After you’ve eaten, while you are brushing your teeth, your dishwasher texts your smartphone to fire up your vehicle via the remote start. Because your ”smart” car can talk to other cars and the road, it knows what streets to avoid due to early morning traffic jams. Your phone notifies you that your route to work has been changed to save you time. And you no longer need to look for a place to park, since your smartphone reserved one of the RFID parking spaces marked as “open” and available in the cloud. Don’t worry about your smart house because as you exited it, the doors locked, the lights went off, and the temperature was adjusted to save energy and money.

Does it sounds too farfetched for 2020? It shouldn’t since a good part of that is in the works now. The German telecommunications giant Deutsche Telecom´s M2M Competence Center has recently stated that there are more than 100 million vending machines, smoke alarms, vehicles, and other devices that now automatically share information. In Europe, M2M communications have moved even the farmers out of barns and into this networked world of “things.” According to IBM Director of Consumer Electronics Scott Burnett, “What we're doing is creating the Facebook of devices. Everything wants to be its friend, and then it's connected to the network of your other device. For instance, your electric car will want to 'friend' your electric meter, which will 'friend' the electric company." Many initiatives in this direction have been already started by companies of all sizes worldwide (see for example www.lhings.com)

In addition of the many technical questions to be yet solved, the security and confidentiality of the information are issues of big concern to IoT developers and users. At the 4th Annual Internet of Things Europe (Brussels, November 12-13, 2012) there were privacy and security debates surrounding the need for separate data protection legislation for the IoT. The privacy of devices, including sensors, is paramount and must be ensured to prevent unauthorized access. What are the emerging security risks? How can it be ensured that the required safeguards are in place to prevent IoT viruses and other security threats?

The IoT avalanche is approaching fast. How this can influence our habits and the way we solve problems using Computational Mechanics techniques is still uncertain. Clearly, new Real Time computing methods and tools will be needed in many applications of the IoT, but this might just be the edge of the iceberg. I would recommend to keep a close track of what is coming and be active players in the new IoT times.

Eugenio Oñate
Editor of IACM Expressions

Flapping-Wing Aerodynamics of an Actual Locust

by
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Tokyo
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Rice University
Houston

Flapping-wing aerodynamics is a class of problems that the Team for Advanced Flow Simulation and Modeling (T★AFSM) <www.tafsm.org> <www.jp.tafsm.org> has been focusing on in recent years (see [1-3]). The wing motion and deformation data is from an actual locust, extracted from high-speed, multi-camera video recordings of the locust in a wind tunnel at Baylor College of Medicine (BCM) in Houston *(figure 1)*.

We have two objectives in this computational mechanics research. The first one is computer modeling and analysis and a good understanding of the flapping-wing aerodynamics of a locust, which one assumes has good flight skills coming from thousands of years of evolution. The second one is using what we learn from the locust flight in designing flapping wings for a micro aerial vehicle (MAV).

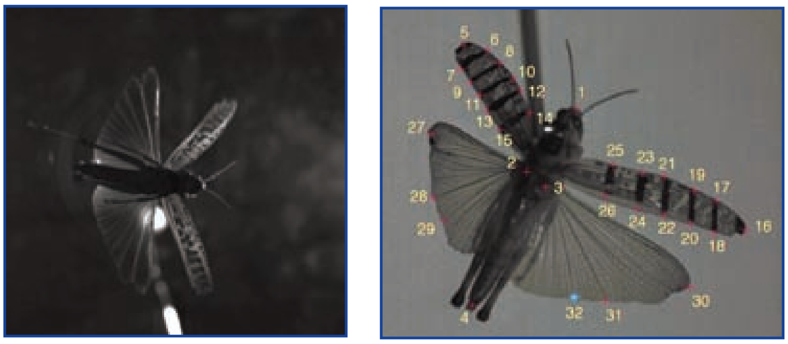


Figure 1:
Wing motion and deformation data is extracted from video recordings of a locust in a wind tunnel, with a large number of tracking points marked on the wings.
Left: *locust in a wind tunnel at BCM.*
Right: *tracking points in the video data set. Pictures courtesy of Fabrizio Gabbiani and Raymond Chan (BCM)*

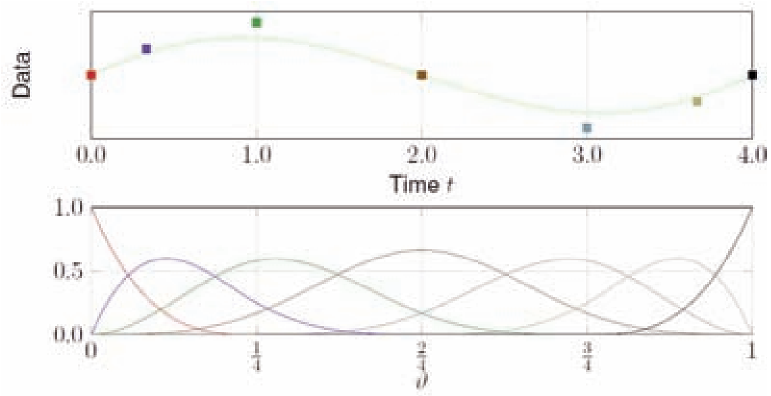


Figure 2:
Temporal NURBS basis functions are used in representing the motion and deformation data for the locust wings.
Top: *data and temporal-control variables.*
Bottom: *basis functions corresponding to the control variables in the parametric space. For details, see [1, 2]*

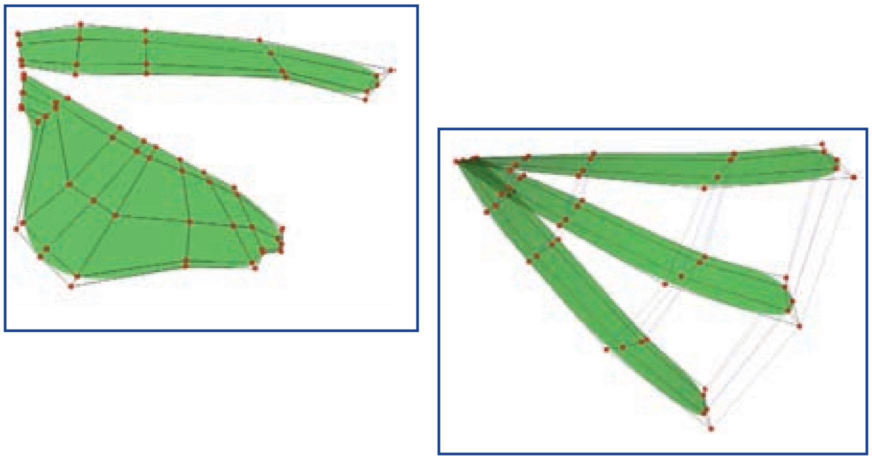


Figure 3:
Left: *forewing (FW) and hindwing (HW) surfaces represented by NURBS and the control points.*
Right: *FW control mesh and corresponding surface at three temporal-control points. This process gives us a NURBS-represented data set in both space and time for each wing. For details on how the time histories of the tracking points from the video recordings are converted to spatial and temporal representations with NURBS basis functions, see [1, 2]*

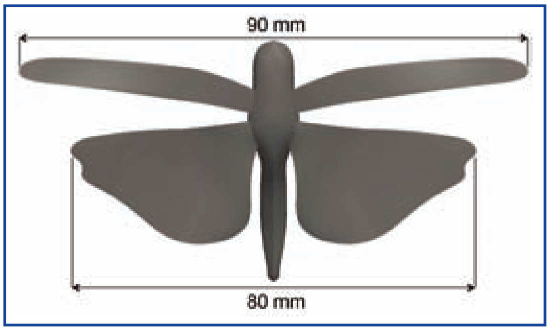


Figure 5:
Length scales involved in the model used in the computations

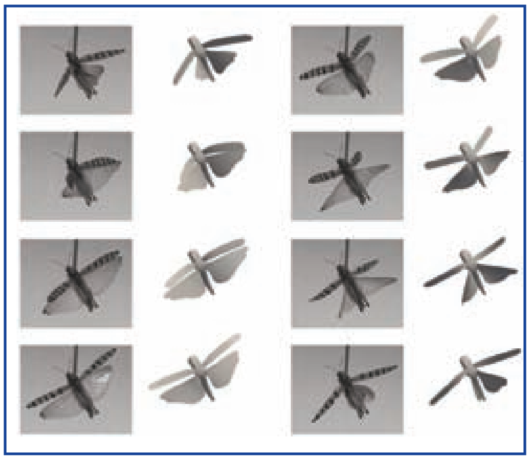


Figure 4:
Comparison of computational model and wind tunnel pictures at eight points in time.
Viewing angles are matched approximately.
Wind tunnel pictures courtesy of Gabbiani and Chan

The core computational technology used is the Deforming-Spatial-Domain/Stabilized Space–Time (DSD/SST) formulation [4, 5], specifically, a new DSD/SST version [6, 7] derived in connection with the residual-based variational multiscale (VMS) method [8, 9]. This new version is called "DSD/SST-VMST." We also use a number of special space–time techniques [1-3] targeting flapping-wing aerodynamics. In the space–time flow computations, we use NURBS basis functions [10] for the temporal representation of the motion and deformation of the locust wings (*figure 2*). This is in addition to using NURBS basis functions for the spatial representation of the wings (*figure 3*). Converting the time histories of the tracking points from the video recordings to spatial and temporal representations with NURBS basis functions is a fairly complex process, with a number of projections in space and time, explained in detail in [1, 2].

Prescribing an accurate wing motion and deformation is important in achieving an accurate flow computation. For that reason, before we start the computation, we compare the wing motion and deformation in our model to the pictures recorded in the wind tunnel (*figure 4*). The length scales involved in the computations are shown in *figure 5*. The air speed is 2.4 m/s, which represents the average wind tunnel speed used in the video recordings. The Reynolds number, based on the air speed and the FW span of 90 mm, is 1.48 x 10^4. The flapping period is 0.047 s.

We use temporal NURBS basis functions also in representation of the motion of the volume meshes computed and in remeshing (i.e., in generating new set of nodes and elements). Given the surface mesh,

Figure 6:
Mesh motion and remeshing using temporal NURBS basis functions. Meshes computed with the mesh moving method introduced in [11] serve as temporal-control points, with longer time in between. Mesh-related information, such as the coordinates and their time derivatives, can be obtained from the temporal representation whenever needed. When we need to remesh, we do that by multiple knot insertions where we want to remesh, making that point in time a patch boundary. For more details, see [1, 2].

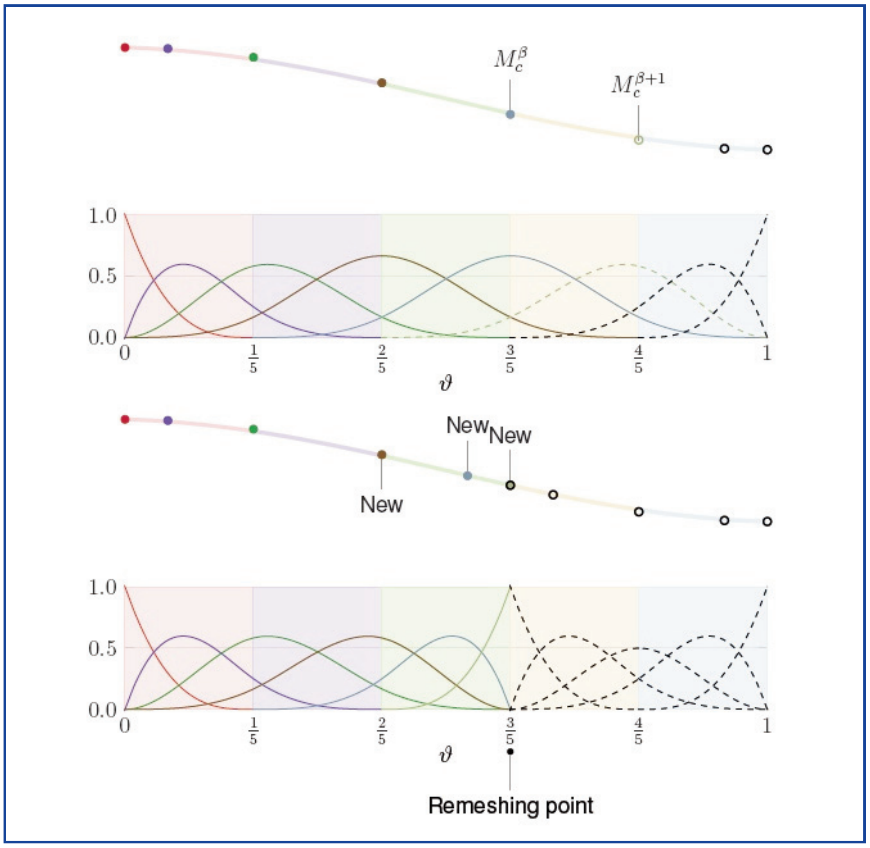
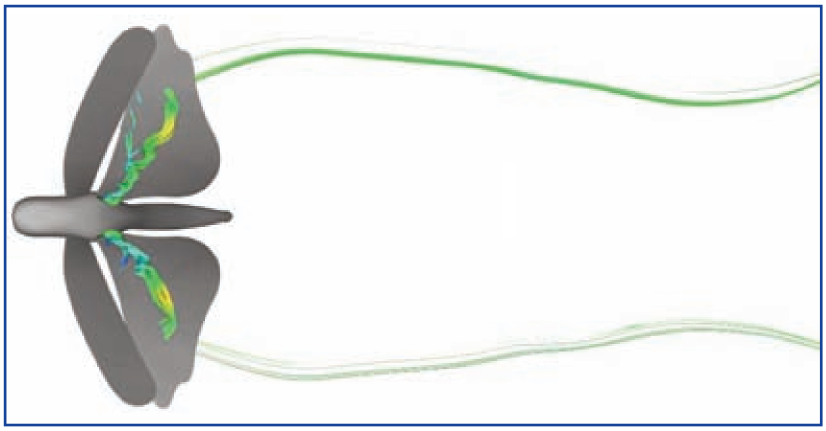


Figure 7:
Vorticity magnitude at an instant during the flapping cycle

we compute the volume mesh using the mesh moving technique we have been using [11]. Here, we apply this technique to computing the meshes that serve as temporal-control points. This allows us to do mesh computations with longer time in between but get the mesh-related information, such as the coordinates and their time derivatives, from the temporal representation whenever we need. Obviously this also reduces the storage amount and access associated with the meshes. The concept of using temporal NURBS basis functions in mesh motion and remeshing is illustrated in *figure 6*. More details can be found in [1, 2].



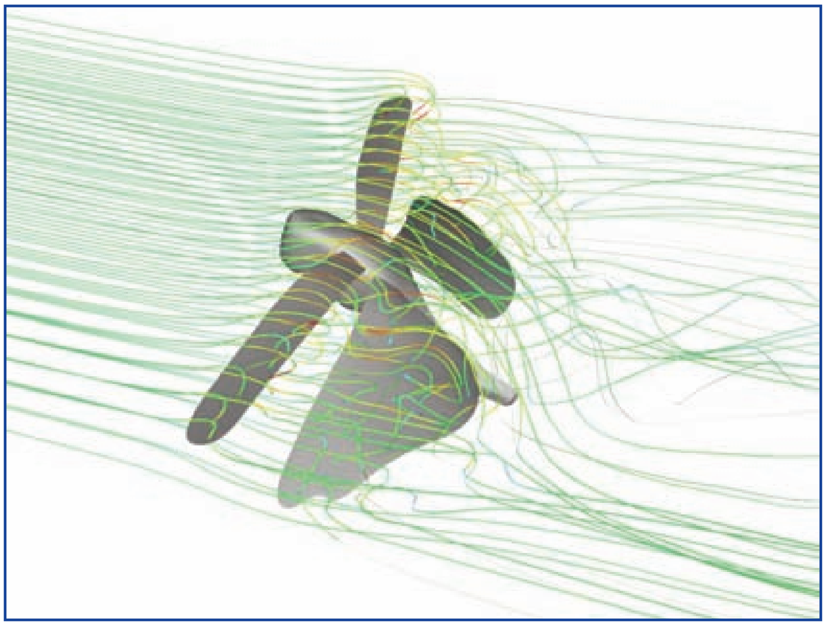


Figure 8:
*Streamlines colored by velocity magnitude at approximately 25% **(top)** and 50% **(bottom)** of the flapping cycle. The vortex structure on the HW is highlighted at top*

Figure 7 shows the vorticity magnitude at an instant during the flapping cycle, and *figure 8* shows the streamlines at two instants.

We use this set of techniques in computation of the bio-inspired flapping-wing aerodynamics of an MAV. The MAV body was inspired by the current unmanned aerial vehicle (UAV) designs. The wing shapes, motion and deformation are from the locust, with some changes in the way the HWs are attached to the body (*figure 9*). The flight conditions are the same as those for the locust. *Figure 10* shows the vorticity magnitude at two instants during the flapping cycle.

