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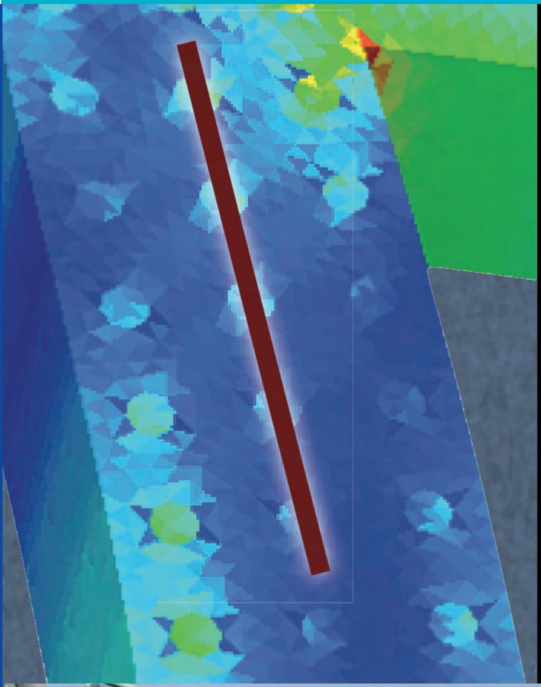

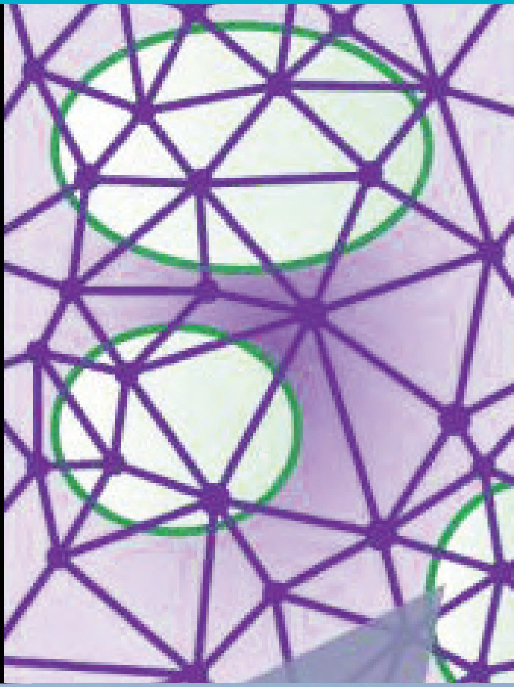

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No 27
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contents

editorial

The publication of this bulletin coincides in time with the celebration of the 9th World Congress on Computational Mechanics (WCCM IX) in the city of Sydney in Australia from 19th o 23rd July 2010. WCCMs are the unique global events of the IACM and are held at two year intervals around the different world regions. WCCM IX has been organized in conjunction with the X Conference of the Asian-Pacific Association for Computational Mechanics (APCAM), an organization which groups a dozen associations in the Asia-Pacific region affiliated to the IACM. I thank Profs. N. Khalili and S. Valliappan and their teams in Australia for an outstanding work in organizing the joint WCCM IX - APCAM congress event.

The Executive Council (EC) of the IACM will meet in Sydney during WCCM IX incorporating seven new members (J.S. Chen, Antonio Huerta, Gregory Hulbert, Pierre Ladeveze, Gui-Rong Liu, Peter Wriggers and Genki Yagawa). These prestigious scientists have been recently elected to the EC by the General Council of the IACM, following the bi-annual renewal process as stated in the IACM Constitution.I wish all much success during the six years term serving in the EC.

Similarly, I would like to express my gratitude and recognition to the members of the EC which term has recently expired for their work and contributions to the IACM. These persons are:

René De Borst, Antony Jameson, Worsak Kanok-Nukulchai, Michael Kleiber, Carlos Mota Soares and Somasundaran Valliappan.

There are not, however, the only changes in the governance of the IACM. My term as President of the IACM, and indeed, that of the three Vice-presidents (T. Belytschko, H. Mang and S. Valliappan) and the General Secretary (S. Idelsohn) has also expired. Consequently, new officers for these positions will be elected by the EC in the Sydney meeting.

I wish the new officers of the IACM best of luck and success in their duties and initiatives.

I want to take the opportunity of these lines to express that it has been a privilege and a unique experience to be the President of IACM for the last eight years.

IACM is today a well established and robust worldwide scientific association that lays on the pillars of 35 affiliated organizations representing 48 countries in the five continents. The support of regional organizations in Computational Mechanics and adjacent fields such as ECCOMAS in Europe and APCAM in the Asian-Pacific region, strengthen the world structure of the IACM which undoubtedly has become the reference international organization in computational engineering and sciences.

Last but not least, many thanks to all the members of the IACM for contributing to the success of a great organization.

Eugenio Oñate
President of IACM

The LATIN Method:

a Paradigm for High-Performance Multiscale and Multiphysics Computational Strategies

by
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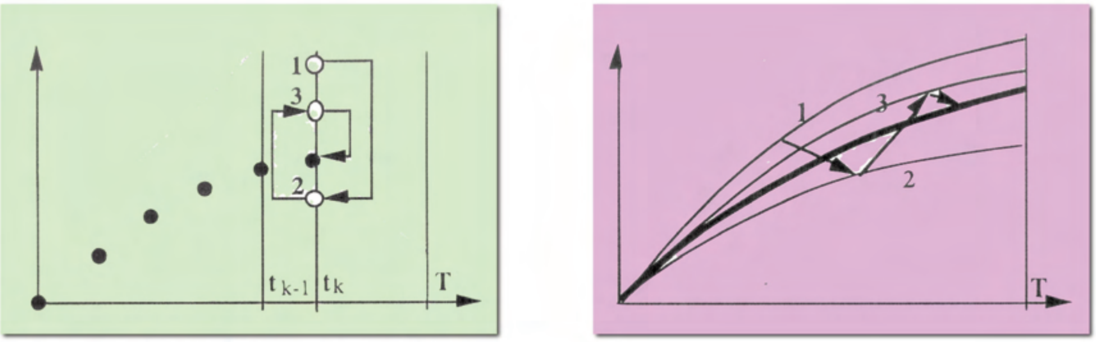
LMT Cachan (ENS Cachan/CNRS/UPMC/PRES)
UniverSud Paris, France
EADS Foundation Chair

Mechanics continues to supply numerous science and engineering problems which remain inaccessible to standard FE codes. Not all these problems are exotic, and many are indeed practical problems. A significant number of these engineering problems are related to today's growing interest in physics-based material models described on a scale smaller than that of the macroscopic structure, with applications such as the design of new materials, structural design and manufacturing. In addition to these large-scale, time-dependent and highly nonlinear problems, one can mention numerous problems involving multiple contact zones (e.g. bolted assemblies), cyclic viscoplastic problems with many cycles, and real-time simulations of complex thermomechanical systems.

The LATIN method addresses the key issue (or, at least, one of the key issues) of the computational strategy itself which is used to solve these large-scale, nonlinear and time-dependent problems. First, looking at classical techniques, one can make a common-sense remark: classical computational strategies appear to work for everything; therefore, like all things universal, they cannot achieve high performance for one domain in particular. There is no miracle: high performance requires custom-made techniques.
Therefore, the LATIN method is designed as a mechanics-based computational strategy whose aim is to achieve the best possible performance level in mechanics. Consequently, this alternative computational approach is rooted in some remarkable properties which are verified by most of the models encountered in structural mechanics. This iterative strategy differs from classical incremental or step-by-step techniques in that, at each iteration, it produces an approximation of the complete structural response over the whole loading history being considered. In other words, the name LATIN (LArge Time Increment) was not chosen very well because the method is essentially nonincremental.
The LATIN method was first introduced in [1] and in [2] for material models with internal variables. A review of the state-of-the-art and more recent extensions can be found in the book [3].

Figure 1:
The LATIN method and classical step-by-step methods



Classical step-by-step methods

Idea: performance ↗↗ = mechanics-based

What makes the equations different in mechanics?

In the process of designing computational strategies, one can face two main undesirable properties:

- the equations can be nonlinear;
- the equations can be global in the space and/or time variables, leading to the resolution of large-scale problems.

We prefer problems which are either linear or local[1]!

It is clear that an equation which is local in the space variables leads, after discretization, to small independent systems of equations associated with the Gauss points. This is a very favorable property, in particular regarding parallel computing.

Let us now consider a structural problem defined over the time-space domain $[0,T]$ x Ω, where the environment of the structure Ω is prescribed through given loads and displacements (*Figure 2*). For the sake of the simplicity, we will assume small displacements and quasi-static conditions. The material model is defined in the classical thermodynamic framework with internal variables. Then, the equations can be divided over the time-space domain $[0,T]$ x Ω into:

- equilibrium and compatibility equations;
- constitutive relations (state equations + state evolution laws).