This article shows that the core and special space–time methods we have developed can be very effective in modeling flapping-wing aerodynamics of an actual locust, and what we learn from that can be used in designing bio-inspired flapping wings for an MAV. The core and special techniques used can be found in [4-7, 1, 2, 12]. The readers can also find material on this subject, and some movies, at our Web sites <www.tafsm.org> <www.jp.tafsm.org>. Research was supported in part by NSF. Method development and evaluation components of the work were supported in part by ARO (second author) and Rice–Waseda research agreement (first author). We thank Fabrizio Gabbiani and Raymond Chan (BCM) for providing us the the wind tunnel data. Several members of the T★AFSM contributed to this research; they are the coauthors of the cited articles [1-3]. ●

Figure 9: *Body and wings for the locust (left) and MAV (right)*

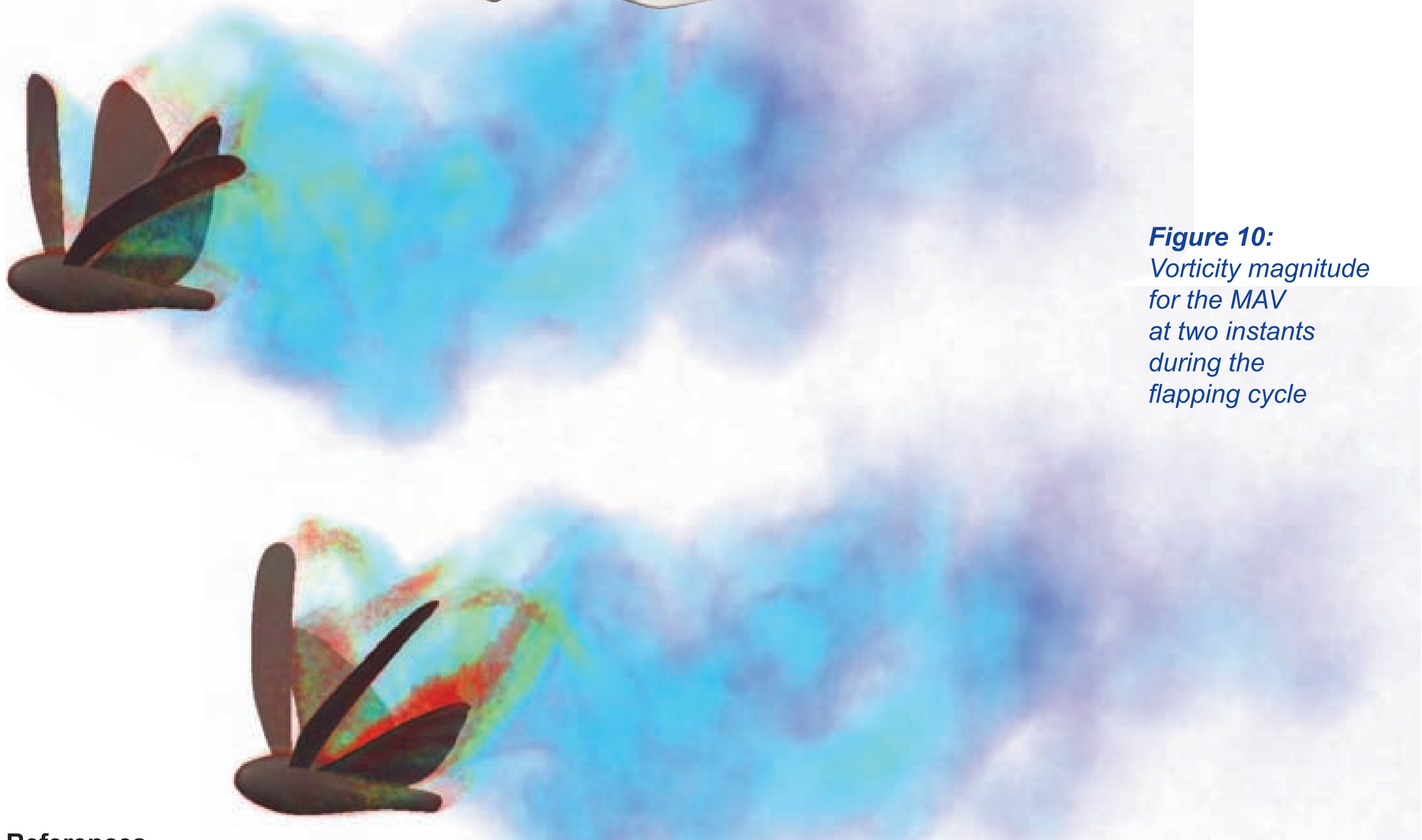


Figure 10: *Vorticity magnitude for the MAV at two instants during the flapping cycle*

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Computational Mechanics for Advanced Timber Engineering

- from material modeling to structural applications -

by
Josef Füssl,
Thomas K. Bader,
Josef Eberhardsteiner
Vienna University of Technology, Austria

Wood products for structural elements are gaining importance in the building sector. Not least because of their evident ecological advantages, their share on the building market increases constantly, and volume consumption is facing enormous growth rates. Nevertheless, dimensioning practice and many existing design rules are still based on an empirical background, which often leads to unsatisfactory results in terms of efficiency and reliability. In order to exploit the full potential of the material and to facilitate its use for modern constructions (*figure 1*), which are characterized by two- and three dimensional bearing components, reliable computation methods for timber engineering are required.

To overcome this undesirable situation, the application of computational methods to wood, engineered wood products, and to timber connections, with the objective to provide an improved mechanical foundation for the intensification and completion of design codes in timber engineering, is forced in recent years. This is expected to boost an efficient use of wood and wood-based products in timber structures. Moreover, based on reliable design methods, new areas of applications for engineered wood products may be accessed.

Current design concepts, used in timber engineering, are characterized by:

- Deficiencies in the mechanical understanding of the clear wood behavior and its relation to microstructural characteristics, which results in a lack of knowledge of material properties for different wood species, and their dependence on wood sample-specific parameters, such as mass density and moisture content.
- Insufficient knowledge about the influence of knots, knot groups and other 'defects' on the mechanical behavior of timber elements, which makes classification of structural timber less efficient and does not allow for full utilization of the potential of the material.
- A high degree of simplification and unification of the underlying mechanical processes. As a result, important mechanical characteristics, such as plate- and lamination effects in wood products as well as the distinct compliant behavior of mechanical connections, are taken into account in a very simplified manner only. Moreover, due to a missing comprehensive mechanical concept applicable to different design tasks, empirical parameters, determined by experiments, are dominating current design concepts.

Figure 1: *Metropol Parasol in Sevilla, Spain, one of the worlds largest timber engineering constructions with 3400 individual wooden elements*

Considering these issues, the wood mechanics-related working group at the Institute for Mechanics of Materials and Structures (IMWS) at Vienna University of Technology pursues a strategy to link microstructural characteristics with mechanical properties of clear wood, which can subsequently be used for modeling of timber, of wood-based products, and of timber structural applications. This design concept is virtually applicable to all design tasks in timber engineering. In this article, the following mechanical models are presented and selected results are given to illustrate the potential of the integrative approach:

- A multi-scale model for wood developed within the framework of continuum micromechanics, which is able to provide clear wood properties as a function of wood species, mass density, moisture content, and other parameters related to the wood microstructure. This model serves as supplier of clear wood properties for all subsequent mechanical tools.

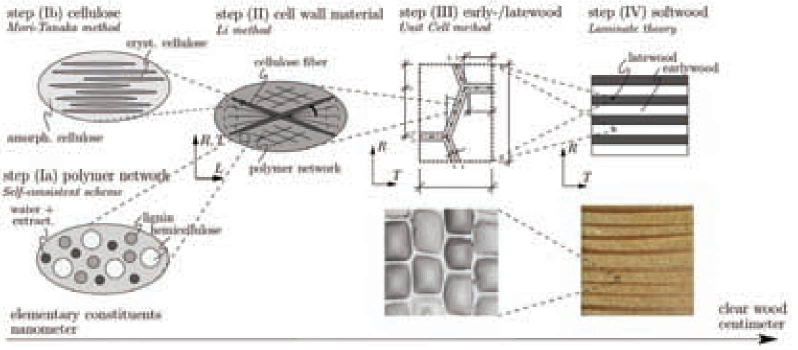
- A 3D Finite-Element model, comprising fiber pattern and orthotropic plastic material behavior, for determining the influence of knots, knot groups and other 'defects' on the mechanical behavior of timber elements. This information is subsequently used for analyzing wood products.
- A 3D stochastic numerical tool to describe mechanical as well as stochastic processes and properties of wood products, such as cross-laminated and glued-laminated timber.
- A 3D Finite-Element model for analyzing dowel connections with the goal to obtain compliance functions depending on connection geometry, loading situation and possible reinforcements.

Multi-scale model for wood

Wood is a natural material with a very heterogeneous microstructure, therefore, showing a highly anisotropic and variable mechanical behavior. However, at sufficiently small length scales, universal constituents inherent in all wood species and samples as well as universal building principles can be identified [1]. These elementary biochemical components are cellulose, hemicelluloses, lignin and extractives. Together, they form a cellulose-fiber reinforced polymeric composite that builds up several layers of the cell walls of wood fibers running in stem direction. Due to the hygroscopicity of wood polymers also water is incorporated in cell walls. The characteristic cellular structure of wood is a result of an assembly of hollow wood fibers, which are up to several mm long. The annual ring structure, typical for temperate softwood and visible to the naked eye, arises from a gradual transition from thin-walled earlywood cells to thick-walled latewood cells, which is formed during one growth season. In hardwood, additionally high amounts of ray cells running in radial direction from pith to bark and larger-sized fibers so-called vessels are present. Characteristic length scales of softwood are illustrated in *figure 2.*

The composition of constituents, their shape and distribution within a micro-heterogeneous material, as well as their mechanical properties and their interaction between each other, govern the mechanical properties at the macroscale. Hence, micromechanical approaches aim at formulating the relationship between microstructure and effective or so-called macro-homogeneous mechanical properties at higher length scales. Doing this in a repetitive manner, multi-scale models representing the hierarchical microstructure of clear wood without growth irregularities can be developed (*figure 2*). At each length scale, so-called representative volume elements or repetitive unit cells are suitably chosen to represent the actually diverse microstructure in a statistically representative manner. As regards micromechanical methods, continuum micromechanical approaches such as the Mori Tanka method and the self-consistent scheme are used in combination with the Unit Cell method and laminate theory.

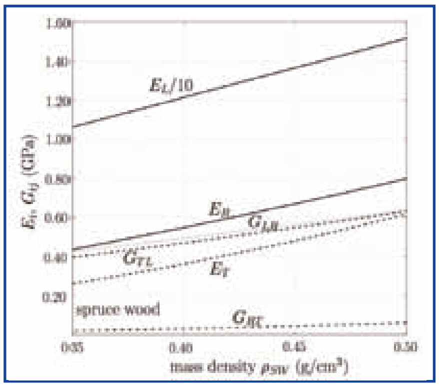
Figure 2:
Hierarchical microstructure of softwood and its representation in a multi-scale micromechanical model



Since 2005, at the Institute for Mechanics of Materials and Structures, micromechanical models for elastic properties [2,3], elastic limit stresses (as a measure for strength) [4], hygro-expansion characteristics [5], and viscoelastic properties [6] of clear wood have been developed. These models have been applied to different wood species (softwood and hardwood) as well as to deteriorated (fungal degradation) and archaeological wood. In all these applications, comparisons with experimental results at different length scales underline the suitability and the predictive capability of the developed models.

The great benefit of such a modeling strategy, combining micromechanics with multiscale observations, is that macroscopic variations in mechanical properties can be related to microstructural fluctuations. Consequently, microstructural characteristics for a better prediction of mechanical properties of clear wood can be identified. Moreover, the anisotropic behavior of wood requires a considerable effort for experimental characterization of material properties, which can be overcome by using micromechanical models in combination with microstructural characterization techniques. Exemplarily, the model-predicted influence of changing mass density on orthotropic Young's moduli and shear moduli of spruce wood are illustrated in *figure 3*. This is for instance used as input to numerical simulation tools for timber,

Figure 3:
Influence of mass density on Young's moduli E_L, E_R, E_T and shear moduli G_{LR}, G_{TL}, G_{RT} of spruce wood (with respect to the longitudinal (L), radial (R), and tangential (T) direction).



for engineered wood products, and for dowel connections in wood, presented in the following sections.

Finite-Element model for timber elements

Continuing with the multi-scale strategy as proposed for clear wood in the previous section, at the next higher observation scale, timber elements are considered. Doing this, it becomes obvious that wood is a naturally grown material, with inhomogeneities like knots and other growth-induced 'defects'. These cause fiber deviations and, thus, significant stiffness and strength reductions in their vicinities due to the orthotropic material characteristics of wood. This is the reason why timber is typically subjected to grading processes, in order to cut out sections, which contain critical knots, and to categorize the remaining logs. Various mechanical and visual grading methods exist, where the influence of knots on the effective bending strength is roughly estimated either on experimentally obtained stiffness values or through surface information from optical measurements (cameras or lasers). Both grading techniques are not able to take the 3D morphology of knots and the resulting fiber deviations appropriately into account. Moreover, no mechanically based prediction about the influence of the knot volume, arrangement and position on certain effective strength values can be made.

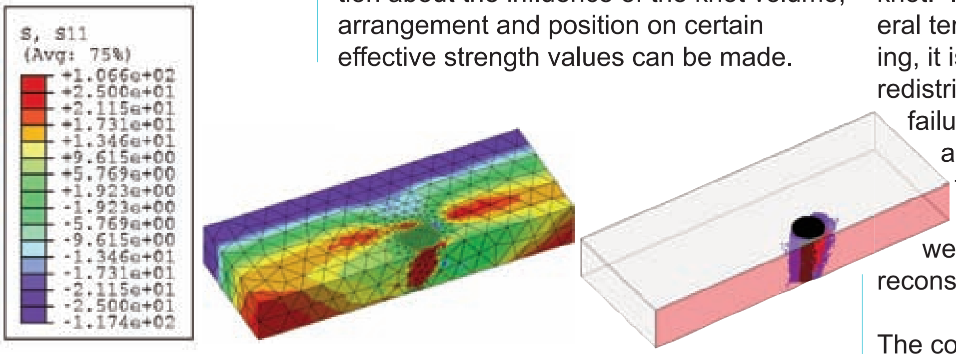


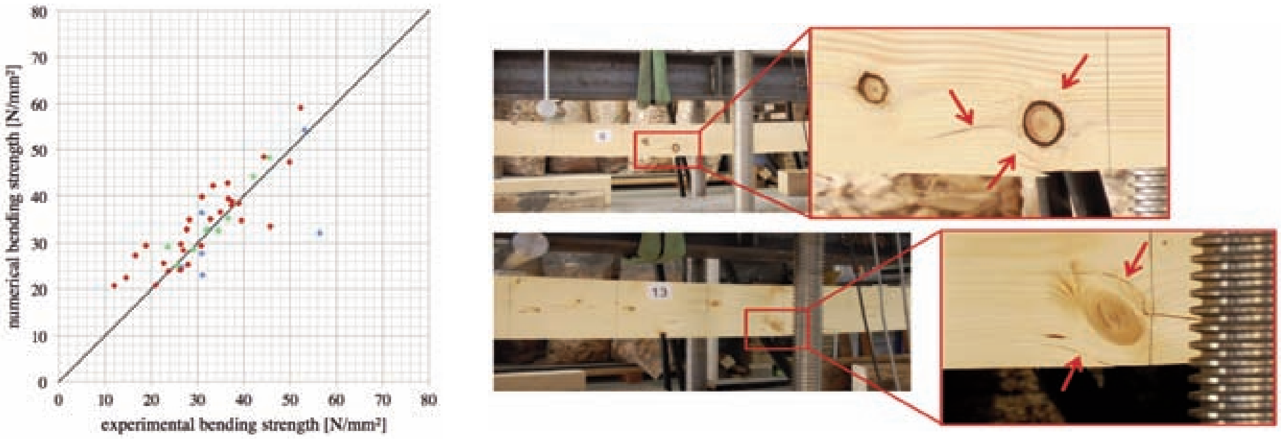
Figure 4: *Section of the 3D Finite-Element model for timber elements with knots and normal stress S11 in longitudinal direction (left), and areas of lateral-tension failure (blue) in the vicinity of a knot (right)*

For this purpose, a numerical simulation tool based on the Finite-Element method (*figure 4*) has been developed at the IMWS, in recent years [7], which enables a 3D virtual reconstruction of timber elements, including all growth- and production-induced 'defects'. The tool is based on a geometrical model, which allows for the description of the 3D fiber course [8] in the vicinity of knots, modeled as rotationally symmetric cones. The elastic behavior of the clear wood, with respect to principal material directions, is obtained from the micromechanical model presented in the section before. In each integration point, failure is described according to the orthotropic criterion of Tsai and Wu [9], and strains are following an associated flow rule in the plastic range.

Experimental observations have shown that structural failure of timber is mainly characterized by brittle failure modes (*figure 5*), which are initiated in areas where lateral-tension stress states appear/dominate. This is the case either around knots, due to strong fiber deviations, or at capped fibers at the surfaces of wooden boards. Within the presented numerical tool, start of structural failure is assessed, by analyzing the stress states in the vicinity of each knot. If the 'plastified' volume due to lateral tension around a knot starts decreasing, it is assumed that global stress redistribution takes place and structural failure occurs. The accuracy of this approach is evaluated by means of four-point bending tests, where 32 boards with different cross-sections were loaded up to failure and manually reconstructed for numerical analyses.

The comparison between the experimentally and numerically obtained bending strengths is shown in *figure 5*. Basically, the bending strengths obtained with the numerical simulation tool agree well with the experimental results. Deviations arise

Figure 5: *Comparison of experimentally and numerically obtained bending strengths of timber elements (left), and failure modes around knots due to lateral tension (right)*



for beam samples with very high density and/or when the main failure mechanism is triggered by capped fibers in the tensile zone. The consideration of these effects within this simulation tool is a current research focus at the IMWS.

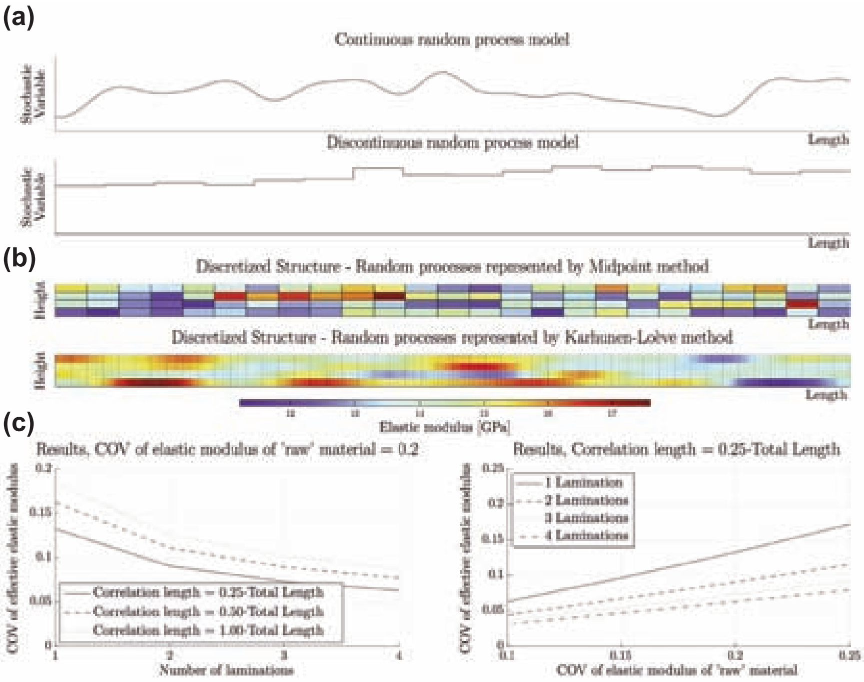
Stochastic approach for wood products

Research on the mechanical behavior of wood products (glued-laminated timber, GLT, and cross-laminated timber, CLT) has mainly been performed experimentally so far. In general, comprehensive test series were carried out and the results were analyzed statistically in order to identify the relation between the distribution of mechanical properties of the laminations and corresponding characteristics of the wood product. Following this approach, only limited insight into the homogenization effects in wood products is gained. In particular, no separation of mechanical and stochastic effects is possible.

In order to obtain enhanced insight, the experimental approaches were complemented by analytical or numerical investigations. The former are mainly based on application of stochastic concepts to mixed parallel-serial systems. Previous numerical approaches mostly use the Finite-Element method to study the internal load transfer and apply a Monte Carlo approach to capture the stochastic character of the problem (see, for example [10]). The high computational effort of such an stochastic scheme allows a very small number of stochastic variables only. Furthermore, it does not indicate the sensitivity of mechanically relevant parameters on the stochastic result. For this reason, more advanced stochastic methods need to be investigated in terms of the applicability to wood-based products [11].

In general, a Stochastic Finite-Element approach can be divided into three parts: (i) the approximation of so-called realizations of the considered stochastic variables with a random process model, (ii) the discretization of the random process/stochastic field, and (iii) the implementation into a Finite-Element Method where the mechanical and stochastic problem is coupled. Considering glued-laminated timber elements, the mass density distribution in longitudinal direction is modeled as a linear random process, while for the distribution of the elastic properties a discontinuous model is used (*figure 6(a)*). The discontinuous random process is defined through information from an optical scanning device (WoodEye) and effective stiffness properties of different knot groups from the Finite-Element method for timber elements, presented in the section before. Various methods exist for the discretization of the stochastic field. In *figure 6(b)* a spatial discretization, in analogy to the discretization of the mechanical problem, and a discretization using a serial expansion (Karhunen-Loève) are exemplarily shown for the elastic modulus in longitudinal direction of a 4-layered GLT beam. These discretization methods were implemented into two different 'closed' Stochastic Finite-Element formulations, (i) the perturbation method, where the stochastic system matrix and the response vector are expressed as Taylor series expansions, and (ii) a spectral approach, where the stochastic part of the system matrix is written as a sum of certain 'basis functions'. The application of these methods to a glue-laminated timber element has shown that both methods are able to capture important effects, such as lamination effects, and deliver appropriate effective stochastic information (*figure 6(c)*) [11], similar to the Monte-Carlo simulation, but with a smaller computational effort. This allows for a stochastic analysis of wood products with a high resolution of the stochastic as well as mechanical conditions.

Figure 6:
(a) Random process models for property fluctuations in longitudinal direction of wooden lamellas,
(b) illustration of two different discretization methods of the stochastic field of a 4-layered glued-laminated timber element, and
(c) influence of the number of laminations and the 'raw' material on the coefficient of variation (COV) of the effective elastic modulus in longitudinal direction of a glued-laminated timber element.



Finite-Element model for dowel connections

Steel dowel connections are commonly used in timber structures since they can transfer and withstand very high loads between structural members. Their mechanical behavior is mainly based on

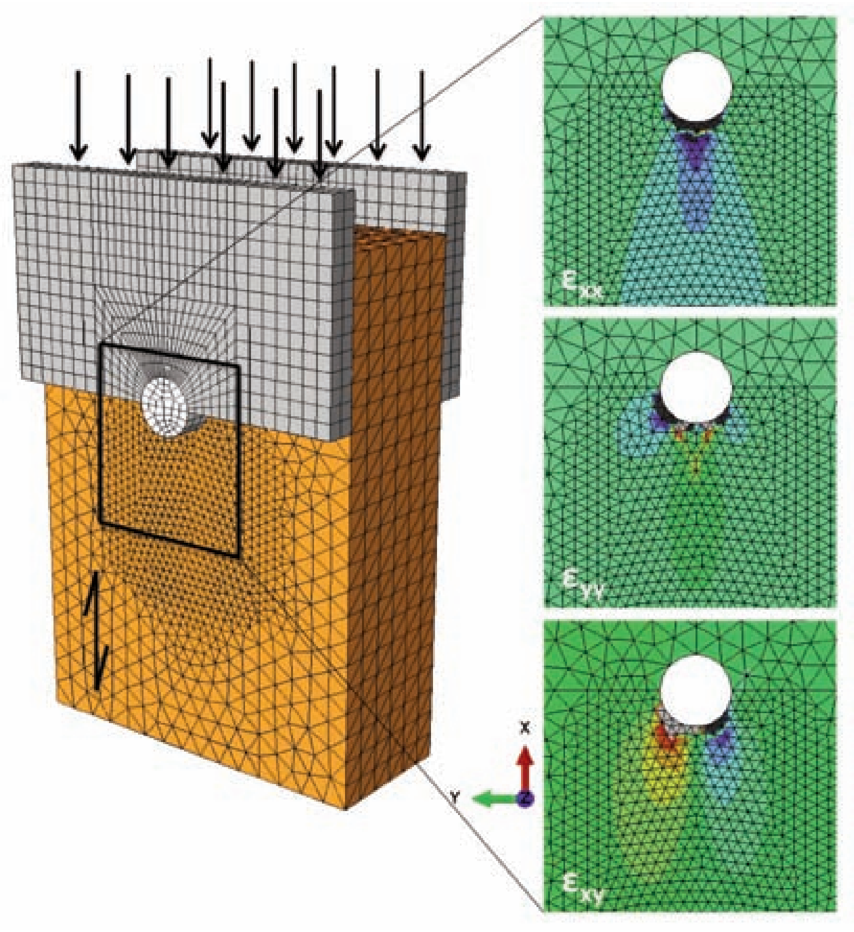


Figure 7:
Simulation of embedment tests (left) with wood loaded in fiber direction (parallel to the x-direction) through steel plates and steel dowel with corresponding strain fields (right) on the wood surface

the interaction between stiff steel dowels and the wooden parts, which further depends on the geometry of the connection and the loading direction. Due to the cylindrical shape of the dowels and the anisotropic behavior of wood, the stress and strain field in the wood around the dowel is very heterogeneous and encompasses stresses perpendicular to the loading direction and shear stresses in addition to compressive stresses in loading direction. Furthermore, due to stress concentrations close to the dowel, non-reversible deformations occur very localized at higher load levels. As a result, a ductile overall behavior of the connection is observed as long as splitting of wood due to stresses perpendicular to the grain is not decisive or prevented by means of lateral reinforcement. Other possible failure modes are related to shear failure under a single dowel or a dowel group (block-shear failure). In case of slender dowels, the load bearing capacity is additionally influenced by material properties of the steel dowel since plastic hinges may evolve before ultimate failure. The consideration of the compliant behavior of dowel connections is of importance for the analysis of timber structures, because it may strongly influence the redistribution of internal loads and subsequently the global deformations of timber structures.

In order to overcome current limitations and simplifications of design equations in standards, we aim at gaining increased insight into the load transfer in dowel connections. This will be the basis for the prediction of ultimate loads of arbitrary configurations of dowel connections with consistent deformation characteristics. Therefore, a numerical simulation tool for dowel connections has been developed [12]. It encompasses an anisotropic elasto-plastic material model for wood, which is based on micromechanical predictions from the presented multiscale model for clear wood. To the clear wood sections a Tsai-Wu failure criterion with an associated plastic flow rule is assigned. Through a contact model, the compliant behavior at the interface between the steel dowel and the wood borehole surface in normal (non-linear pressure-overclosure relationship) and tangential (friction) direction, is taken into account.

The numerical simulation tool was applied to single-dowel connections as well as to dowel embedment tests (*figure 7*) with different configurations related to material properties and geometry. Finite Element calculations were compared to experimental data. This shows that the model is particularly suitable for the study of the deformations of connections up to the serviceability limit, where the contact behavior considerably influences the deformation characteristics. Additionally, strain fields in steel to wood embedment tests were measured by means of a Digital Image Correlation system and used for a comparison with model predictions.

Based on these findings, more complex loading conditions and connection configurations can be studied. A future extension of the model concerns brittle failure of connections due to tensile stresses perpendicular to the grain or shear stresses, where fracture mechanics approaches will be applied.

Summary and conclusions

In this article, mechanical methods for advanced timber engineering, aiming at an improved understanding of the mechanical processes from the material scale up to structural applications, are presented. At the clear wood scale, a continuum micromechanics based multi-scale model gives access to microstructural-function relationships, i.e. it links microstructural characteristics such as mass density and moisture content with effective clear wood properties. This information is subsequently used in 3D numerical simulation tools for timber and dowel connections. The former allows for determining the influence of knots on the effective stiffness and strength of timber, while the latter gives insight into the stress-/ and deformation states within dowel joints and can be used to obtain global compliance functions for different connection geometries. Furthermore, the obtained effective stiffness behavior of timber elements with certain knot groups, together with information about the knot distribution and configuration within wooden boards from optical scanning devices, serve as input to stochastic Finite-Element approaches for wood-based products. The combination of a mechanical description, which is able to adequately take stress transfer between lamellas into account, with stochastic approaches makes it possible to assess probability distributions for effective material parameters of wood products, based on stochastic information of the 'raw' material (wooden lamellas).

In conclusion, computational mechanical methods applied to wood, wood products, and structural components of timber structures provide enhanced insight into load-transfer characteristics from the material level up to structural applications. The integrative use of the developed tools ensures reliable input data for subsequent numerical models. Continuous refinement of each tool, utilization of interactions, and exploitation of synergies between them, accompanied by thorough experimental validations, will finally lead to a comprehensive analysis tool, which can serve as a profound basis for design concepts in timber engineering. ●

> *"Continuous refinement of each tool, utilization of interactions, and exploitation of synergies between them, accompanied by thorough experimental validations, will finally lead to a comprehensive analysis tool, which can serve as a profound basis for design concepts in timber engineering."*

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Universal Meshes:
Enabling High-Order Simulation of Problems with Moving Domains

by
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What do crack propagation problems, fluid-structure interaction problems, phase-boundary evolution problems, and shape optimization problems have in common? By the time you finished reading the question the answer would have likely popped in your mind: they are types of problems motivated by important engineering applications in which finding the domain of the problem is part of the solution. These problems are more generally known as free or moving boundary problems. If these do not feel challenging enough, then try considering problems in which the boundary of the domain itself has some interesting dynamics. For example, the in-plane turbulent motion of a soap film induced by the surrounding air, the swimming of small microorganisms in which the thin vesicles that form their bodies are currently modeled as two-dimensional fluids with through-the-plane bending stiffness [1], and the propagation of a hydraulic fracture, in which the dynamics of the fracturing fluid on the crack surface is often modeled with Reynolds' lubrication equations [2].

It would not be an understatement to say that this class of problems has fascinated the computational mechanics community for decades now. The fundamental issue that needs to be addressed is, among several others, how to approximate both the domain and the solution as the domain evolves. It would be a mirage to pretend that within this article we could comprehensively review the universe of proposed methods for this class of problems. It is useful, however, to think about them in terms of the order of approximation of the domain; after all, the domain is part of the solution, so it should be approximated with the same order as the

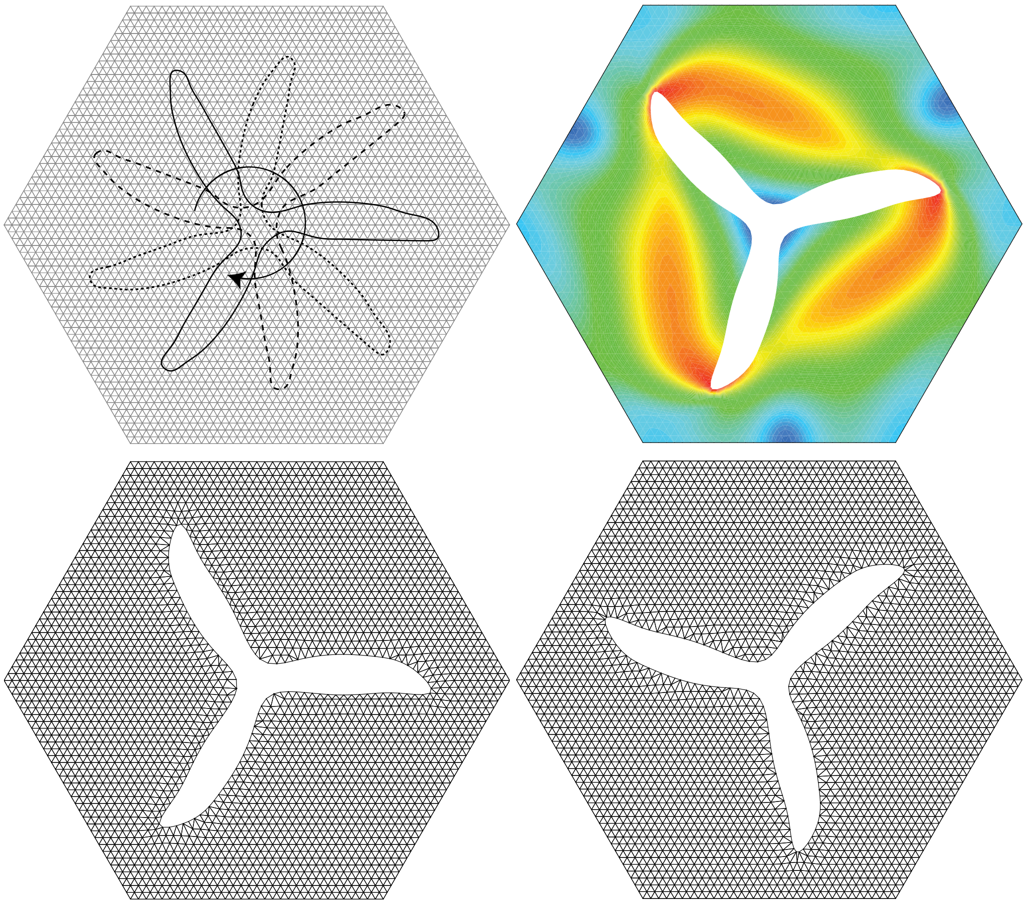


Figure 1: *Rigid propeller rotating at a constant angular velocity in a Newtonian fluid in two-dimensions. The Universal Mesh made of equilateral triangles (top-left) is deformed to exactly mesh the domain of the fluid for any angle of the propeller (bottom). Top-right: Snapshot of the speed contours.*

solution sought. For example, the so-called level set method (which truly stands for a variety of algorithms) is often applied on structured meshes and the domain is represented implicitly with a level set function. In most methods this function is piecewise affine, and this constrains the approximation of the domain to be at most second-order with the mesh size (for example, in the Hausdorff distance). Level set functions based on piecewise higher-order polynomials or rational functions are possible, but other complexities often appear when constructing approximation schemes of the same order for the solution. A similar remark applies to most embedded or immersed boundary methods, which either cut elements, as in extended finite element methods, or represent the boundary of the domain as a collection of connected segments [3,4]. As a second example we mention fluid-structure interaction methods based on an Arbitrary Lagrangian-Eulerian (ALE) description for the kinematics of the domain. In this context, approximations of the evolving domain of any order are possible. These methods are based on deforming a mesh that is fixed to a reference domain. Such deformation is described by a deformation mapping (or diffeormorphism), and its image is the deformed domain at each time instant. The limitation of these methods is found for some large deformations of the reference domain, such as in the propeller example of *Figure 1*. In these situations the deformed mesh can be highly sheared or even entangled, similar to what is often encountered when simulating solids under very large shear deformations.