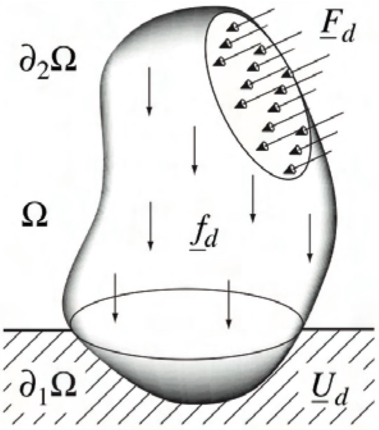


Figure 2:
The structure being studied over $[0,T]$

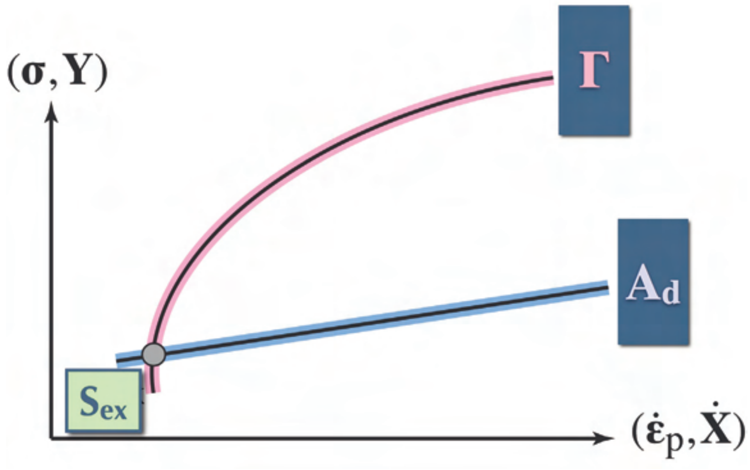


Figure 3:
The geometric representation associated with the problem being studied

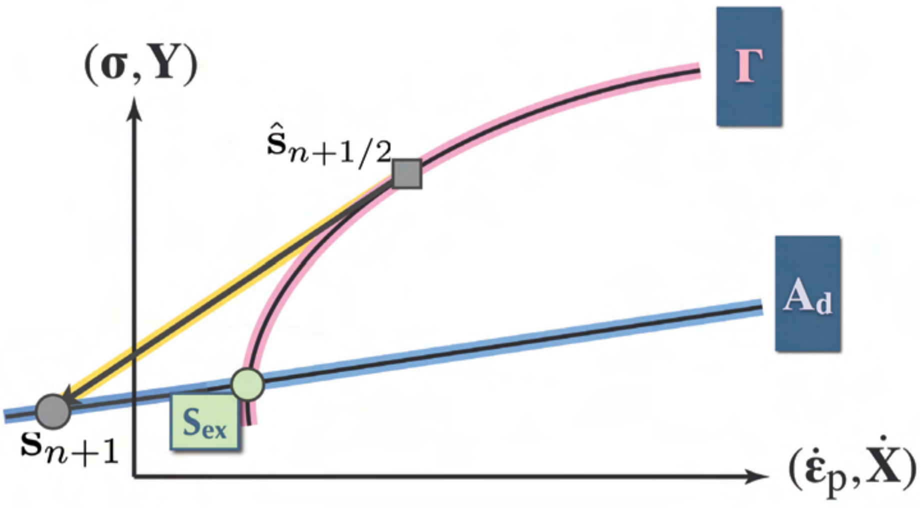


Figure 4:
One iteration of the LATIN method over $[0,T]$ x Ω

The former are linear equations, while the state evolution laws are local in both the space and time variables; the status of the state equations is less clear. Introducing a change of variables for the internal state variables, we proved that these equations can take a linear form (which we call the "normal" formulation [2], [3]) for most material models. These equations are also local in the space variables.

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[1] ***Definition:***
An equation is local in the space variables if it connects pointwise quantities defined at the same point (e.g. Hooke's law).

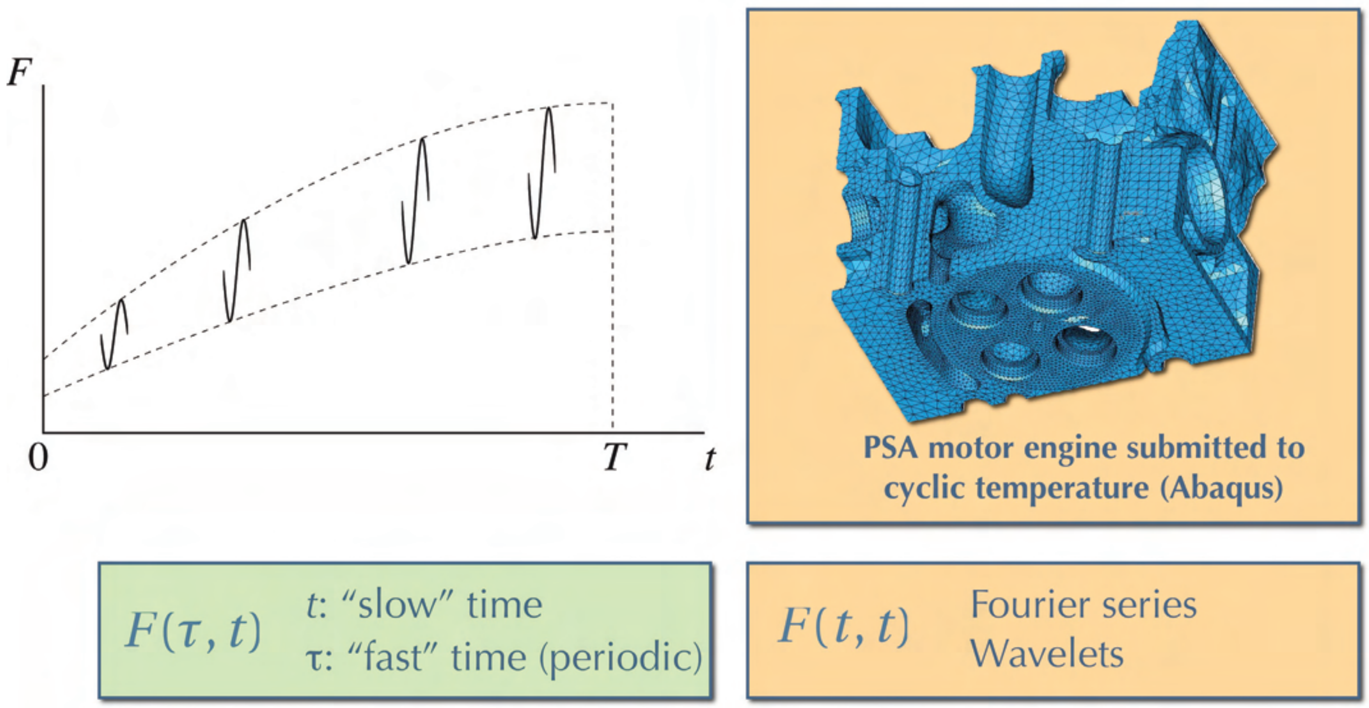

Figure 5:
Two-time-scale description

> *"This iterative strategy differs from classical incremental .... at each iteration, it produces an approximation of the complete structural response over the whole loading history being considered."*

The LATIN method: principles

The LATIN method operates over the time-space domain $[0,T]$ x Ω, and its first principle (P1) consists in separating the difficulties. Thus, the equations are divided into:

- a set of linear equations which can be global in the space variables:
  - o the equilibrium and compatibility equations;
  - o the state equations.
- a set of equations which are local in the space variables and can be nonlinear:
  - o the state evolution laws.

In the geometric representation of *Figure 3*, (A_d) and (Γ) represent the solutions of the first and second set respectively. The exact solution is the intersection of (Γ) and (A_d). The partitioning into (A_d) and (Γ) is very natural, (A_d) being associated with the free energy and (Γ) with the dissipation.

The second principle (P2) is also very natural. It consists in solving the two sets of equations alternatively until practical convergence. In order to do that, one uses search directions given as parameters. One possible choice (the Newton set) consists of the tangent direction and its conjugate (see *Figure 4*).

A major difference compared to classical quasi-Newton techniques is that the tangent does not refer to the stiffness, but to the operator which defines the state evolution laws.

In summary, at the nth iteration, one must solve a linear problem defined over $[0,T]$ x Ω in order to get s_n, and a local problem in the space and time variables in order to get $\hat{s}_{n+1/2}$.

The strong convergence of this iteration process has been proven in the case of non-softening materials. The distance between two successive approximate solutions defines a good and easily obtained error indicator.

What makes the LATIN method efficient?

The first two principles lead only to a reformulation of the problem being studied, but there is a third principle associated with the resolution of the linear problem defining s_n, which is a global problem over the time-space domain $[0,T]$ x Ω. Principle (P3) consists in using what we called "radial loading approximations" [1], [2], [3], in which the solution is described as a finite sum of products of a time function by a space function. F. Chinesta and I have recently coined the name “Proper Generalized Decomposition” (as an extension of Proper Orthogonal Decomposition) for this type of approximation. In this approach, one calculates the solution of the problem and the shape functions used to describe it simultaneously by means of an iterative process. This is what makes the PGD method different.