Universal Meshes

This scenario prompted us to rethink the way to construct approximations to problems with moving domains. In particular, in a situation like the one in *Figure 1*, in which a mesh needs to be constructed for any possible position of the propeller, we made the observation that while the set of all elements intersecting the propeller at any single position (*Figure 1, top-left*) does not exactly mesh the domain, it is actually very close to doing so. Hence we wondered: would it be possible to simply deform such a set of elements so as to exactly match the domain? If we could do that for any position of the propeller, then the mesh on the background would be a *Universal Mesh* for all the domains needed in the problem.

It turns out that this idea is possible, so far in two-dimensions and with meshes made of triangles. The algorithm we proposed to do so is illustrated in *Figure 2* [5,6].

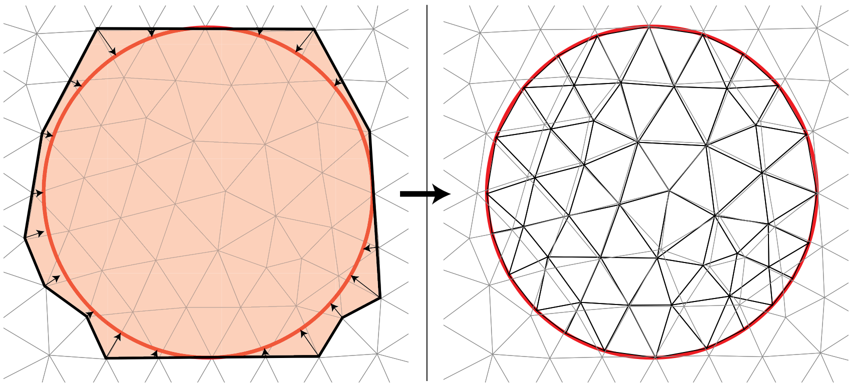


Figure 2:
Sketch of the algorithm applied to a circular domain (in red)
Left: *Elements with one node inside the domain are selected (in light red). Then their boundary (in black) is projected onto the circle with the closest point projection, and nodes in the interior of the circle are relaxed away from the boundary*
Right: *A theorem guarantees that the resulting mesh for the circle (in black) will have good quality elements. For comparison, the original Universal Mesh is also shown in the background (in gray)*

It consists of three steps:
(a) Loop over the elements in the mesh and select all elements that have at least one vertex inside the domain,
(b) project the boundary of the region formed by the (closure) of all these elements onto the boundary of the domain through the closest point projection, and
(c) relax some of the vertices near the boundary away from it, for example but not necessarily, along the direction normal to the boundary.

A video explanation of how this algorithm works can be found in [7], in which we showcase the robustness and speed of the algorithm through an interactive implementation in a tablet device. Given that the algorithm is pretty simple, it is fair to ask why it has not been proposed earlier (a related idea can be found in [8])? Well, a naïve application of this idea on arbitrary meshes, even Delaunay meshes, quickly reveals that elements with bad aspect ratios or inverted elements could easily appear [5]. We analyzed under what conditions on the Universal Mesh and the domain it is possible to use the algorithm above and obtain a mesh with a guaranteed lower bound on the element quality. The result is expressed as a theorem [6], and it essentially states that if (1) the domain is smooth (C^2), (2) the size of each element intersected by the boundary is small enough (with upper bounds that depend on the local curvature or local feature size of the domain), and (3) some angles of the element, or better perhaps all angles in the mesh, are acute, then the algorithm renders a good-quality mesh, with the boundary of the mesh coinciding exactly with the boundary of the domain.

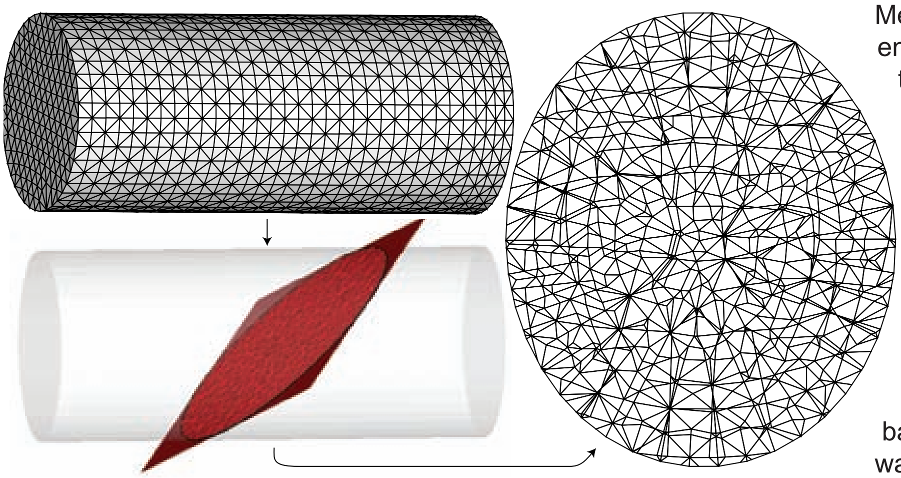


Figure 3:
Why is simulating hydraulic fractures a difficult problem? One reason is that a nice mesh is needed on the crack surfaces to solve for the motion of the fluid, and simply cutting elements does not render one

Furthermore, the upper bounds for the element mesh size near each point of the domain boundary can be explicitly computed, and used to robustly and automatically estimate whether a given Universal Mesh is able to mesh the domain or needs to be replaced. Another appealing feature of the algorithm is that it defines a one-to-one map between the domain and the closure of all the elements selected in step (a), and that by interpolating this map we precisely recover the isoparametric map. Consequently, when such interpolation is performed, the algorithm above can be simply regarded as a robust meshing preprocessor, and any elements of the user's liking can be adopted.

So, what is distinctive about a Universal Mesh then? A key advantage and difference over standard meshing algorithms is that for a problem with a moving domain the connectivity of the Universal Mesh is retained as the domain changes (as long as no new smaller features appear), and hence the data structures in the problem do not have to be rebuilt from scratch (or just minimally altered). Things like iterating over the geometry, often necessary when the domain itself is part of the solution, are now simple and possible. Algorithms based on a Universal Mesh have in some way the best of both worlds: the advantages of immersed boundary methods in that the geometry can undergo large changes or motions with minimal changes to the grid, and the accuracy of ALE methods that deform the mesh to approximate the domain.

This is the basic idea. We show some application examples next.

Applications

When we showcase the use of Universal Meshes we like to begin with the example of the propeller in *Figure 1*, since it precisely embodies the balance between ALE and immersed boundary methods that a Universal Mesh provides. To construct the spatial discretization for this problem

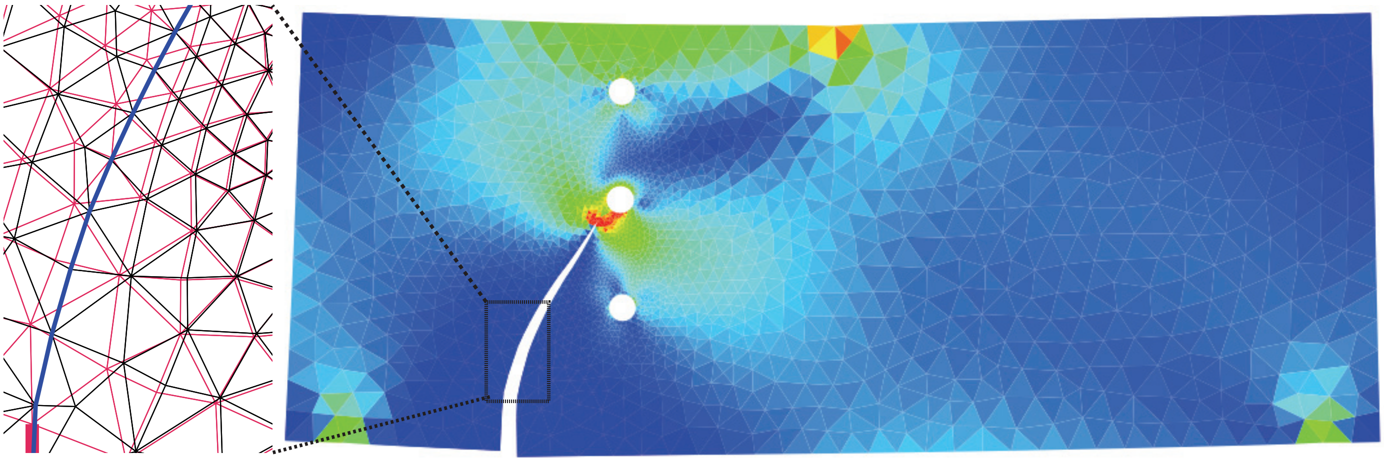


Figure 4:
A Universal Mesh used to simulate a traditional example of brittle crack propagation. The inset shows the Universal Mesh in red and part of the initial crack in a thick pink segment. The deformed mesh (in black) exactly meshes the crack path (in blue), so no elements were cut

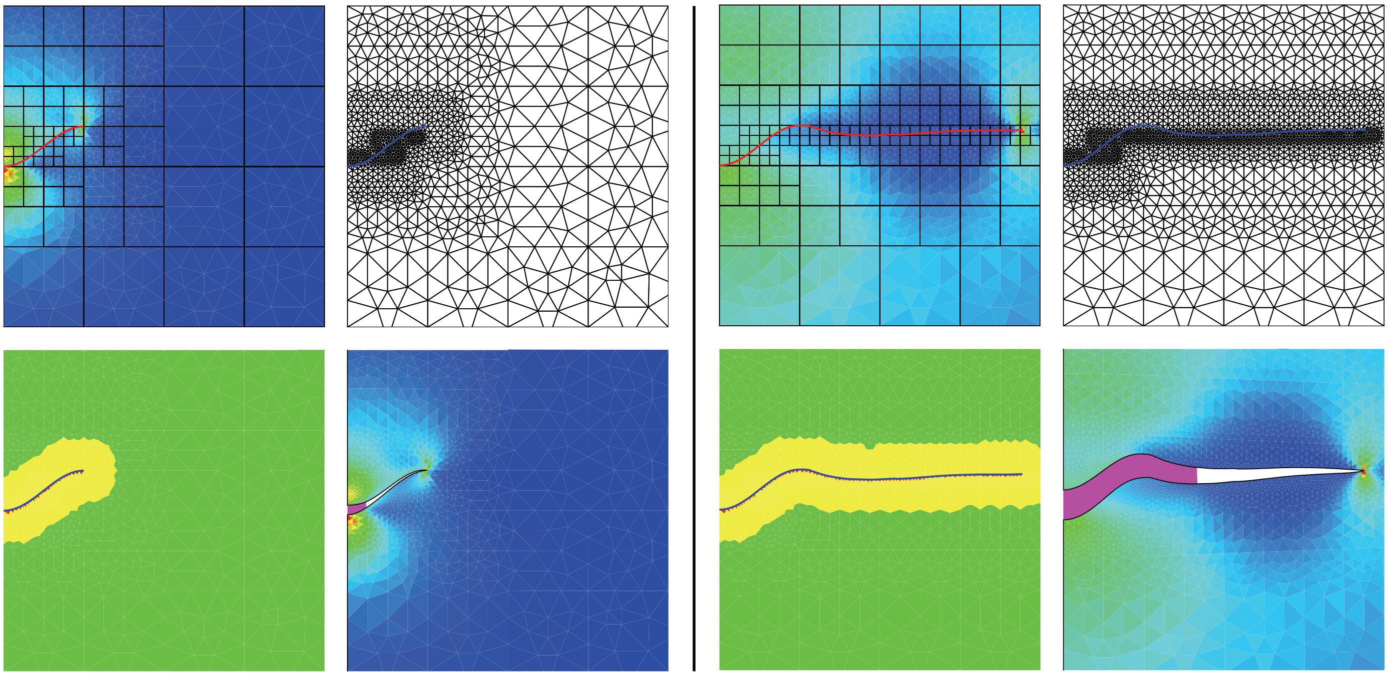


Figure 5:
Simulation of an initially curved hydraulic fracture in plane strain, with zero far-field stresses and symmetry conditions on the left. Each of the two snapshots shows the Universal Mesh (top-right), the quadtree used to refine it as the fracture evolves (top-left), the elements perturbed to accommodate the crack in the reference configuration (in yellow, bottom-left), and the von Mises stress in the deformed configuration of the rock (enlarged), with the fluid inside the crack in pink (bottom-right). At each loading step the Universal Mesh is deformed to exactly mesh the crack surface

we did not have to build any special elements, rather, we could choose among any of the stable combinations for incompressible flow: in this case a P2/P1 Taylor-Hood element. It would be nice to have the same flexibility for time integration, wouldn't it? It so happens that it is also possible to choose the preferred time integrator; we call it a plug-and-play approach, and for problems with smooth enough solutions, it enables the construction of methods of any order for problems with moving domains [9]. For the propeller we adopted a standard second-order Runge-Kutta method.

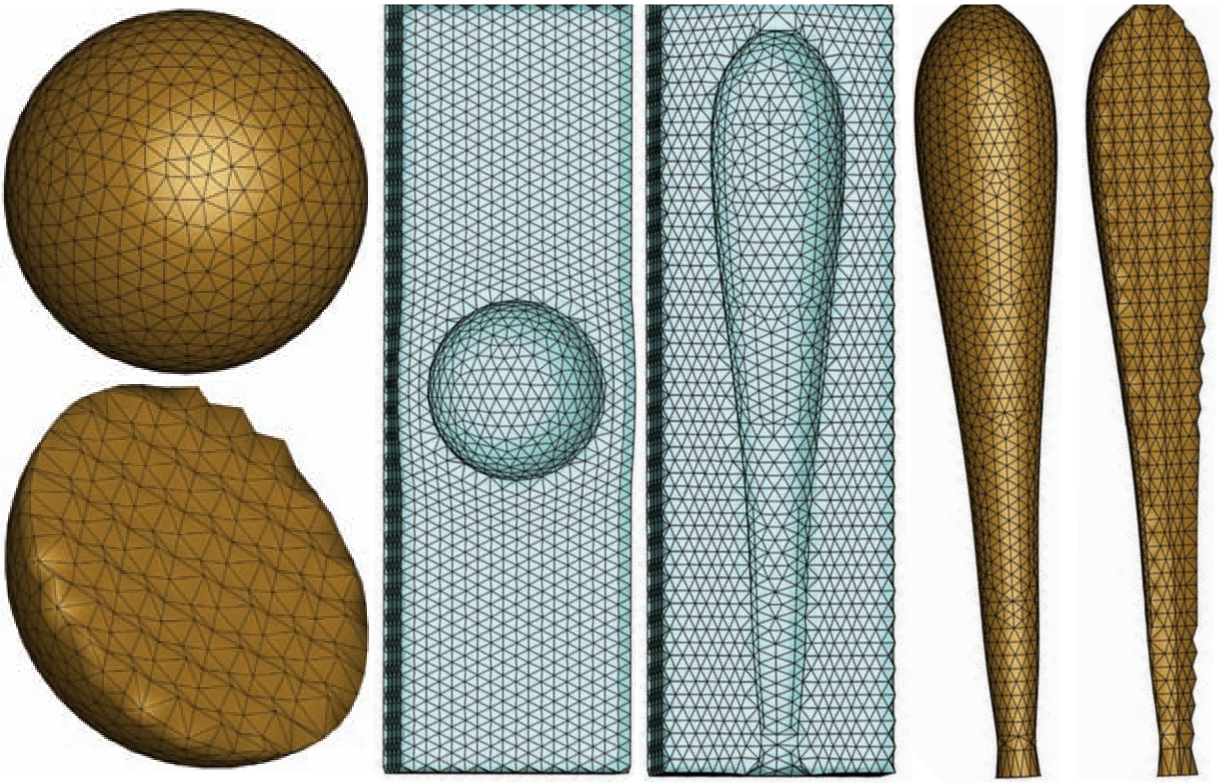
A different type of fluid-structure interaction problem was what motivated us a few years ago to create Universal Meshes. You may have heard about it lately, since it holds the promise to essentially change the global energetic landscape [10]. We are talking about the simulation of hydraulic fractures. Extensive reserves of natural gas are trapped in rocks with low permeability, and the main way to enhance gas flow is to massively fracture the rock by injecting fluid at high-pressure. The reason this problem is difficult to simulate is that not only do we need to allow arbitrary crack propagation, but as the crack surfaces evolve, we also need a reasonable mesh on them to solve the partial differential equations that describe the fluid motion through the crack. Simply cutting elements does not lead to a good mesh on the crack surfaces (*Figure 3*). In contrast, by deforming a Universal Mesh we are guaranteed to have a nice surface mesh on the cracks (*Figure 4*). Of course, for accuracy reasons the Universal Mesh often needs to be periodically changed, and this is what we show in *Figure 5* for an initially curved hydraulic fracture in plane strain (for straight fractures, see [2]). A peculiar aspect of these simulations is that at each time-step we need to iterate over possible cracks to find one that satisfies Griffith's criterion, and the Universal Mesh makes this a rather simple chore. On a more general note, the computation of the fluid motion on the crack surfaces is one example of how to take advantage of a Universal Mesh to solve partial differential equations on a manifold embedded in the mesh (not necessarily meshed).