In short, one can say that the shape functions in the PGD method depend on all the data, i.e. both on the operator and on the right-hand side, which is clearly different from POD approximations. Developments of PGD for many other problems could be seen in the last IACM Expression Bulletin [26.]. PGD turns out to be the key to the efficiency of the LATIN method because it drastically reduces both the computation cost and the information storage requirements. Unfortunately, the PGD approximation over the time-space domain works very well only for quasi-static problems.

Extensions to large-displacement and large-strain problems were introduced in [3] thanks to an original reformulation which is formally similar to that of small displacement problems. Developments involving complex material models and instabilities have been made [3], [4].

The LATIN method: a paradigm, and some applications

◁ *Cyclic viscoplasticity with thousands of cycles*

The LATIN method lends itself very well to complex loading histories. A development for cyclic viscoplasticity was presented in [3], [4]. An application to a PSA motor engine was carried out using an ABAQUS routine (see [5]).

◁ *PGD: development and extension*

See the last IACM Expression Bulletin, [26].

◁ *Multiparameter nonlinear time-dependent problems*

Here, one uses the property that with the LATIN method the iterative process can be initiated by any time-space function, including the PGD. This is illustrated by the analysis of lines of pretensioned titanium bolts, involving contact and friction [7]. With a dedicated LATIN approach, the gain in computation cost is a factor of about 50. Parallel computing using N processors $(N < 10)$ leads to an additional gain by a factor of $N/2$.

◁ *Multiscale and multiphysics computational srategies*

An additional characteristic of the multiscale LATIN computational strategy [3] is the partitioning of the space-time domain. The structure is defined as an assembly of substructures and

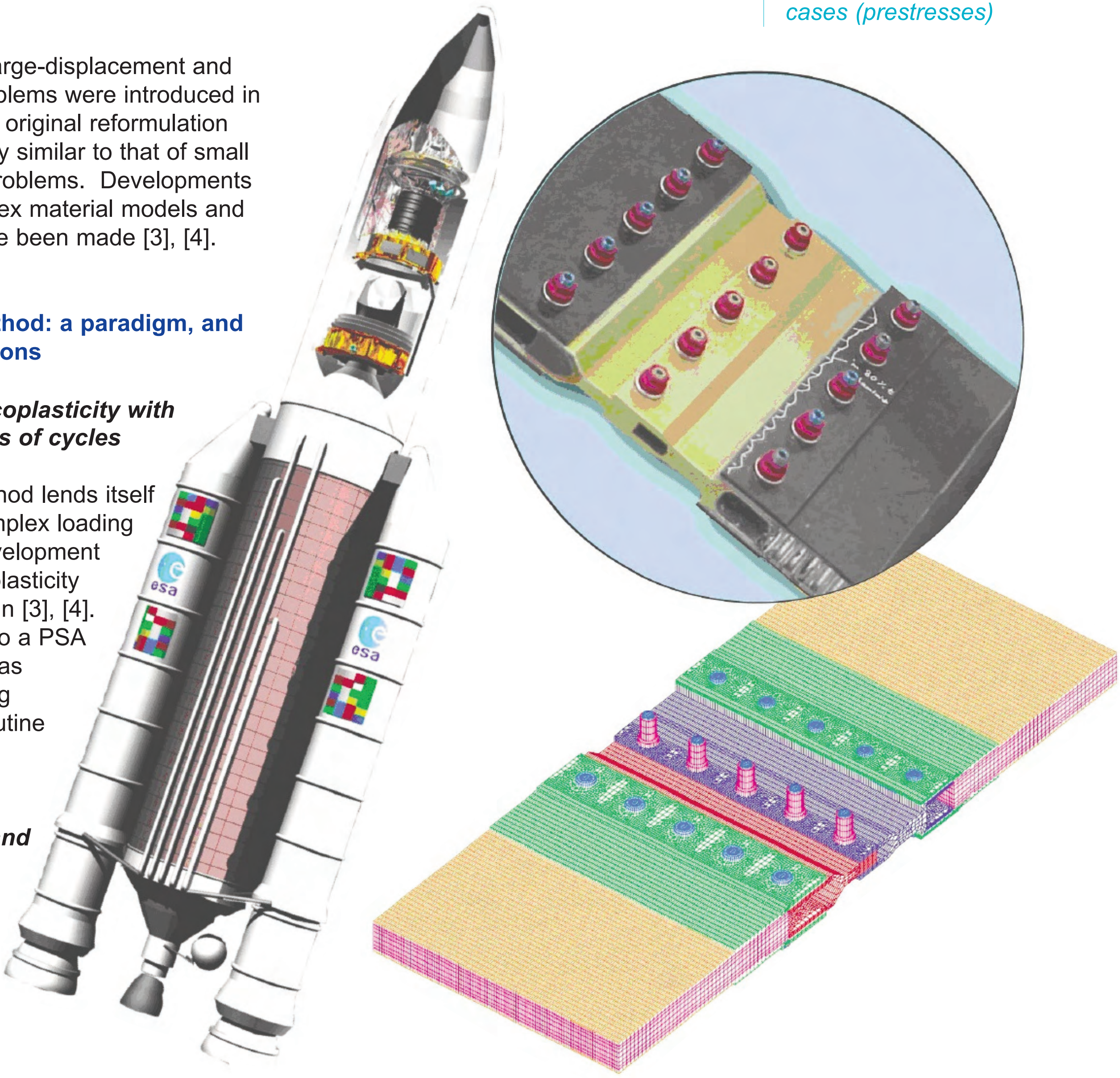

Figure 6: *A parametric study of 625 cases (prestresses)*

interfaces. Each component has its own variables and its own equations. The time interval is divided into subintervals, using the discontinuous Galerkin method to handle possible discontinuities.

The junction between the macroscale and the microscale takes place only at the interfaces [8]. Each quantity of interest is considered to be the sum of a macro quantity and a micro complement, where the macro quantities are defined as "mean values" in time and in space, and the associated micro complements are the complementary parts; this is a choice. An important point is that due to the Saint Venant principle, the effects of the micro complements are localized in space. This method incorporates space and time homogenization [9]. *Figure 7* describes the macro part of the normal forces at the interface at time T.

Many applications have already been developed. A particular example is an answer to the engineering challenge, known as "Virtual Testing" (AIRBUS-EADS), of reproducing the physics of a test in all its details until ultimate fracture. Even in the case of a simple test coupon, the computational micromodel [10] leads to a nonlinear problem with billions of DOFs, which cannot be solved using commercial codes.

The multiscale LATIN method provides an alternative resolution technique. Consequently, this computational micromodel is now used as a "virtual reference material".

Figure 8 shows the calculated final state of a test coupon, which is very close to the actual experiment.

In order to develop suitable strategies for multiphysics problems, the main idea is to use the concept of "interface between physics", which can be viewed as an extension of the "material" interface classically introduced between two substructures [11]. ●

References:

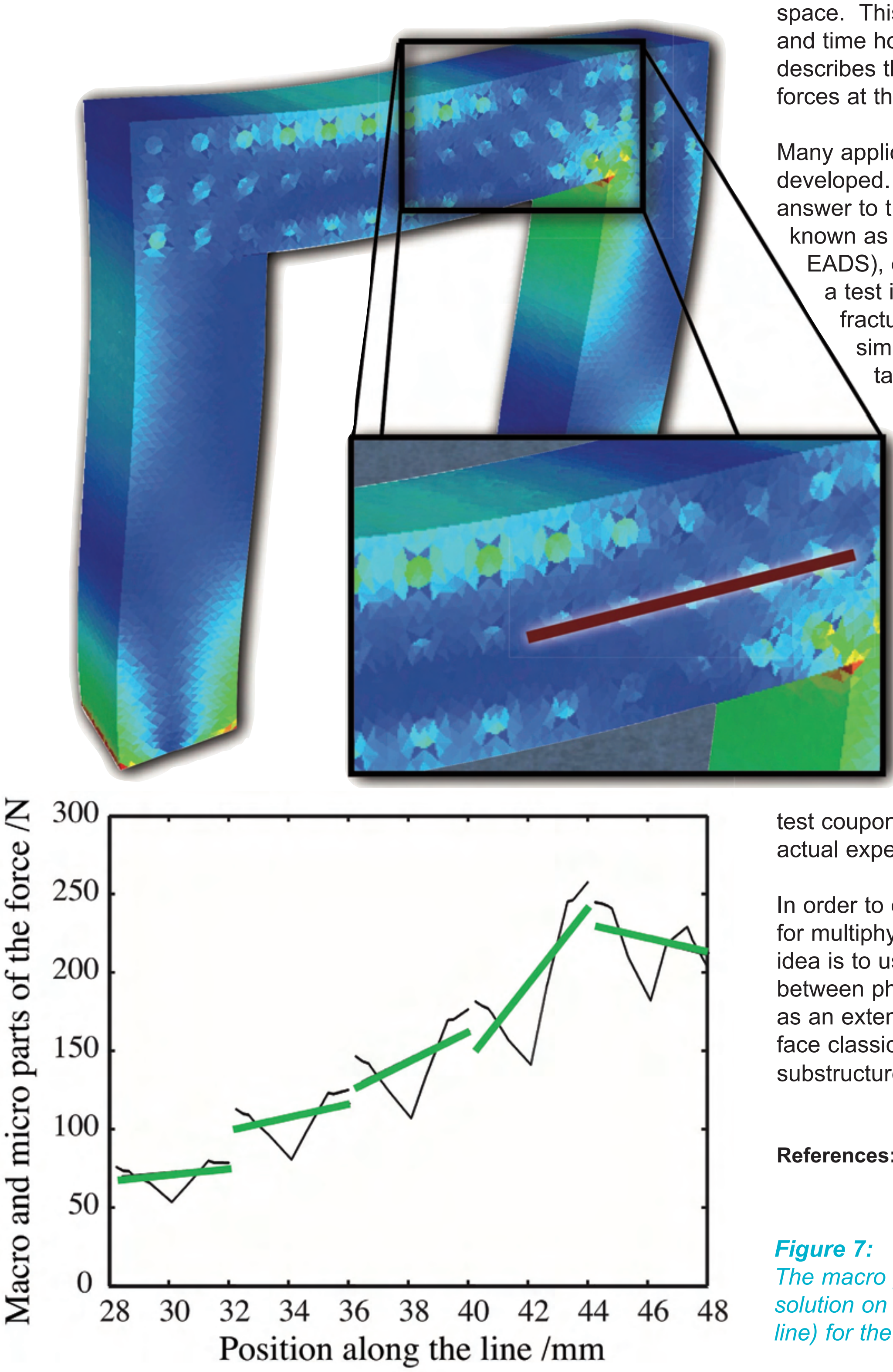

Figure 7:
The macro part (thick green line) and the solution on the microscale (thin black line) for the force along the red line

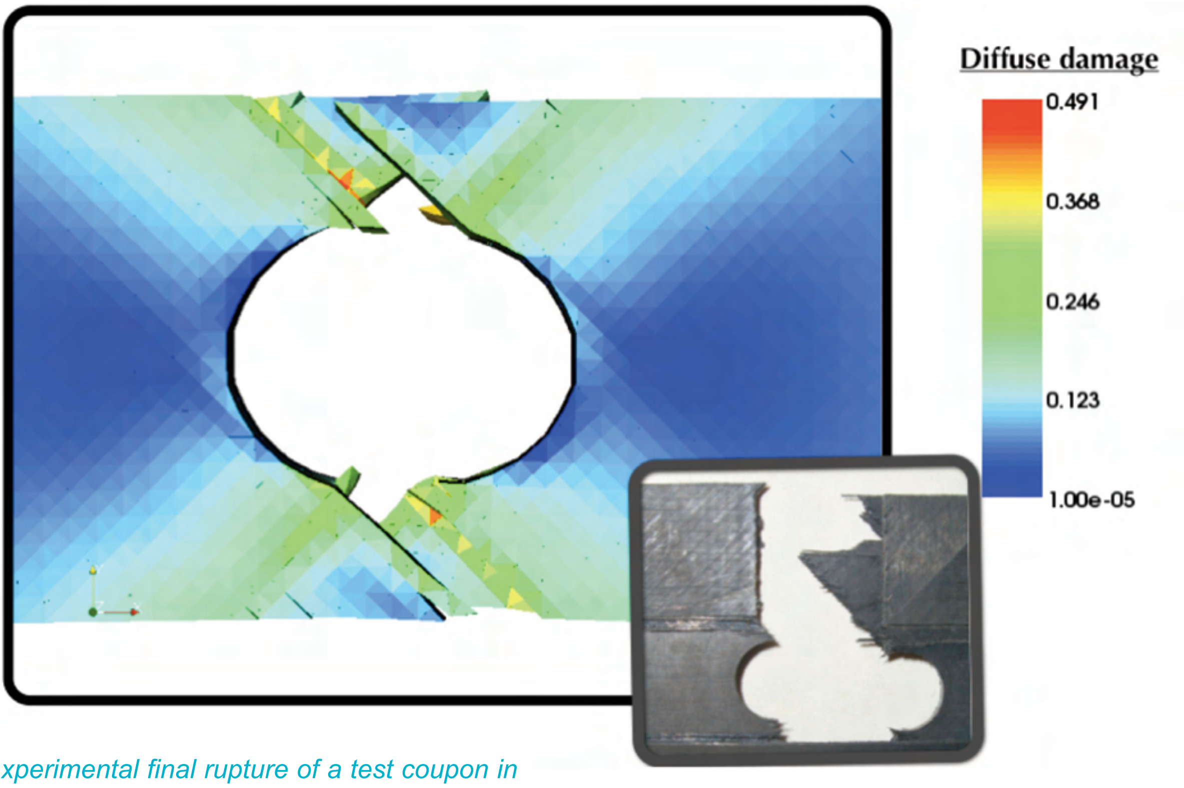

Figure 8:
Calculated and experimental final rupture of a test coupon in tension ([452/-452]s holed specimen in traction)

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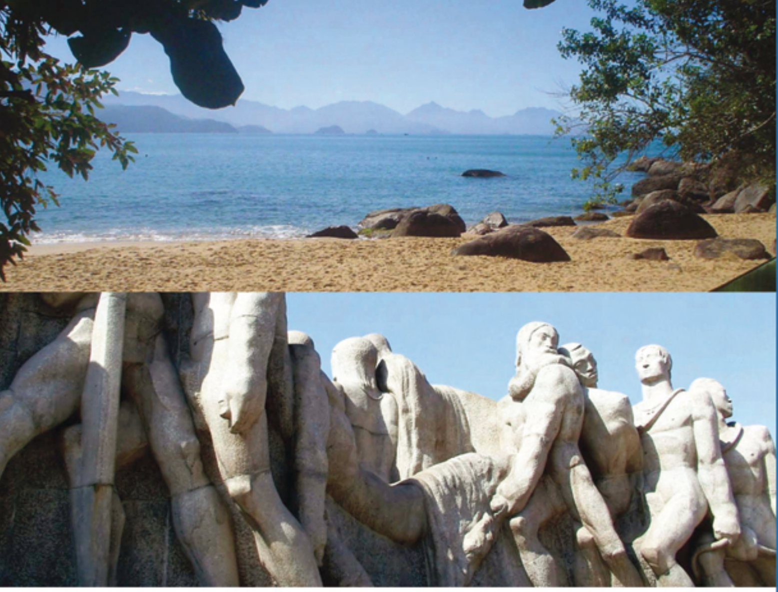

The Escola Politécnica da Universidade de São Paulo is pleased to announce and invite you to the **10th World Congress on Computational Mechanics**, to be held in São Paulo, Brazil, July 8–13, 2012.

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Computational Mechanics of Integrity & Durability in Extreme Environment for Concrete & Reinforced-Concrete Structures

by
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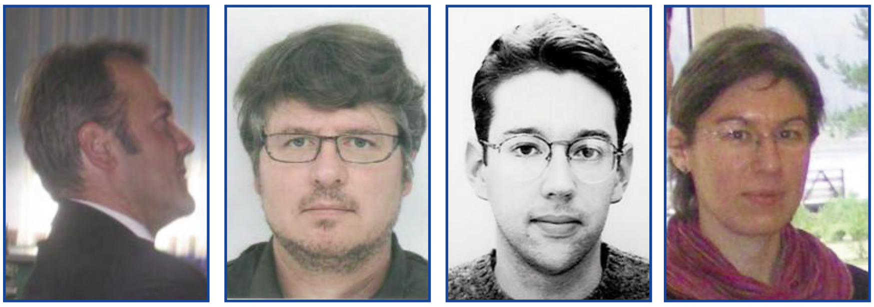
The computational mechanics has nowadays matured into one of the scientific domains clearly demonstrating the major potential for improving the quality of life in modern technological society. A number of exciting new application fields has motivated possible directions for present and future developments (e.g. see review by Oden et al. [2003]). However, there is no lesser scientific challenge in the computational mechanics developments capable of enhancing the understanding and increasing the predictive capabilities for complex mechanics phenomena under diverse loading in the 'old' application fields that have been studied for considerable time with more traditional methods.

The case in point is study of concrete and reinforced concrete structures, and the present need that is brought about by new questions pertaining not only to structural integrity but also to durability issues. The latter requires novel, refined numerical models and corresponding computational methods that can take into account the material heterogeneities, related uncertainties and yet provide more detailed information of direct value for durability assessment, such as crack spacing and opening, which cannot be done by the traditional designer tools.