> *" The beauty of a Universal Mesh is that we now know how to robustly deform it to exactly mesh a domain, provided the conditions laid out by the theorem are satisfied. "*

Outlook

The beauty of a Universal Mesh is that we now know how to robustly deform it to exactly mesh a domain, provided the conditions laid out by the theorem are satisfied. So far we have a theorem in two-dimensions and for geometries without corners, so the story is just starting and a lot remains to be done. We have compelling reasons to believe that similar ideas will work in three-dimensions, and *Figure 6* shows a preliminary example. For those who may want to test them, we will soon have an open source code available at our website: lavxm.stanford.edu. ●

Figure 6:
Preliminary examples in three-dimensions. The same Universal Mesh of tetrahedra was deformed to exactly match the surfaces of a sphere and a baseball bat. The surface meshes shown in both objects are of good quality, and so are the elements in the interior, exposed here by removing all elements with some vertices above the cut plane. In the process, the exterior of each object has been meshed as well, and those meshes are displayed in the two central pictures



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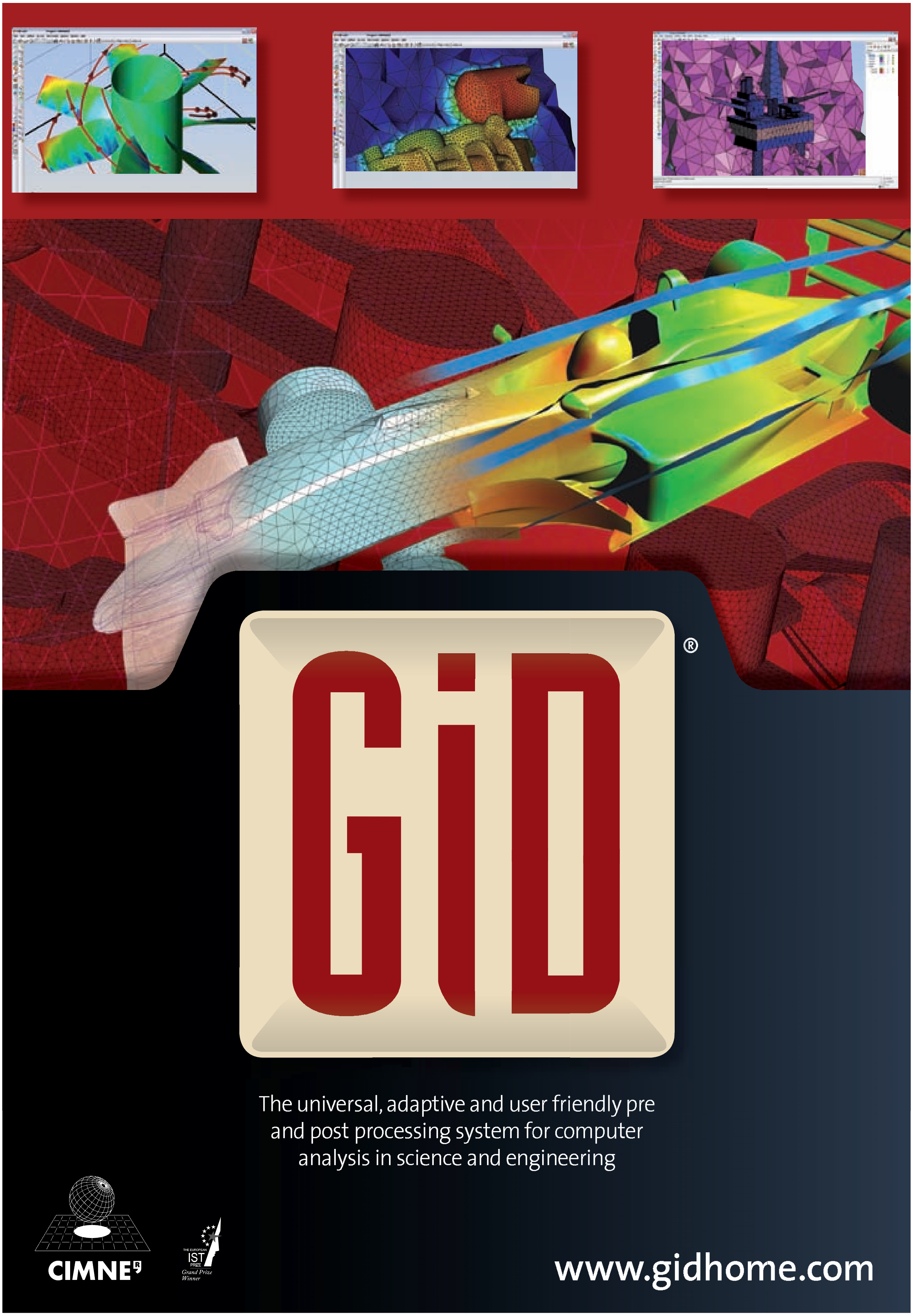
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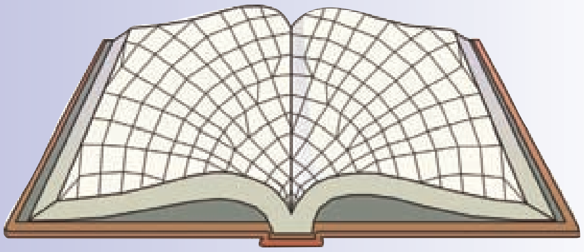
INTRODUCTION TO FINITE ELEMENT ANALYSIS:

FORMULATION, VERIFICATION AND VALIDATION

Barna Szabó and Ivo Babuška,
Wiley, West Sussex, UK, 2011



BOOK REVIEW

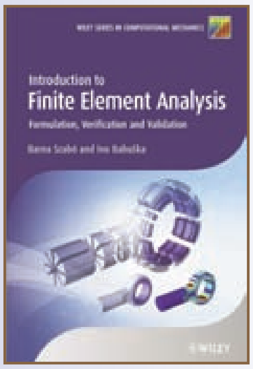
ISBN: 978-0-470-97728-6
364 pages, hard cover, £65.00 (List Price)
Contents: Preface, 1. Introduction, 2. An outline of the finite element method,
3. Formulation of mathematical models, 4. Generalized formulations,
5. Finite element spaces, 6. Regularity and rates of convergence,
7. Computation and verification of data, 8. What should be computed and why?
9. Beams, plates and shells, 10. Nonlinear models, Appendices A-F, Bibliography, Index.

The main theme of this delightful book is verification and validation, or in one word reliability, in the context of Finite Element (FE) analysis. The FE methodology itself is also presented, without assuming previous familiarity with the method. The book is intended as a textbook for undergraduate engineering students, but I think that other readers, such as practitioners of FE in industry, as well as first-year graduate students, can benefit a lot from it as well. The 10 chapters can be roughly divided into two parts: the part describing the FE method, consisting mainly of chapters 2-5 and certain sections in chapters 9 and 10, and the part discussing validation, verification and errors, which consists mainly of chapters 1, 6-8 and other sections in chapters 9 and 10.

This is the second book that the authors wrote together. The first one was Finite Element Analysis [Wiley, 1991]. Both are excellent, although they are quite different from each other.

Chapter 1 discusses the very concepts of validation and verification, decision making and design rules for computational models. The discussion is accompanied with illustrating examples. Reliability issues in engineering computing are demonstrated via real-life events: the failure of the Tacoma Narrows Bridge and the Sleipner offshore platform accident, among others. These failures were caused by lack of sufficient validation or verification of models: in the Tacoma case certain physical effects were not taken into account in the mathematical model, whereas in the the Sleipner case the FE mesh was too coarse and generated large errors.

Chapter 2 presents the FE method in 1D. It is an excellent treatment of the entire methodology, starting from the conceptualization of the mathematical model, going through the construction of the discrete model, and discussing validation, verification and error estimation in the process. The authors do here a fine job by briefly presenting the concepts and immediately illustrating them in a very effective manner. Validation is a concept that can be discussed at length (with many words and no equations), but when only starting to learn about the FE method most readers would not have the patience for such long discussions. I believe that the way that this material is presented in Chapter 2 is ideal: easy to digest, short and to the point, yet all the important issues can be found here, well explained and illustrated.


Introduction to
Finite Element Analysis
Formulation, Verification and Validation
Barna Szabó and Ivo Babuška

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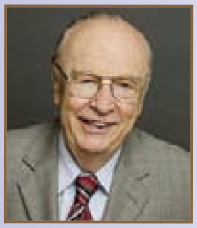
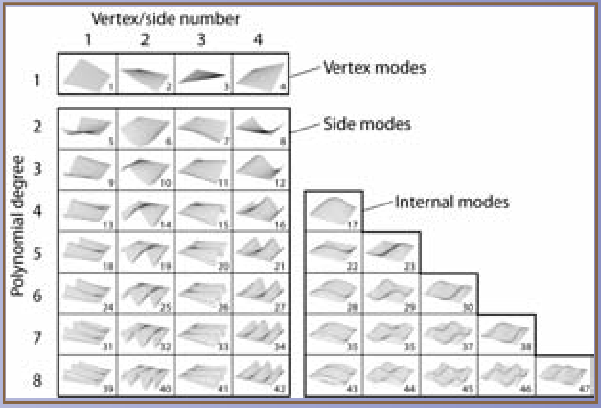
Barna Szabó


Ivo Babuška

Let us mention a typical cause of frustration to teachers and students in studying the FE method. As opposed to finite difference methods, whose basic idea and motivation can be explained in about ten minutes, thus providing the students with an "immediate satisfaction", the presentation of the FE method, even for the simplest 1D problem, requires at least a couple of hours, if done properly. One has to show how to formulate the weak form of the problem (or the minimization form) from the strong form, how to expand the solution in basis functions, how to construct these basis functions, etc. When young engineering students study this subject, they (and especially the less patient ones) may be initially frustrated from not seeing where this is all leading to. Most importantly, the weak form seems more complicated than the original strong form, and students may wonder why this complication is desired at all. The motivation for developing the weak form is not immediately clear to the students, and the teacher has to promise them that the benefits would become clear later.

The authors of this book found an ingenious way to circumvent this pedagogical problem. In section 2.2 they obtain directly the discrete variational formulation in an interesting and original manner. They expand the approximate solution in basis functions and substitute this expansion *into the energy norm of the error*. Minimizing this error norm leads to the familiar discrete set of equations. Thus, the student is provided with an immediate motivation: the FE formulation minimizes the error in the energy norm. The whole presentation, including a numerical example with two degrees of freedom, takes only three book pages. As opposed to the traditional treatment, where the weak form is presented early and the best approximation theorem is presented much later, here best approximation plays an early role in introducing the method, whereas the weak form is discussed later (section 2.3, where the weak form is called the generalized formulation), after the student is already motivated to understand the variational formulation in more depth. I find this approach useful and refreshing. There are additional similar "gems" along this book, which I will not mention here, in order to keep the review reasonably short.

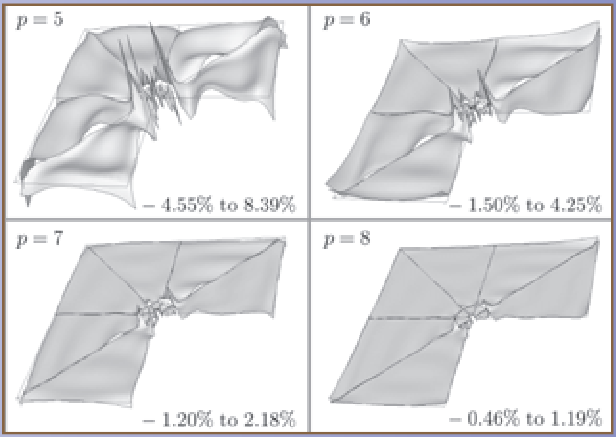
Figure 1:
Hierarchic shape functions. This figure appears in the book as Fig. 5.4 on p. 151



Chapter 3 discusses the strong forms of linear boundary value problems in 2D and 3D. These problems include heat conduction, elasticity and Stokes flow. Additional subjects covered here are symmetry, anti-symmetry, periodicity, dimensional reduction from 3D to plane and axisymmetric configurations and to 1D, and incompressible elastic materials.

Chapter 4 discusses weak forms (= generalized formulations) in 2D and 3D. The authors manage to make the discussion rigorous and at the same time easy to read and comprehend for undergraduate engineering students – a non-trivial achievement. The chapter includes a discussion of the minimum potential energy for elasticity. It also includes a very brief discussion on elastodynamics, eigenvalues and incompressible elasticity. These last sections provide the reader with only a taste for the discussed subjects; the interested reader can seek a more complete treatment elsewhere.

Figure 2:
Errors in stresses for an L-shaped domain. This figure appears in the book as Fig. 7.7 on p. 226.



Chapter 5 discusses FE shape functions. Among others, hierarchic shape functions are presented here (see Fig. 1). These shape functions, devised originally by the authors, were initially claimed by some to be deficient, since they violate the holy grail of FE verification, i.e., the patch test. More precisely, rigid body rotation imposed on hierarchic elements induces small non-zero strain. However, the authors provide on p. 157 a very convincing argument for the usefulness of these elements despite this fact. Chapter 5 also includes discussion of the integration and differentiation of FE quantities.

Chapter 6 deals with regularity and error estimation. Again the authors give an easy-to-digest treatment while maintaining rigorousness. Most of the chapter is concerned with *a priori* error estimates, although it ends with a short discussion of *a posteriori* estimates and adaptivity. Chapter 7 explains how to compute quantities other than the nodal primary solutions, and emphasizes the verification of this computation.

Section 7.3, using many examples and detailed exercises, shows how one can guarantee a reliable solution of quantities of interest, e.g., of stresses (see Fig. 2). Section 7.4 discusses the computation and verification of flux and stress intensity factors for geometrical singularities. Chapter 8 includes a case study for a specific model (see Fig. 3). Conceptualization (first discussed in Chapter 2) is re-visited in the setting of metal fatigue, and the statistical nature of comparing experiments with predictions is addressed, demonstrating again the formulation, verification and validation for the studied problem.

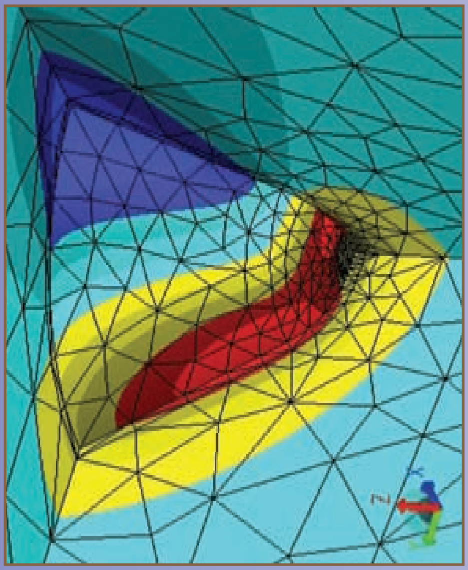


Figure 3: *Stress contours for the case study of Chapter 8. A gray-scale version of this figure appears in the book as Fig. 8.7(b) on p. 249*

Chapter 9 covers beams (both Timoshenko and Bernoulli-Euler), plates (both Reissner-Mindlin and Kirchhoff) and some shell models. Section 9.4 discusses the Oak Ridge experiment and the validation and verification associated with it. Any student or practicing engineer can learn a lot from this important section, that shows how the concepts that have been discussed are employed in practice in the industrial world. Chapter 10 deals with nonlinear models; its purpose, it seems, is mainly to make the reader aware of the existence and importance of such models, since the treatment here is very far from being complete.