One is facing a double challenge in this kind of studies. The first one is convincing the traditional designers of the concrete structures that the computational mechanics has a lot to offer to their domain (the doubts of practicing engineers are perhaps best spelled by a famous quote attributed to Leonhardt [1975] that "a crack in concrete is also a crack in theory ..."); the second one is convincing the experts in computational mechanics that one can indeed make a number of original scientific contributions in working on not very 'new' materials, like concrete ... (the latter is certainly not a favorite subject even in the most elaborate treatise on the subject, e.g. see Zienkiewicz and Taylor [2005]). Personally, I was one of those not convinced 10 years ago, before coming to work at Laboratory of Mechanics and Technology (LMT-Cachan), where there is a long tradition of working in close collaboration with French industry partners, established by founding fathers, Jean Lemaître and Pierre Ladeveze. If I could name only one thing that I learned at LMT-Cachan, the choice would surely be about the kind of scientific challenge that can be raised in trying to solve the 'real life' problems.



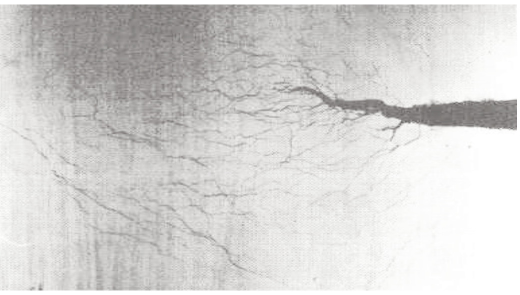
Authors: A. Ibrahimbegovic, L. Davenne, J.-B. Colliat & D. Brancherie

Application domains and paper contents

In France at present time, close to 90% of electrical power is generated by nuclear industry. For the last 10 years, our research group has had a very extensive collaboration with the national nuclear energy champions, such as EDF-French Electrical Power Company or CEA-Atomic Agency Commission, as well as the IRSN-Institute for Radioprotection and Nuclear Safety. There are many issues regarding the safety of the nuclear installations under extreme conditions, a number of them studied by our team, such as large plane impact (Ibrahimbegovic et al. [2009a]), earthquake (Davenne et al. [2003]) or fire (Ibrahimbegovic et al. [2004]).

In this short review we will take for motivation the worst case scenario of the reactor explosion in a nuclear power plant, such as the Chernobyl disaster that happened in former USSR in 1986. In trying to prevent (or at least reduce) the undesirable effects in such a case, the nuclear reactors in France are systematically placed inside a massive protection structure built of either reinforced of pre-stressed concrete. The question that ought to be answered pertains to reliable prediction of the failure mechanisms for such a structure, along with the detailed results that are typically not asked for in the standard design procedure, such as crack spacing and opening, which are of great importance for quantifying the leaking of radioactive substance and gasses. We note in passing that very similar questions are also asked for any other massive structure or infrastructure, in the studies of its integrity and durability.

Figure 1:
Characteristic failure mechanisms of massive structure with FPZ followed by macro-crack appearance:
a) experimental observations,
b) computed response invariance for non-structured and structured finite element mesh, despite different macro-crack representations



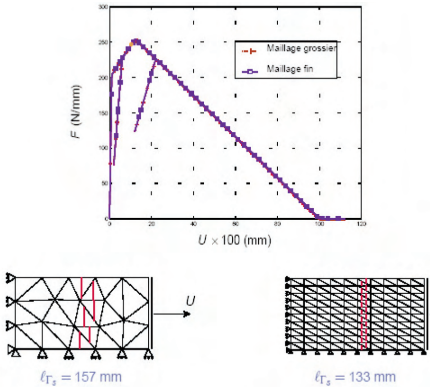
(a)

> *"…. Our presentation gathers all the numerical models and computational methods needed for dealing with this worst case scenario…."*

Our presentation gathers all the numerical models and computational methods needed for dealing with this worst case scenario. Namely, we pass in review the essential ingredients of mechanics model for localized failure of massive structures: more reliable representation of failure mechanism of concrete by appealing to meso-structure models that separate aggregate from cement paste; accounting for probability aspects with uncertainty in geometry at meso-scale that translates into phenomenological model providing intrinsic interpretation of size-effect; finally, the most realistic description of damage mechanisms in reinforced-concrete that is capable of providing the crack spacing along with the right order of crack appearance for any particular loading program.

Localized failure of massive structures

We briefly recall here the salient features of the constitutive model for localized failure of massive structures. We follow our recent works where the models of this kind are furnished for plasticity, damage and coupled damage-plasticity (see Brancherie and Ibrahimbegovic [2009], Ibrahimbegovic et al. [2008, 2009] The key idea is as follows: we assume that the failure mechanism of a massive structure always starts with the creation of the fracture process zone (FPZ), with a large number of micro-cracks, followed by the final appearance of a macro-crack (see *Figure 1a*). We also assume that the FPZ introduces inelastic, yet still hardening behavior with a very large number of micro-cracks of different orientations that can be represented by continuum model, whereas the macro-crack will lead to softening behavior that can be represented with the corresponding displacement discontinuity.



(b)

It is important to note that two damage mechanisms remain active and keep communicating throughout the loading program, producing the invariant response for any structured or non-structured finite element mesh in spite of different representations of macro-crack (see *Figure 1b*). We note in passing that the identification procedure of material parameters for any such model can be carried out by using the approach proposed in Kucerova et al. [2009] (see also Ibrahimbegovic et al. [2009b]).

Concrete multi-scale model and size effect

Further increase in predictive capabilities of the concrete damage model can be obtained by appealing to the multi-scale interpretation of the damage mechanisms (e.g. see Ibrahimbegovic and Markovic [2003]). This kind of multi-scale approach fits within the standard computer code architecture, since at the macro-scale the user interface is pretty much the same as those of standard finite element computer programs. Any of the macro-scale elements is filled-in with micro-scale elements that can take into account the heterogeneities and fine details of the damage mechanism developments. In other words, the macro-scale element is a platform where one should seek the solution of another boundary value problem and store the results in terms of corresponding macro-scale element arrays (see *Figure 2*). This approach is perfectly suitable for parallel computing and makes the task of load balancing on different processors quite easy. Namely, as soon as the computation on one macro-scale element is completed, we push the next one to start computational procedure and pull another one into a waiting slot (e.g. see Niekamp et al. [2009]).

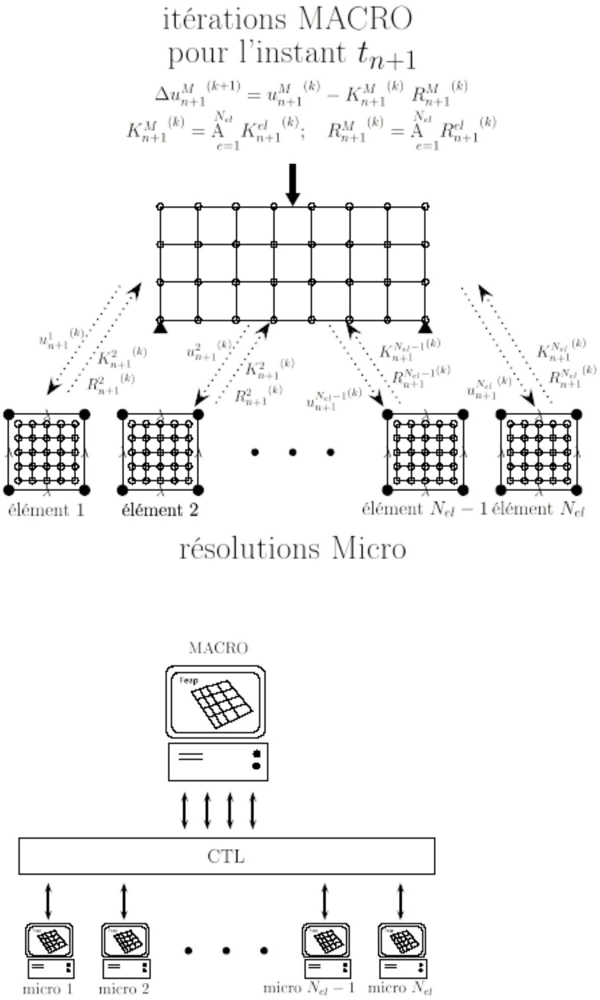
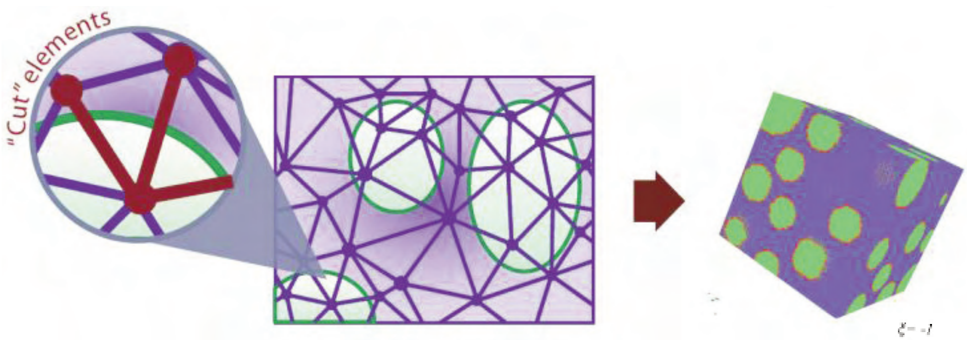


Figure 2:
Multi-scale solution procedure, with the macro-scale interface in the standard finite element code, and parallel solution with CTL middleware (see Niekamp et al. [2009])