I will point here to what I regard as slight deficiencies. First, in section 2.3.1 the authors discuss “essential boundary conditions” while in sections 2.3.2 and 2.3.3 they discuss “Neumann boundary conditions” and “Robin boundary conditions”. The term “natural boundary conditions” is not mentioned in these sections. On the other hand, in section 2.1.4 it is stated that “the Neumann and Robin boundary conditions are also called natural boundary conditions.” I see this as an inaccurate and slightly confusing terminology. The differential forms of the boundary conditions identify them as Dirichlet, Neumann or Robin conditions, while the terms “essential” and “natural” relate to the way they are enforced in the variational formulation. (For example, a Dirichlet condition is enforced as a natural condition in some non-standard FE formulations.)

Second, there is no discussion or even mention of the sparsity of the stiffness matrix. The authors state on p. 61 that “discussion of the various solvers... is beyond the scope of this introductory exposition.” This being so, I still think that it is important for anyone who studies the FE method for the first time to be aware of the way in which the local FE shape functions lead to a sparse matrix and of the importance of the latter.

Third, pp. 113-115 include an example with numbers and physical units. This in itself is useful, but what I do not like is that the numbers are substituted into the equations right from the beginning. Thus, equation (4.9) and Table 4.1 and the text around them include both variables and numbers mixed together. In my opinion, substituting numbers at any stage except the very end of the derivation is counter-productive. In the formula $q=-2u'$, is the factor 2 a dimensionless coefficient that comes out of the derivation, or is this simply the formula $q=-ku'$ with $k=2\ \mathrm{W/mK}$ substituted? The student would have a hard time following all the steps of the derivation if some of the parameters are replaced by their numerical values. Also, substituting numbers early denies one from the extremely important ability to check the units – an excellent means to find mistakes in the derivation.

It is important to emphasize that these deficiencies are very minor and “local”, and do not reduce from the extremely high quality and usefulness of the book.

Each chapter concludes with a Chapter Summary, which gives a short overview of the important items included in the chapter, with added comments and conclusions. Some of the conclusions have important implications on the reliability of practical FE analysis. The book contains quite a few exercises, to some of which the solutions are given in Appendix F. The book is not only very well written but also has a pleasant appearance and is inviting to read. A very nice bonus that comes with the book is the access to the student edition of the p-version software StressCheck. In addition, various teaching aids are available to faculty through a companion website.

I highly recommend this as a textbook for an undergraduate engineering course on FE analysis. Moreover, I recommend this book to every engineer who practices FE computation, since this is a well-written and unique source for studying the extremely important issue of reliability of FE analysis in practice. ●

Chilean Society for Computational Mechanics

for all inclusions under CSCM pleace contact:

Marcela Cruchaga
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Universidad Técnica Federico Santa María (UTFSM) has hosted the XI Workshop on Computational Mechanics (JMC 2012, acronym in Spanish) at Valparaíso during October 4th and 5th, 2012. The Workshop, coorganized by USM and the Chilean Society for Computational Mechanics (CSCM), was officially opened by Prof. Eugenio González Vergara, Head of the Mechanical Engineering Department at UTFSM. Prof. Alexander Quaas, Head of Research and Postgraduate School of the University, also participated in the Open Ceremony. Prof. Franco Perazzo, Chair of the meeting, has warmly welcomed the participants: faculty members and students coming from different universities located along Chile. Prof. Marcos Toledo, responsable of the Master Program on Mechanical Engineering, Prof. Mario Toledo and Prof. Luis Pérez Pozo co-chaired the meeting.

Figures 1:
Prof. Alexander Quass, Prof. Eugenio González Vergara and Prof. Lorena Barba during the Open Ceremony

A kindly reception was devoted to Prof. Lorena Barba whom got her Engineering Degree at UTFSM and, she is currently Assistant Professor of the Mechanical Engineering at Boston University. Prof. Barba delivered an illustrative talk on GPUs as Plenary Lecture title “The rise and future of GPUs for computational engineering”.

The two-days Workshop encompassed Technical Parallel Sessions summarizing 59 works from several areas of computational mechanics and, including presentations given by enterprise members. Moreover, a collection of 25 full written papers were reported in the journal of the CSCM “Cuadernos de Mecánica Computacional”, Vol. 10 (2012).

In addition, software companies displayed stands showing the capabilities of their products. The CSCM thanks their paticipation and valuable support to the meeting, as well as the human and economical resources bringing by UTFMS throught the Mechanical Engineering Department, the Master Program on Mechanical Engineering and the Research and Postgraduate School of the University. In particular, the CSCM warmly thanks the participation of authors and speakers and, specially acknowledges the active participation of under and post graduate students.

Figures 2:
Prof. Franco Perazzo welcomed the participants to JMC 2012

Finally, the CSCM cordially invites to participate in the next version of the Workshop (JMC 2013) to be held in Santiago de Chile at the Universidad de Santiago de Chile (USACH) from 3 to 4 October 2013. Contact Profs. Claudio García (claudio.garcia@usach.cl) or Marcela Cruchaga (marcela.cruchaga@usach.cl) for further information on the next meeting or visiting the web page of the CSCM **www.scmc.cl**.

Figures 3:
Participants to the XI Workshop on Computational Mechanics JMC 2012 at Universidad Técnica Federico Santa María at Valparaíso

22nd International Workshop o of Materials H

The 22nd International Workshop on Computational Mechanics of Materials (IWCMM 22), a USACM thematic conference, was recently held in the Sheraton Inner Harbor Hotel, Baltimore, Maryland, on September 24-26, 2012.

IWCMM-22 was hosted by the Whiting School of Engineering at Johns Hopkins University, and partially sponsored by the National Science Foundation and the US Association of Computational Mechanics. Somnath Ghosh, the Michael G. Callas professor in Civil Engineering and Mechanical Engineering at Johns Hopkins University and the director of the Air Force Center of Excellence in Integrated Materials Modeling (CEIMM) was the workshop Chair.

Figure 1:
Conference site

IWCMM-22 covered all aspects of modeling and simulations of the mechanical behavior of a range of materials at different length and time scales. It provided platform for discussion of deformation and fracture mechanisms under different loading and environmental conditions. The materials of interest range from traditional materials such as metals, alloys, polymers and composites to advanced and emerging materials and bio-materials.

This was the first time that the International Workshop on Computational Mechanics of Materials was held in the US, or any other country in the Americas. The conference was a huge success with a large number of high quality presentations and discussions. This thematic conference exceeded participation that the workshop has seen in the previous years. It provided a forum for bringing together researchers and practitioners from academia, industry, government and laboratories all over the world and discuss latest advancements and future directions in various areas pertaining to computational mechanics of materials. About 230 attendees participated in this workshop, which featured a variety of different programs. Of them there were 159 participants from the US, 44 from Europe, 5 from Asia and 1 from Africa. 70% of the participants were from academia, 23% were from government laboratories and 7% from industry.

There were 9 plenary and 4 semi-plenary lectures on current topics of interest, and 18 mini-symposia with keynote talks and

New USACM Awards

The U.S. Association for Computational Mechanics is pleased to announce the re-naming of two of its awards. Last January, the **J. Tinsley Oden Medal** replaced the USACM Computational and Applied Science Award. Recently two new medals were established as follows.

The **Belytschko Medal** will given in recognition of outstanding and sustained contributions to computational structural or solid mechanics (CSM). These contributions shall generally be in the form of important research results that significantly advance the understanding of theories and methods impacting CSM. Industrial applications and engineering analysis that advance CSM shall also represent accomplishments worthy of recognition. [This award replaces the former USACM Computational Structural Mechanics Award.]

The **Thomas J. R. Hughes Medal** will be given in recognition of outstanding and sustained contributions to the broad field of Computational Fluid Dynamics (CFD). These contributions willl generally be in the form of important research results that significantly advance the understanding of theories and methods impacting CFD. Industrial applications and engineering analyses that advance CFD shall also represent accomplishments worthy of recognition. [This award replaces the former USACM Computational Fluid Mechanics Award.] ●

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regular presentations. After Professor Ghosh's welcome, Prof. J. Tinsley Oden of UT Austin started off the conference with his plenary presentation entitled "Selection, Validation, and Control of Models in Computational Mechanics". A special attraction was a symposium on Materials Genome Initiative or MGI that featured Dr. Cyrus Wadia of the White House Office of Science and Technology policy, Dr. Julie Christodoulou of Office of Naval Research, and Dr. Dennis Dimiduk of Air Force Research Laboratory as the plenary speakers. Keynote talks were given by important people from industry that are actively pushing the MGI/ICMSE theme. The symposium ended with a panel discussion on the future directions of MGI and how academic-industry-government laboratories research should prepare for this challenge. Kevin Hemker of Johns Hopkins University and Tarek Zohdi of UC Berkeley served as moderators of this panel. The banquet witnessed an interesting presentation by Prof. K.T. Ramesh, who is the director of the newly formed Hopkins Extreme Materials Institute (HEMI) at Johns Hopkins University, entitled "Going to Extremes".

The success of the IWCMM-22, the first time held in the US, have made the founders of this workshop including Professor S. Schmauder of the University of Stuttgart to consider bringing it back to the US again soon. With the emerging topics like MGI. ICMSE and other themes, it is expected that a focused thematic conference on this topic will see significant growth and vitality in the years to come.

For more information on the 22nd IWCMM, visit iwcmm.jhu.edu. ●

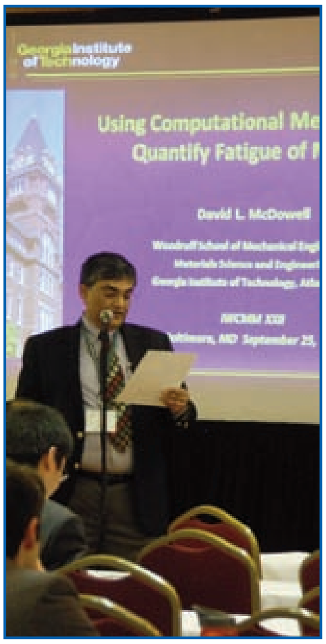

Figure 2:
Professor S. Ghosh introducing Professor David L. McDowell

Figure 3:
Conference banquet

Figure 4:
(from left to right) Dr. Dennis Dimiduk (Air Force), Professor Somnath Ghosh (Johns Hopkins University), and Professor J.T. Oden (University of Texas at Austin) at the welcoming reception

Figure 5:
Conference registration table and banner

USACM Announcements

- Workshop on Nonlocal Damage and Failure: Peridynamics and Other Nonlocal Models, March 11-12, 2013, San Antonio, Texas (ndf2013.usacm.org)
- 12th U.S. National Congress on Computational Mechanics, July 22-25, 2013, Raleigh, North Carolina (12.usnccm.org)
- Methods and Validation in Medicine and Biology II: Biomechanics and Mechanobiology, February 13-14, 2014, Berkeley, California

Israel Association for Computational Methods in

The Israel Association for Computational Methods in Mechanics (IACMM) has held two IACMM Symposia since our last report (see IACM Expressions No. 30). In this issue we shall report on them.

The 31st IACMM Symposium was held in October 2011 in Ben-Gurion University of the Negev, in Beer-Sheva. The local organizers were Zohar Yosibash and Koby Bortman. The very impressive Opening Lecture was given by Prof. Jacobo Bielak from Carnegie-Mellon University, USA, and was entitled “End-to-end earthquake simulation: from source to urban impact”. *Figure 1* is a slide taken from this talk. *Figure 2* shows Prof. Bielak with the IACMM Council.

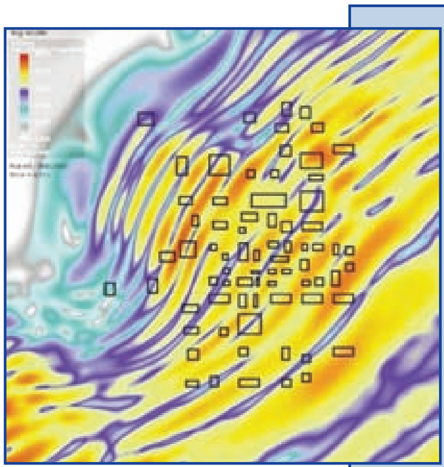

Figure 1:
Figure taken from the Invited Lecture of Prof. Jacobo Bielak in ISCM-31: simulation of an earthquake, showing ground-motion surface velocity

The symposium also included 11 other lectures, presented by practitioners and researchers from industry and academia. *Figures 3, 4* and *5* show illustrations from the lectures of Michael Bogomolny from Plasan Sasa Ltd, Shachar Berger from Ben-Gurion University, and Gil Marom from Tel-Aviv University, respectively.

The 32nd IACMM Symposium was held in March 2012 at the Afeka College in Tel Aviv. The local organizers were Dalia Fishelov and Yoni Stanchescu. A fascinating Opening Lecture was given by Prof. Jaume Peraire from MIT, USA, on “Hybridized discontinuous Galerkin methods for computational mechanics”. The afternoon Keynote Lecture was given by Prof. Marek Behr from Aachen University, Germany, on “Model

Figure 2:
Prof. Jacobo Bielak with the IACMM Council, at ISCM-31. From right: Zohar Yosibash (also Local Organizer of ISCM-31), Jonathan Tal, Pinhas Bar-Yoseph, Dan Givoli (President), J.B., Emanuel Ore, Amiel Heszage (Secretary/Treasurer), Isaac Harari, Moshe Eisenberger (member of Rev. Committee)

Figure 3:
Figure taken from the lecture of Michael Bogomolny at ISCM-31 on topology optimization of structures

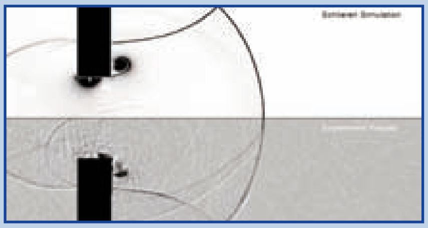

Figure 4:
Figure taken from the lecture of Shachar Berger at ISCM-31, showing the comparison between numerical and experimental schlieren images of a shock wave

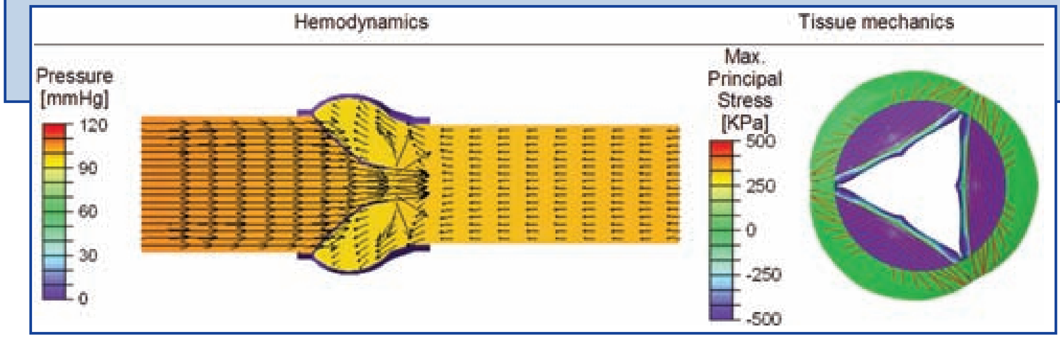

Figure 5:
Figure taken from the lecture of Gil Marom at ISCM-31, showing a fluid-structure interaction model in blood flow analysis

Figure 6:
Figure taken from the Keynote Lecture of Prof. Marek Behr at ISCM-32 on computational mechanics for optimal design

development and optimal design with applications to biomedical and production engineering". See *Figure 6*, which is taken from his interesting talk. ISCM-32 included 8 additional contributed talks.

Figure 7 is a picture of the interested audience at ISCM-32. *Figure 8* shows the Invited Speakers of ISCM-32 with their hosts, and *Figure 9* shows them with the IACMM Council at the end of the Symposium.