A very limited predictive capability of the vast majority of the phenomenological anisotropic damage models, especially for non-proportional loading, is our main motivation for looking into the details of the microstructure. In fact, as shown by Benkemoun et al. [2010], the models of this kind can already be quite successful at the meso-scale level, where we can distinguish between the aggregate, cement paste and interface transition zone (see *Figure 3*). On top of such a geometry representation, where for simplicity the aggregate is considered spherical, we can construct the structured mesh representation for discrete lattice-like model. The original feature of each lattice is its ability to account for inelastic constitutive behavior along with the localized failure for each different phase. For the structured mesh, the latter results with the need to enhance the element kinematics by additional modes representing the strain and the displacement discontinuities (see *Figure 3*). The ED-FEM representation we proposed (see Ibrahimbegovic and Melnyk [2007]) has the same number of enhancement parameters as the well-known X-FEM representation. However, contrary to X-FEM, the present ED-FEM representation can clearly distinguish between the enhancement parameter for the total strain field, as opposed to the enhancement parameter for the displacement field for localized plastic deformation, and thus provide a more robust computational procedure, outlined in (1).

$$\left\{\begin{array}{c} A_{e=1}^{n_{el}}\left[f^{int,e}-f^{ext,e}\right]=0 \\ h_1^e=0 \\ h_2^e=0 \end{array}\right. \qquad \forall e\in[1,n_{el}]$$

$$\left\{\begin{array}{l} f_a^{int,e}=\int_{\Omega_1^e}B_a^T\sigma_1\,dx+\int_{\Omega_2^e}B_a^T\sigma_2\,dx \\ h_1^e=\int_{\Omega_1^e}\tilde{G}_1^{e,T}\sigma_1 dx+\int_{\Omega_2^e}\tilde{G}_1^{e,T}\sigma_2 dx+t_{\overline{x}} \\ h_2^e=\int_{\Omega_1^e}G_2^T\sigma_1 dx+\int_{\Omega_2^e}G_2^T\sigma_2 dx \end{array}\right. \qquad (1)$$



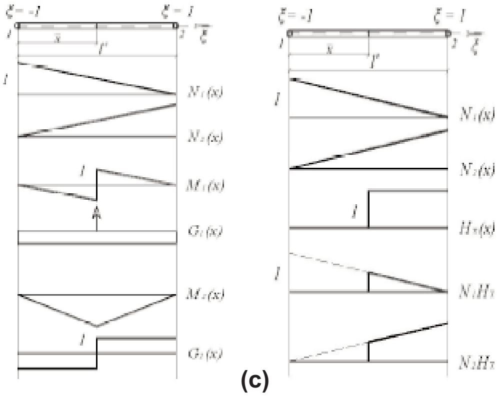


Figure 3:
Delaunay triangulation and discrete model representation of two-phase model of concrete:
a) two-phase truss-bar elements for representation of cohesive forces,
b) meso-scale representation of geometry,
c) comparison of enhanced displacement field constructed for a single cohesive link of 2-node truss-bar element by using ED-FEM versus X-FEM, and the same number of enhancement parameters

The proposed model can provide quite realistic results, including the isotropy of elastic response, the detailed representation of the FPZ, as well as the localized failure phase with softening (*see Figure 4*).

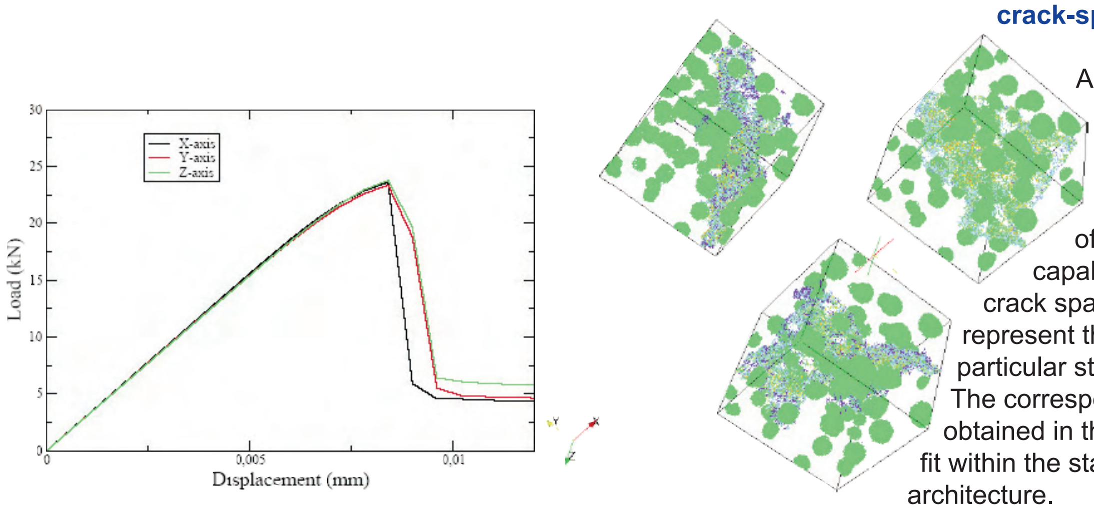


Figure 4:
Computed force-displacement diagram for simple tension test, constructed for 3 different directions, confirming the capability of the present model to describe isotropic elastic response

Finally, the proposed model can also provide the intrinsic interpretation of the size-effect, which is often observed in failure of massive structures. This can be achieved by replacing the failure parameters of our macro-scale model by random fields, whose probability distribution is obtained from meso-scale model computations (Ibrahimbegovic et al. [2010a]). In this setting, the size effect will simply reduce to difference between the homogeneous failure pattern dominated by the FPZ and highly heterogeneous pattern with the macro crack as dominant failure patter (Colliat et al. [2007]).

Reinforced-concrete model predicting crack-spacing

As shown by Ibrahimbegovic et al. [2010b], both ED-FEM and X-FEM are needed in constructing the corresponding model of reinforcement-concrete capable of predicting the crack spacing. The key idea is to represent the bond slip along a particular steel bar by X-FEM. The corresponding modification obtained in this manner can nicely fit within the standard computer code architecture.

Another ingredient which helps the proposed procedure to fit within the standard computer code architecture is the operator split method that separates the reinforced-concrete response at frozen slip from the bond-slip redistribution along the steel bar due to crack propagation within a particular increment. This solution procedure is briefly summarized in (2).

```
-for $n = 0, 1, 2 \dots$
-Given: $\mathbf{d}^c_n$, $\boldsymbol{\alpha}_n$, internal variables at $t_n$
-Find: $\mathbf{d}^c_{n+1}$, $\boldsymbol{\alpha}_{n+1}$, internal variables at $t_{n+1}$
-Iterate: $(i) = 1, 2 \dots$
-Iterate: $(j) = 1, 2 \dots$
        compute internal variable evolution for given $\mathbf{d}^{c,(i)}_{n+1}$, $\boldsymbol{\alpha}^{(j)}_{n+1}$
            $\frac{\partial \mathbf{r}^{sbs,(i)}}{\partial \boldsymbol{\alpha}_{n+1}} (\boldsymbol{\alpha}^{(j+1)}_{n+1} - \boldsymbol{\alpha}^{(j+1)}_{n}) = -\mathbf{r}^{sbs}(\mathbf{d}^{c,(i)}_{n+1}, \boldsymbol{\alpha}^{(j)}_{n+1})$ ;
-Test convergence locally
IF $\| \mathbf{r}^{sbs}(\mathbf{d}^{c,(i)}_{n+1}, \boldsymbol{\alpha}^{(j)}_{n+1}) \| > tol$ NEXT $(j)$
ELSE $\| \mathbf{r}^{sbs}(\mathbf{d}^{c,(i)}_{n+1}, \boldsymbol{\alpha}^{(j)}_{n+1}) \| < tol \Rightarrow \boldsymbol{\alpha}^{(i+1)}_{n+1} = \boldsymbol{\alpha}^{(j+1)}_{n+1}$ NEXT $(i)$
        $[\frac{\partial \mathbf{r}^{cs}}{\mathbf{d}^{c,(i)}_{n+1}} - \frac{\partial \mathbf{r}^{cs}}{\boldsymbol{\alpha}^{(i)}_{n+1}} (\frac{\partial \mathbf{r}^{sbs}}{\boldsymbol{\alpha}^{(i)}_{n+1}})^{-1} \frac{\partial \mathbf{r}^{sbs}}{\mathbf{d}^{(i)}_{n+1}}] (\mathbf{d}^{c,(i+1)}_{n+1} - \mathbf{d}^{c,(i)}_{n+1}) = -\mathbf{r}^{cs,(i)}_{n+1}$
-Test convergence globally
IF $\| \mathbf{r}^{cs}(\mathbf{d}^{c,(i+1)}_{n+1}, \boldsymbol{\alpha}^{(i+1)}_{n+1}) \| > tol$ NEXT $(i)$
ELSE $\| \mathbf{r}^{cs}(\mathbf{d}^{c,(i+1)}_{n+1}, \boldsymbol{\alpha}^{(i+1)}_{n+1}) \| < tol \Rightarrow \boldsymbol{\alpha}_n \longleftarrow \boldsymbol{\alpha}^{(i+1)}_{n+1}, \mathbf{d}_n \longleftarrow \mathbf{d}^{c,(i+1)}_{n+1}$
$(n)$
```