The Assembly Meeting at ISCM-32 included an award ceremony. The winner of the Lecture Competition which spanned the lectures of the 30th and 31st IACMM Symposia was announced to be Elad Priel, a former student of Prof. Zohar Yosibash at Ben-Gurion University. Dr. Priel attended ECCOMAS-2012 and presented his work in Vienna. The IACMM award consisted in support for this travel. The winner of the 2011 IACMM Thesis Competition was announced to be Lev Podshivalov, a former student of Prof. Anath Fischer and Prof. Pinhas Bar-Yoseph at the Technion. His thesis is entitled "Multiscale Finite Element analysis of 3D bone micro-structure". *Figure 10* shows Dr. Podshivalov receiving a certificate for this achievement. ●

Figure 7:
Audience at ISCM-32

Figure 8:
*Invited Speakers of ISCM-32 with their hosts.
From left: Dan Givoli, Dalia Fishelov (Local Organizer), Jaume Peraire, Marek Behr, Amiel Heszage, Eva Schlauch (student of M.B.) and Oded Gottlieb*

Figure 9:
*IACMM Council and the Invited Speakers of ISCM-32.
From left: Dalia Fishelov, Oded Gottlieb, Amiel Herszage, Isaac Harari, Marek Behr, Jaume Peraire, Pinhas Bar-Yoseph, Michael Engelman, Eva Schlauch and Dan Givoli*

Figure 10:
Lev Podshivalov (left) receives a certificate from the president and secretary/treasurer of IACMM for reaching the 1st place in the 2011 IACMM Thesis Competition

Argentine Association for Computational Mechanics

for all inclusions under
AMCA
please contact:
Victorio Sonzogni
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MECOM 2012
X Argentine Congress on Computational Mechanics

The beautiful city of Salta, in the north-western Argentine, held the X Argentine Congress on Computational Mechanics (MECOM 2012) from 13 to 16 November 2012. It was organized by the Faculty of Engineering of the National University of Salta. The organizing committee was chaired by Liz G. Nallim and Mario W. E. Toledo, while the Scientific Committee was chaired by Alberto Cardona.

Invited lecturers for this congress were: Sergio Idelsohn (CIMNE, España; CIMEC-INTEC, Argentina);. Eugenio Oñate (CIMNE-UPC, España); Raul Feijoo (LNCC/CNPq, Brasil); Miguel Cerrolaza (UCV, Venezuela); Sergio Oller (CIMNE-UPC, España-Argentina); Tayfun Tezduyar (Rice University, USA); Mario Storti (INTEC-CONICET-UNL, Argentina); Rainald Löhner (George Mason University, USA).

More than 300 people attend the Congress. Full length papers were submitted to a review process prior to publication. From them, 250 papers were accepted and included in the XXXI Volume of the AMCA Series “Mecánica Computational”, edited by A. Cardona, P. Kohan, R. Quinteros and M. Storti. The papers at “Mecánica Computacional” are publicly available at the website: http://www.cimec.org.ar/ojs/inex.php/mc/issue/archive .

A special session was devoted to undergraduate students, with awards for the best posters. The first award was for Nicolás Guillén from the National University of Cordoba, while the second one went to Augusto Romero from the National Technological University, Regional Faculty of Cordoba.

Other events took place in this week, together with MECOM 2012:
- the XXX International Meeting of the CIMNE Classrooms Network;
- the Third Meeting of Users of OpenFOAM in Argentina;
- and an information meeting of the National System of HPC (SNCAD) of the Ministry of Science, Technology and Productive Innovation of Argentina.

Homage to Prof. Sergio Idelsohn in his 65th Birthday

MECOM 2012 gave frame to a reconnaissance of the Argentine community of Computational Mechanics to Sergio Idelsohn for his 65th anniversary. In fact, Thursday 15th, the day of the congress banquet, was Sergio's birthday.

Figure 1:
Special Session devoted to Sergio Idelsohn, from left to right: G. Buscaglia, P. Jacovkis, O. Allix, S. Idelsohn, J.C. Heinrich, E. Oñate, N. Nigro and R. Lohner

The footprint left by Sergio in the Computational Mechanics in Argentina is huge. He created the International Center of Computational Methods in Engineering (CIMEC) and was one of the promoters, and for many years president of AMCA.

He gave the Mecom 2012 opening plenary lecture, and there was a special session devoted to his contributions. He received expressions of affection from his friends and disciples.

Figure 2:
Participants Mecom 2012

AMCA Awards 2012

The AMCA Awards 2012 were granted during the Congress Banquet of MECOM 2012.

The award for Young Researchers was granted to **Rodrigo Paz** and to **Lisandro Dalcin**, from the CIMEC, Argentina. **Mario Storti**, from CIMEC, Argentina, received the award for Scientific, Professional and Teaching Career. The award to the International Scientific Career, was for **Tayfun Tezduyar**, from the Rice University, USA.

The jury for the AMCA Awards 2012 was integrated by: E. Dvorkin, R. Löhner, G. Marshall, X. Oliver, P. Sanchez, J. Signorelli and V. Sonzogni. ●

Figure 3:
AMCA Award 2012 for Young Researcher: Rodrigo Paz

Figure 3:
AMCA Award 2012 for Young Researcher: Lisandro Dalcin

Figure 3:
AMCA Award 2012 for Senior Researcher: Mario Storti

Figure 3:
AMCA Award 2012 for International Researcher: Tayfun Tezduyar

Call for Papers

ENIEF 2013

XX Congress on Numerical Methods and their Applications

Mendoza, Argentina, 18 - 22 November 2013

The Argentine Association for Computational Mechanics (AMCA) announces the XX Congress on Numerical Methods and their Applications, which will be held in Mendoza, Argentina, organized by the National Technological University of Mendoza.

Mendoza is a beautiful city, in the mid-western Argentina, land of high mountains (like the Aconcagua Mount) and fine wines.

Email: **enief2013@frm.utn.edu.ar**
Web: **www.enief2013.frm.utn.edu.ar** ●

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SEMNI please contact
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TWO SEMNI MEMBERS HAVE BEEN AWARDED DURING THE LAST ECCOMAS CONFERENCE

The last September 10-14th the European Conference on Computational Methods in Applied Sciences and Engineering (ECCOMAS) took place in Vienna, organized by the Technical University of Vienna.

The opening ceremony took place at the magnificent Musikverein palace, the same from which the famous New Year's concert is broadcast to the whole world. During this opening ceremony the European Community on Computational Methods in Applied Sciences awarded its members. These awards are given each two years to outstanding scientists in the field of computational methods.

SEMNI is proud to announce that two of its members have been awarded this year, out of a total of five awards.

The Ludwig Prandtl Medal is awarded for outstanding and sustained contributions to the area of computational fluid dynamics (CFD). These contributions shall generally be in the form of important research results, which significantly advance the understanding, and application of theories and methods impacting CFD. The medal carries the image of Ludwig Prandtl.

This year's Prandtl medal recipient is professor Sergio Idelsohn, from the International Centre for Numerical Methods in Engineering (CIMNE), in the Polytechnic University of Catalonia at Barcelona. In words of the jury, "Professor Sergio Idelsohn's research activities spread over a range of multidisciplinary fields where he has contributed relevant theories and methods of scientific and industrial relevance. His key research lines are Particle Finite Element Methods, Meshless Methods, Phase Change Problems, Reduction Methods, and Quasi-Newton Methods".

Figure 1:
Prof. Idelsohn receiving the medal from ECCOMAS president, Prof. Papadrakakis

ECCOMAS has also established the Olgierd C. Zienkiewicz award for researchers under the age of forty in the field of computational solid and structural mechanics. This year's awardee has been prof. Cueto (*ex aequo* with prof. Alessandro Realli, from Italy).

Prof. Cueto is a very active member of SEMNI, and, in spite of his youth, he belongs to the SEMNI executive board since 2006. The scientific activity of professor Cueto encompasses a broad number of fields, like meshless methods, material forming modelling, reduced order modelling methods, or biomechanics.

In addition, he has actively participated in the organization of a large number of Conferences, Invited Sessions and Minisymposia as well as in a number of editorial works.

Figure 2:
Prof. Cueto receiving the diploma from ECCOMAS president, Prof. M. Papadrakakis

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Announcement of a New
APACM Thematic Conference
COMPSAFE2014

The **Japan Association for Computational Mechanics** (JACM), the **Japan Society of Computational Engineering and Science** (JSCES), and **International Research Institute of Disaster Science**, **Tohoku University** (*Figure 1)* will co-organize a new APACM Thematic Conference, **COMPSAFE2014** (1st International Conference on Computational Engineering and Science for Safety and Environmental Problems) during 13-16 April 2014 in Sendai, Japan. The conference topics are computational mechanics, computational engineering and science technologies, and their applications related to:

(1) safety- / risk-related, disaster-preventing topics including various types of natural hazards such as earthquake, tsunami, typhoon / hurricane / cyclone, flood, explosion of volcano, land slide;
(2) any kinds of accidents and failures of engineering artifacts such as fractures, crashes, explosion; and
(3) environmental and social problems such as air / water pollution, radioactive contamination, global environment problems, evacuation and so on.

The conference venue will be Sendai International Center (http://www.sira.or.jp/icenter/english/index.html). Sendai is a city with a population of one million, and is the political and economic center of Japan's Tohoku (northeast) Region. Although Sendai is a large city, it is known throughout Japan as a modern city in harmony with nature (Figure 2). The city possesses beautiful scenery, such as the Hirose-gawa River that runs through central Sendai, and the lush zelkova trees that line its streets. Sendai has many universities and is also well known as an academic city. Sendai also values history and culture. Many traditional events, such as the Sendai Tanabata Festival, continue to this day. We invite you to discover Sendai, a modern city that retains its natural beauty and tradition. Although the Tohoku Region were attacked by The Great East-Japan Earthquake and Tsunami on 11th March 2011, you will witness the efforts of recovery / reconstruction in the quake- and tsunami-scarred regions.

Important dates are as follows :

Online submission of minisymposia proposals	15 May 2013
Deadline for minisymposia proposals	1 September 2013
Online submission of abstracts	1 October 2013
Deadline for abstract submissions	15 December 2013
Online submission of extended abstracts	15 January 2014
Deadline for extended abstract submissions	1 March 2014

Please visit our website **(http://www.compsafe2014.org)** in more detail.

Figure 1:
Group photo of JACM and JSCES members at the reception after 1st Local Organizing Committee meeting on 31st October 2012

Figure 2 :
Cherry blossom and a Temple in Spring in Sendai

JAPAN ASSOCIATION FOR COMPUTATIONAL MECHANICS

JACM NEWS

The JACM celebrating the 10th anniversary in 2012 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.sim.gsic.titech.ac.jp/jacm/index-e.html). The number of individual members is about 300. JACM organized 14 mini-symposia at WCCM 2012 held in São Paulo, Brazil.

JACM 2012 ANNUAL MEETING

Figure 1: *The attendees of the JACM meeting held on 10th July 2012*

The 2012 JACM annual meeting was held on the occasion of WCCM2012 at São Paulo on 10th July 2012 (*Figure 1*). About 30 members got together to discuss the future prospects of the association such as the co-organization of an APACM Thematic conference with JSCES. They also celebrated the 2012 JACM award recipients listed below.

The JACM Computational Mechanics Award :
Professors Masanori Kikuchi (Tokyo University of Science), Seiichi Koshizuka (The University of Tokyo) and Marie Oshima (The University of Tokyo) (*Figure 2*).

Figure 2: *Recipients of JACM Computational Mechanics Award Professors M. Kikuchi , S. Koshizuka and M. Oshima*

The JACM Fellows Award :
Professors Takashi Furumura (The University of Tokyo), Hirotsugu Inoue (Tokyo Institute of Technology) and Kenji Takizawa (Waseda University) (*Figure 3*).

Figure 3: *Recipients of the JACM Fellows Award Professors T. Furumura, H. Inoue, K. Takizawa*

The JACM Young Investigators Award :
Dr. Ryo Onishi (Japan Agency for Marine-Earth Science and Technology), Professors Masao Ogino (Nagoya University) and Akiyuki Takahashi (Tokyo University of Science) *(Figure 4*).

Figure 4: *Recipients of the JACM Young Investigators Award: Dr. Ryo Onishi (Left), Professors M. Ogino (Center) and A. Takahashi (Right)*

INTERNATIONAL COMPUTATIONAL MECHANICS SYMPOSIUM 2012

ICMS2012

A JACM supported event **"International Computational Mechanics Symposium 2012"** (http://www.jsme.or.jp/conference/cmdconf12) was held during 9-11 October, 2012 in Kobe, which was the 25th anniversary event of Computational Mechanics Division (CMD) of Japan Society of Mechanical Engineers (JSME). Professor S. Yoshimura is currently serving as the Division Chair as well.

The symposium was chaired by Dr. Ryutaro Himeno of Riken, Japan (*Figure 5*). Besides a number of mini-symposia, 5 plenary lectures were made by Professors Jack Dongarra of University of Tennessee (*Figure 6*), J. S. Chen of UCLA, Roger Ohayon of CNAM, Genki Yagawa of Toyo University (*Figure 7*), and Dr. Yuji Oinaga of Fujitsu. Dr. Oinaga talked about K-computer. The venue of the symposium is located next to the "K-computer" facility which is currently ranked the second in computational speed in the world (*Figure 8*).

The participants enjoyed a technical tour to the K-computer. About 140 presentations were given in 12 mini-symposia covering almost all the fields in computational mechanics, such as meshfree methods, boundary element method, solid mechanics, fracture mechanics, fluid/fluid-structure interaction problems, design optimization, etc. Among 177 participants, 15 were from Asia excluding Japan, 8 were North and South America and 19 were from Europe. The rest of participants were from Japan. ●

Figure 5 :
Opening speech by Dr. R. Himeno

Figure 6 :
Professor Dongarra's plenary lecture at Conference Hall of Kobe University

***Figure 7** :*
Profs. J. S. Chen, G. Yagawa, R. Ohayon, H.-Y. Hu (Tunghai University, Taiwan) and S. Yoshimura during the reception at Ka-Cho-En (Flower-Birds-Garden) (From left to right)

Figure 8 :
Supercomputer "K-Computer"

The Japan Society for Computational Enginering and Science

Message from the new President

On behalf of the Japan Society for Computational Engineering and Science (JSCES), I would like to introduce the recent trends and activities as one of the Japan's biggest organizations in the field of computational mechanics.

First of all, the JSCES renewed the Executive Council in May 2012 after the elections, which is formed by the following members (two-year term in the JSCES's bylaws): K. Kashiyama (Chuo U, President), S. Koshizuka (U Tokyo, Vice-President), K. Yamamura (Nippon Steel ＆Sumitomo Metal, Vice-President), D. Isobe (Tsukuba U, Secretary General), Y. Umezu (JSOL), M. Oshima (U Tokyo), S. Obayashi (Tohoku U), H. Okada (Science U Tokyo), M. Okuda (Fujitsu), H. Okuda (U Tokyo), T. Kobayashi (Mechanical Design), N. Sasaki (Hitachi), R. Sawada (Toyota Motor), N. Takano (Keio U), H. Takahara (NEC), A. Tezuka (AIST), K. Terada (Tohoku U), H. Nakamura (Itochu Techno Solutions), S. Hagiwara (Saga U), T. Yamada (Yokohama NU), K. Ohtomi (Toshiba, inspector), N. Takeuchi (Hosei U, inspector)

Prof. Kazuo Kashiyama,
The President of JSCES

At present, the JSCES has about 850 regular members, 50 student members and 75 corporate (special) members. The regular members from private companies occupy about 40% of all, which is a good ratio to realize the fruitful activities on computational engineering and science. Accommodating the requests of the members, the JSCES has established the following sectional research committees: Creative Design and Manufacturing (since 2009) chaired by K. Ohtomi (Toshiba), High Quality Computing (since 2009) chaired by M. Shiratori (Yokohama NU) and Simulation and Visualization (since 2012) chaired by K. Suzuki (U Tokyo).

The JSCES periodically holds annual meetings, which commonly collect more than 350 papers and several plenary lectures by oversea prominent researchers. Also, the JSCES publishes both quarterly magazines and internet-based refereed journals. Moreover, the JSCES has organized several international conferences held in Japan and is now planning to host the International Conference on Computational Engineering and Science for Safety and Environmental Problems (COMPSAFE 2014) in Spring, 2014 as a thematic conference of APACM, which will be co-organized with the Japan Association for Computational Mechanics (JACM). As you know, the Great East Japan Earthquake in 2011 caused the enormous damage to the human life and economic activities in Japan. We believe that the computational engineering and science will play a crucial role for the prevention of natural disaster and for the reconstruction of Japan.

Finally, the JSCES has continuously supported and will continue to support the IACM activities.

Kazuo Kashiyama

Korea-Japan Workshop

This year, the Sixth Korea-Japan (KJ) Joint Workshop on Computational Engineering with the Computational Structural Engineering Institute of Korea (COSEIK) was held on May 31, 2012 at Kyoto Kyoiku Bunka Center (Kyoto, Japan) in conjunction with the JSCES annual conference (May 29-31, 2012). The opening remark by Prof. K. Kashiyama (President of JSCES, Chuo University) was followed by twelve talks interchangeably given by Korean and Japanese scientists (*figure 2*), including keynote talks by Prof. Kengo Nakajima (The University of Tokyo) and Prof. Moon-Young Kim (Sungkyunkwan University). The workshop was closed by the address given by Prof. M-Y. Kim (former Vise-President of the COSEIK).