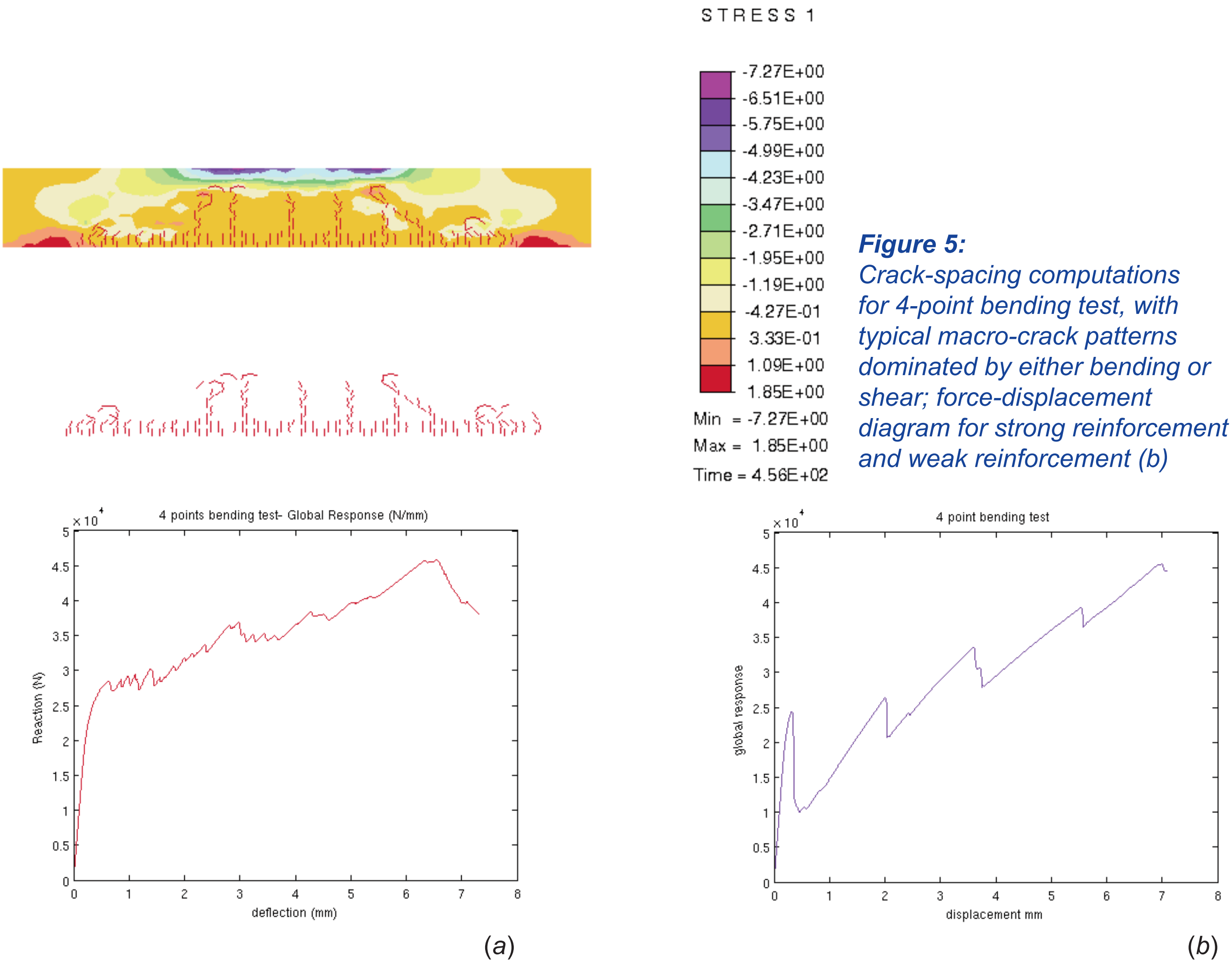
(2)

> *"…. all the models of current interest go well beyond the traditional phenomenological models, with the right mixture of discretization techniques, probability and computational methods…. "*

The results obtained with this model, shown in *Figure 5*, pertain to the difference in force-displacement diagrams for strong and weak reinforcement. Moreover, we can compute not only resulting crack spacing and opening but also the correct order in crack appearance, which validates proposed model and confirms its ability to represent the unloading and partial closing of previously activated cracks (see *Figure 6*).

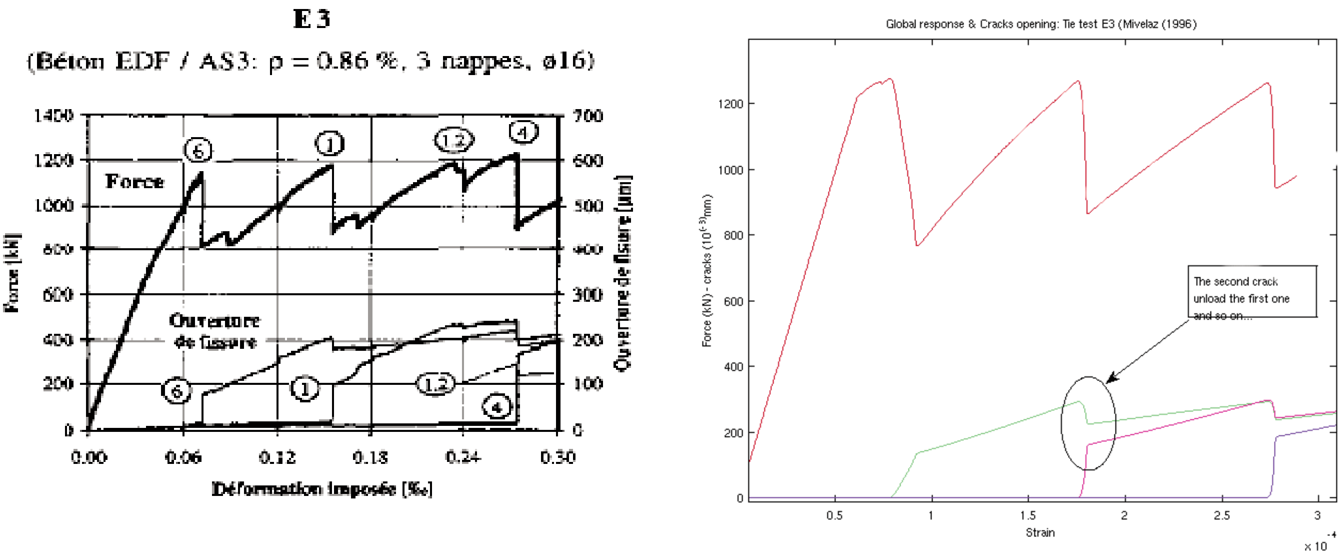
Conclusions

There are many other issues in constructing the models of this kind that have not been addressed herein. In general, all the models of current interest go well beyond the traditional phenomenological models, with the right mixture of discretization techniques, probability and computational methods (see Ibrahimbegovic [2010] for a more complete list of current works).



(*a*) (*b*)

Figure 5:
Crack-spacing computations for 4-point bending test, with typical macro-crack patterns dominated by either bending or shear; force-displacement diagram for strong reinforcement (a) and weak reinforcement (b)



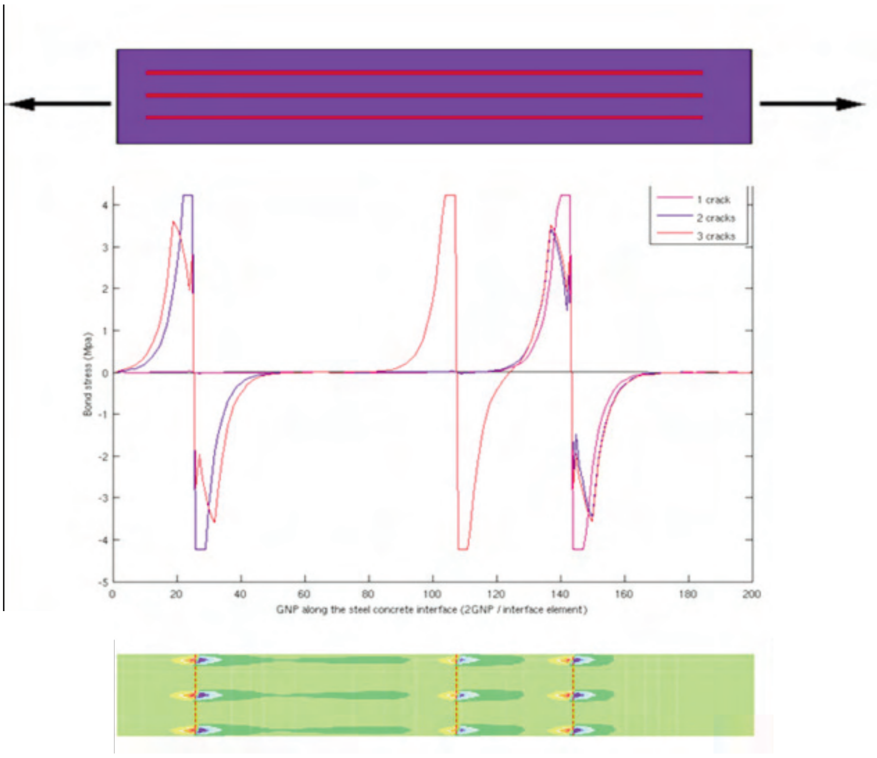


Figure 6:

Validation test for proposed reinforced-concrete model predicting crack spacing: force-displacement response and resulting crack opening; order of appearance of macro-cracks

Another potentially fruitful research area concerns the multi-physics framework for this kind of problems. Namely, once you have developed refined models for mechanics, one would like to complete with the refined models for extreme environment interpretation (e.g. fluid-structure interaction; see Ibrahimbegovic and Papadrakakis [2010] for a more complete review of current works, or thermodynamics Kassiotis et al. [2009], or yet corresponding extension to dynamics Markovic et al. [2009]).