Kenjiro Terada

Group shot of participants of the Sixth Korea-Japan Workshop

Summer Short Course: Finite Elements in Flow Problems

"The Summer School for Finite Elements in Flow Simulations" was hosted by the JSCES and held on August 7-9, 2012, at the CST Hall of Nihon University in Tokyo, Japan. Following the success of the first seminar held in 1995, summer schools, each of which consists of short courses for "Finite Elements Flow Problems", have been held every 2-4 years at Tokyo. This summer school lasted three days and was attended by about 140 participants.

The organizing committee invited Prof. Thomas Hughes (The University of Texas at Austin) and Prof. Tayfun Tezduyar (Rice University) as special guest lecturers. Other lecturers were S. Fujima (Ibaraki U), H. Okumura (Toyama U), K. Kashiyama (Chuo U), S. Tanaka (U Tokyo), H. Watanabe (U Tokyo), T. Nomura (Nihon U), K. Takizawa (Waseda U), C. Kato (U Tokyo), M. Oshima (U Tokyo) and H. Okuda (U Tokyo). Each lecture was followed by questions and answers, which were exchanged among participants.


Special guest lecturers:
Profs. T.J.R. Hughes & T.E. Tezduyar

The summer school covers both fundamental and advanced topics about the finite element methods in flow problems, which include the stabilized formulations along with finite element programming, the ALE methods, the space-time methods, the formulations and algorithms for fluid-structure interactions/free-surface flow/turbulent flow, the basis for isogeometric analysis, the space-time FSI techniques, the variational multi-scale method for turbulent flow and the multi-core and GPU computing techniques. The original textbook was compiled for this summer school and was published by Maruzen Publishing Co., Ltd.


Snap shot of the lecture room
(about 140 participants)

The reception was held on the second day in conjunction with the exhibition of hardware and software vendors at the cafeteria in the venue. The fruitful discussions were performed among the lecturers, participants and vendors. All the events in this summer school were quite successful. The organizing committee would like to thank the lecturers for their efforts in preparing their contributions.

Kazuo Kashiyama

1st. Spain - Japan Workshop on Computational Mechanics

On September 17, 2012 the 1st. Spain - Japan Workshop on Computational Mechanics took place in CIMNE in Barcelona, Spain. The Workshop was hosted by the International Center for Numerical Methods in Engineering (CIMNE) and included presentations held by Japanese and Spanish scientists of international prestige in the field of Computational Mechanics.

The successful meeting achieved its main purpose: to provide a forum for interchange of research experiences in Spain and Japan in the field of Computational Mechanics, being an opportunity for defining future joint activities and projects between researchers in Japan and Spain in the field.

The Japanese delegation was headed by Prof. Norio Takeuchi (Hosei University), former President of the JSCES, and Prof. Kazuo Kashiyama (Chuo University), President of JSCES. Other membres of the delegation were Professors Daigoro Isobe (Tsukuba University), Kengo Nakajima (University of Tokyo), Marie Ohshima (University of Tokyo), Kenjiro Terada (Tohoku University) and Takahiro Yamada (Yokohama National University).

Spain was represented by Professors Marino Arroyo (Technical University of Catalonia – UPC), Ramón Codina (UPC), Antonio Huerta, Secretary General of the International Association for Computational Mechanics (IACM)(UPC), Sergio Idelsohn (CIMNE), Javier Oliver, President of the Spanish Society for Numerical Methods in Engineering (SEMNI) (UPC) and Eugenio Oñate (Director of CIMNE).


Different moments during the 1st Spain- Japan Workshop on Computational Mechanics

The Workshop included technical presentation on different topics of computational fluid and solid mechanics, coupled problems and large scale scientific computing among others. The full programme of the event can be seen on:
http://congress.cimne.com/Spain_Japan_Workshop/frontal/Program.asp

ECCOMAS 2012
Sixth European Congress on Computational Methods in Applied Sciences and Engineering

10 - 14 September 2012
Vienna, Austria

by
Josef Eberhardsteiner,
Helmut Böhm,
Franz G. Rammerstorfer
Chairmen
Herbert A. Mang
Honorary Chairman
Martina Pöll
Secretary General

The most prominent and largest events organized by the European Community on Computational Methods in Applied Sciences (ECCOMAS) are its congresses that are held at four years' intervals. The 6th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2012) took place from September 10 to 14, 2012 in Vienna, Austria. ECCOMAS 2012 was jointly organised by the Institute for Mechanics of Materials and Structures and the Institute of Lightweight Design and Structural Biomechanics of Vienna University of Technology, represented by Herbert A. Mang, Josef Eberhardsteiner, Helmut Böhm, and Franz G. Rammerstorfer.

The organisers have made a determined effort to include not only engineering scientists but also engineers applying computational mechanics to solve challenging practical problems. For that purpose, an Industrial Committee was established in addition to the Local Organising, Executive, and Scientific Committee.

The organisers were overwhelmed by the response to the Call for Papers. Out of almost 2100 submitted abstracts, 85 % were accepted for presentation at ECCOMAS 2012. Reflecting the fact that ECCOMAS 2012 was a scientific event of an European association, approximately 75 % of the contributions were from Europe, 15 % from Asia and Australia, and about 10 % from the Americas. The countries with the highest number of presentations were Germany with 337, France with 233, followed by Austria with 124, Italy with 108, US with 95, Poland with 86, and Spain with 79 contributions.

The more than 2100 registered participants and accompanying persons came from 61 different countries around the world.

The scientific programme of ECCOMAS 2012 consisted of 2 plenary lectures, 36 semi-plenary lectures, 108 mini-symposia, and 36 technical sessions.

The Opening Ceremony was held in the Golden Hall of Musikverein. In this prestigious hall, the famous New Year's Concert by the Vienna Philharmonic Orchestra is broadcast worldwide every year. The Opening Ceremony contained welcome addresses by Prof. Eberhardsteiner, co-chair of the congress, Prof. Manolis Papadrakakis, president of ECCOMAS, Prof. Peter Wriggers, vice-president of IACM, Prof. Sabine Seidler, rector of Vienna University of Technology, and Prof. Heinz Engl, rector of the University of Vienna.

Figure 1:
Golden Hall of Musikverein

Figure 2:
Orchestra of Vienna University of Technology

At the ECCOMAS awards ceremony, the following awards were bestowed on:

- *Lena Wiechert-Yoshihara* (ECCOMAS best PhD award in the field of computational solids and structures),
- *Max Duarte* (ECCOMAS best PhD award in the field of computational fluid dynamics),
- *Elias Cueto* and *Alessandro Reali* (O.C. Zienkiewicz award for young scientists in the field of computational engineering sciences),
- *Harald van Brummelen* (J.L. Lions award for young scientists in the field of computational mathematics),
- *Sergio Idelsohn* (Prandtl medal for outstanding and sustained contributions in the field of computational fluid dynamics),
- *Herbert A. Mang* (Euler medal for outstanding and sustained contributions in the field of computational solids and structural mechanics), and
- *Erwin Stein* (Ritz-Galerkin medal for outstanding and sustained contributions in the field of computational methods in applied sciences).


Figure 3:
Awards ceremony
(E. Stein, M. Papadrakakis)

The Opening Ceremony was accompanied by the orchestra of Vienna University of Technology performing pieces from the Austrian composers Johann Strauß II, W.A. Mozart, Franz Schubert, and finally the Europe hymne.


Figure 4:
Plenary Lecturers:
M. Geers and F. Brezzi

Following the Opening Ceremony, the two plenary lectures were given at the Musikverein. Prof. Franco Brezzi's lecture was on "Virtual element methods". Prof. Marc Geers gave a lecture on "Modelling material failure across the scales: the multiscale paradigm".

The first event of the Social Programme was the Welcome Cocktail which took place on September 10, Monday evening, at the Arcade Court of the congress venue, the University of Vienna.


Figure 5:
Welcome Cocktail

As a further part of the Social Programme, an organ concert at St. Stephen's cathedral was organised.

Finally, on September 12, Wednesday evening, the congress banquet took place both at the City Hall (by invitation of the Mayor of Vienna) and in the Orangery at Schönbrunn Palace.

ECCOMAS 2012 was one of the largest congresses in the history of computational methods in applied sciences and engineering. What is more important than the size of a scientific event, however, is its quality. In the case of ECCOMAS 2012, to the great pleasure of the organisers, the level of the scientific presentations as a whole was very high. It reflected the impression about computational methods in applied sciences and engineering as a dynamic field living up to its claim of a discipline on the forefront of technological progress.

The organisers would like to thank all individuals, organisations, institutions, boards, committees, councils, and last but not least sponsors that contributed to the organisation of ECCOMAS 2012. ●


Figure 6:
Arcade Court of the University of Vienna

NU 2012 WORKSHOP IN HONOR OF WING KAM LIU

by
Dong Qian
University of Texas at Dallas
and
Ted Belytschko
Northwestern University

The 2012 NU Summer Workshop on Computational Engineering and Science was held in Evanston, Illinois from July 22nd to 23rd, 2012. This workshop was held in honor of Professor Wing Kam Liu at Northwestern University on the occasion of his 60th birthday. More than 60 participants attended the workshop including scholars from Stanford, Northwestern, UCLA, UT Austin, Columbia, UIUC as well as international institutions such as Universitat Politecnica de Cataluny, Tsinghua University, and Peking University. In addition, many of Wing's current and former students and postdocs were able to join.

There were 36 presentations which covered a wide range to topics including multiscale methods, meshfree and particle methods, computational material analysis, bio/nano mechanics. Featured speakers were Professors Tom Hughes, Ted Belytschko, JS Chen, Charbel Farhat, Jacob Fish and many junior researchers.

The workshop was split into six sessions according to the technical themes. Each presentation was 10 minutes while a moderator led a 20-minute discussion at the end of each session. This arrangement allowed for fully informative presentation styles while providing sufficient time for discussion.

The workshop concluded with a dinner banquet with many of Professor Wing Kam Liu's colleagues and former students sharing stories and experiences of working with Wing (*Figures 1 - 4*).

With the successful experience of the NU 2012 workshop, the planning for the NU 2013 workshop is well under way. This workshop will be held on April 17-21, 2013 in Evanston, Illinois to honor Professor Ted Belytschko's 70th birthday. NU 2013 will adopt a somewhat different format than NU2012: each session will focus on a question provided by a speaker that will be circulated to all attendees before the workshop. It is anticipated that this will lead to lively discussions.

An organization committee has been formed and members of the committee include Professors Wing Kam Liu, Jacob Fish, JS Chen and Haim Waisman. Future updates on the workshop will be sent to the computational mechanics community. ●

Figure 1: *Professor Tom Hughes shared his stories while serving as the Ph.D. advisor for Professor Wing Kam Liu at Caltech in the early 80s*

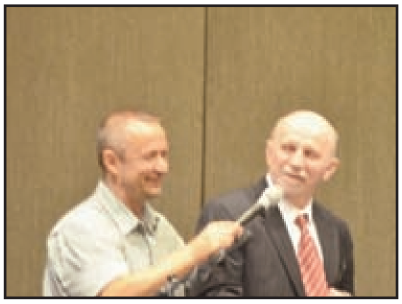

Figure 2: *Professor Ted Belytschko gave a very lively talk- full of jokes- that was reminiscent of his customary style (before his accident)*

Figure 3: *Professor Wing Kam Liu gave his acknowledgement to all of his students and colleagues*

Figure 4: *Professor Wing Kam Liu received a gift from Professor Dong Qian on behalf of Wing's students*

conference diary planner

24 - 28 Feb 2013 **FEF 2013 : Finite Elements in Flow Problems**
Venue: San Diego, USA *Contact:* http://www.tafsm.org/TH70/

11-12 March 2013 **Workshop on Nonlocal Damage and Failure: Peridynamics and Other Nonlocal Models**
Venue: San Antonio, USA *Contact:* http://nfd2013.usacm.org

10 - 12 April 2013 **Fluid Structure Interaction 2013**
Venue: Gran Canaria, Spain *Contact:* http://www.wessex.ac.uk/

22 - 24 April 2013 **EASFORM 2013 - Conference on Material Forming**
Venue: Aviero Portugal *Contact:* http://www.esaform2013.com/

29 - 31 May 2013 **MARINE VI: Computational Marine Engineering**
Venue: Hamburg, Germany *Contact:* http://congress.cimne.com/marine2013

3 - 5 June 2013 **ADMOS 2013 - Conference on Adaptive Modeling and Simulation**
Venue: Lisbon, Portugal *Contact:* http://www.lacan.upc.edu/admos2013

5 - 7 June 2013 **CFRAC 2013 - Comp- Modeling of Fracture & Failure of Materials & Structures**
Venue: Prague, Czech Republic *Contact:* http://mech.fsv.cvut.cz/cfrac/

11 - 13 June 2013 **BEM / MRM 2013 - Boundary Elements and Other Mesh Reduction Methods**
Venue: New Forest, UK *Contact:* http://www.wessex.ac.uk

12 - 14 June 2013 **SEECCM III : South-East European Conference on Computational Mechanics**
Venue: Island of Kos, Greece *Contact:* http://www.seeccm2013.org

12 - 14 June 2013 **COMPDYN 2013 - Comp. Methods in Structural Dynamics and Earthquake Engineering**
Venue: Island of Kos, Greece *Contact:* http://venus.santafe-conicet.gov.ar

17 - 19 June 2013 **COUPLED V: Coupled Problems in Science and Engineering**
Venue: Ibiza, Spain *Contact:* http://congress.cimne.com/coupled2013

17 - 21 June 2013 **ICCS17 - International Conference on Composite Structures**
Venue: Porto, Portugal *Contact:* http://paginas.fe.up.pt/~iccs17/

1 - 4 July 2013 **ECCOMAS Thematic Conference on Multibody Dynamics**
Venue: Zagreb, Croatia *Contact:* http://eccomas-multibody.fsb.hr/dates.php

22 - 25 July 2013 **USNCCM12 - 12th U.S. National Congress on Computational Mechanics**
Venue: Baltimore, USA *Contact:* http://iwcmm22.jhu.edu/

3 - 5 Sept 2013 **COMPLAS XII: Computational Plasticity. Fundamentals and Applications**
Venue: Barcelona, Spain *Contact:* http://congress.cimne.com/complas2013

9 - 10 Sept 2013 **ICOVP 2013 - International Conference on Vibration Problems**
Venue: Lisbon, Portugal *Contact:* http://www.icovp.com/

17 - 19 Sept 2013 **FDM 2013 - Fracture and Damage Mechanics**
Venue: Sardinia. Italy *Contact:* http://fdm.engineeringconferences.net/

18 - 20 Sept 2013 **PARTICLES III: Particle-based Methods. Fundamentals and Applications**
Venue: Stuttgart, Germany *Contact:* http://congress.cimne.com/particles2013

25 - 27 Sept 2013 **IV ECCOMAS Thematic Conference on Mechanical Response of Composites**
Venue: S.Miguel, Azores, Portugal *Contact:* http://www1.dem.ist.utl.pt/composites2013/

9 - 11 Oct 2013 **MEMBRANES V: Textile Composites and Inflatable Structures**
Venue: Münich, Germany *Contact:* http://congress.cimne.com/membranes2013

28 - 30 Oct 2013 **EVACES 2013 - Experimental Vibrating analysis for Civil Engineering Structures**
Venue: Ouro Preto, Brasil *Contact:* evaces2013 at ufjf.edu.br

11 - 14 Dec 2013 **APCOM 2013 - Asia Pacific Congress on Computational Mechanics**
Venue: Singapore *Contact:* http://www.apcom2013.org

30 June - 2 July 2014 **EURODYN 2014 - European Conference on Structural Dynamics**
Venue: Porto, Portugal *Contact:* www.fe.up.pt/eurodyn2014

20 - 25 July 2014 **ECCM V and ECFD VI - Eur. Conf. on Computational Methods / Fluid Dynamics**
Venue: Barcelona, Spain *Contact:* http://www.wccm-eccm-ecfd2014.org/

20 - 25 July 2014 **WCCM XI - World Congress on Computational Mechanics**
Venue: Barcelona, Spain *Contact:* http://www.wccm-eccm-ecfd2014.org/

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ECCOMAS

IACM and ECCOMAS
are pleased to announce the
joint organization of

11th. World Congress on Computational Mechanics (WCCM XI)

and

5th. European Conference on Computational Mechanics (ECCM V)

6th. European Conference on Computational Fluid Dynamics (ECFD VI)

20 - 25 July 2014 - Barcelona, Spain

www.wccm-eccm-ecfd2014.org