Finally, improved predictive capabilities of the used models would also be very useful for optimal design under extreme loading (e.g. see Ibrahimbegovic et al. [2005]). ●

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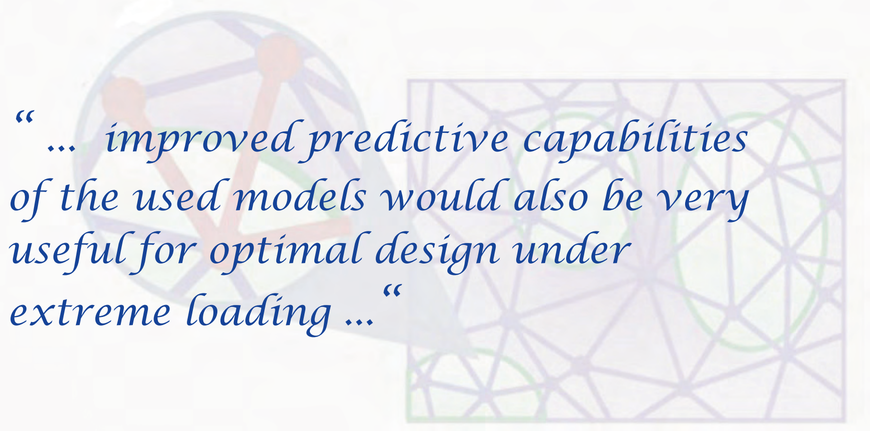

" ... improved predictive capabilities of the used models would also be very useful for optimal design under extreme loading ..."

Dawn of Magnesium Civilization - Ultimate Alternative Energy Recycling System -

by
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It won't take us that long to reach the end of the time of the jackpot (a big hit) that we human beings have been temporarily experiencing. After the Industrial Revolution that began in the 18th century, we have consumed abundant fossil fuel to enrich our lives to meet our material needs. In the 18th century, coal was the main source of fossil fuel, however oil recovery started in the latter half of the 19th century, and in the 20th century, the world was changed dramatically by oil. We have been living in nothing but oil civilization. We take a life relying on electric appliances or going out wherever we want by car for granted. However such a blessed situation is merely a kind of fluke that has lasted only for 200 years.

It is reported that the reserve to production ratio (RPR) is approximately 150 years for coal, 60 years for natural gas, and 40 years for oil, the shortest of all. According to the majority of the predictions, oil production will reach its maximum by the year of 2020, and after that it will face a decrease (PEAK OIL). On the other hand, the demand for oil and coal will increase more and more in future, far from decreasing. Use of fossil fuel has a major problem not only because its limited capability for meeting the energy demand but also its probability for causing destruction of the environment.

> *".... internal combustion engine car, including the hybrid car, has problem with both the supply of fossil fuel and the exhaust gas."*

However, it is not so simple to use renewable energy such as solar energy or wind power in place of fossil fuel. When you think about usage of renewable natural energies, it is solar power generation that first comes mind. Then is it possible to supply all the energy necessary for Japan by building an enormous solar power generation station? Let us calculate. According to the data from NEDO (New Energy and Industrial Technology Development Organization), the total energy from sunlight in Japan is about 3650 MJ/m^2 in a year. On the other hand, the overall energy consumption of Japan is 560 billion x 44 MJ. Assuming that with solar cells we are able to extract 30% of the 3650 MJ/m^2 solar energy, the area of 22,500 km^2 is needed.

However, in the case of solar power generation, it doesn't end there. In Japan it is not unusual for rain to continue more than ten days, especially in the rainy season. If we have to stop factories and offices whenever the weather worsens, the economy does not function well. We would need the ability to store energy for 10 days. Then the area needed for solar power generation rises by a factor 10 and would occupy 60% of the country since the area of Japan is 378,000 km^2. Furthermore, it is difficult to store energy for 10 days. There are no rechargeable batteries that are capable of storing sufficient electricity for operating factories.

Then how would it be if electricity generated from natural energy becomes transportable in a different form? It is a vision called "the hydrogen society". The hydrogen is then stored in a tank and carried where it is used in fuel cells. The biggest problem is rather clear; hydrogen is difficult to store and transport. Let's look at a service station, for example. Even a very small tank in a service station is around 10 m^3. This has the capacity to fill up 200 cars. If we try to achieve the same amount of energy with hydrogen at 1 atmospheric pressure, 33,000 m^3 will be required.

Then is it possible to use a tank under higher pressure? It is not so easy. Such a gas pressure would be tremendous beyond imagination. Because one can find a hydrogen tank that can bear 700 atmospheric pressure, some might think that we should use that, but in this case the load becomes 7,000 tons per m^2. It might be possible to build a small hydrogen tank for a car, but it is easy to figure out that it is impossible to build a tank that can store energy for general use.

Using hydrogen in liquid form instead of gas, it is necessary to maintain the temperature around -250 degrees and this requires large amount of energy. This is illogical. Another way is to use metallic alloys for hydrogen storage, but that will not be suitable for large-scale storage because we need such an alloy of several billion tons for replacing oil and coal which are consumed 10 billion tons in a year.

Magnesium civilization

I hope I was able to make you understand how difficult it is to replace oil and coal.

Will it be really possible to make such a circulation happen? The society, I have been envisioning is the one using "magnesium" as an energy currency [1]. Hearing about the magnesium out of blue, perhaps there no reader is convinced and agrees to say, "Indeed!" When we think of magnesium, what is known to us would probably be magnesium chloride "NIGARI (bittern)", used for making tofu. Because of high strength and lightweight, magnesium alloys are used for parts in cell-phones, PCs, cars and planes. An elderly person might remember that magnesium was used in flash bulbs of cameras. Magnesium is an ideal material as "fuel". The heat release of coal is 30 MJ/kg, magnesium has 25 MJ/kg, slightly less than coal. Magnesium, when it reacts with oxygen, only becomes magnesium oxide, which is harmless.

A tank of extraordinary size, 1 km x 1 km x 10 m, would be necessary to store the energy for a power station with 1 GW per day capacity, when generating energy with hydrogen at 1 atmospheric pressure. However if we use magnesium, the size of the tank will be 15 m x 15 m x 10 m.

Then a question that naturally comes to mind is, "Why no one has been using it so far if it is that ideal as fuel?" It is because burning 11 tons of coal to smelt 1 ton of metal magnesium is needed now. There is not a single stupid person who merely burns the magnesium made this way as fuel. Just like there is no one who burns paper money to warm his body. The price of metal magnesium is at 250 yen per kg. From this point of view, magnesium cannot be used as fuel in a casual way.

Then how would it be if there was cheap magnesium abundantly available to generate fuel? For this purpose, solar energy is used. Even though it is solar energy, it does not mean generating electricity with a solar cell and it is not solar heat either. I use the technology called "the solar-energy pumped laser" [2], which converts sun light directly into laser energy (*Figure1*). Where are the materials to smelt with laser brought from? The ore including the magnesium compound is common anywhere on the earth, the 6th most common among the metallic elements deposited in the earth crust, but there is another place where you can find large amounts of magnesium a lot cheaper. It is the oceans. 1.29g of magnesium is contained in 1 kg of seawater. Because the earth has 1,400 x 1,015 tons of seawater; the gross weight of magnesium becomes 1,800 trillion tons which is equivalent to the energy for approximately 100,000 years, because fossil fuel used as energy in the world per year is approximately 10 billion tons, by oil conversion.

By extracting magnesium compound that is contained in seawater unlimitedly and smelting it to metal magnesium with laser, we can use the metal magnesium as fuel for factories, homes and transportation. In addition, using magnesium as fuel is not the end of the story yet. Magnesium oxide is generated when magnesium is burned, and returning this into metal magnesium by smelting

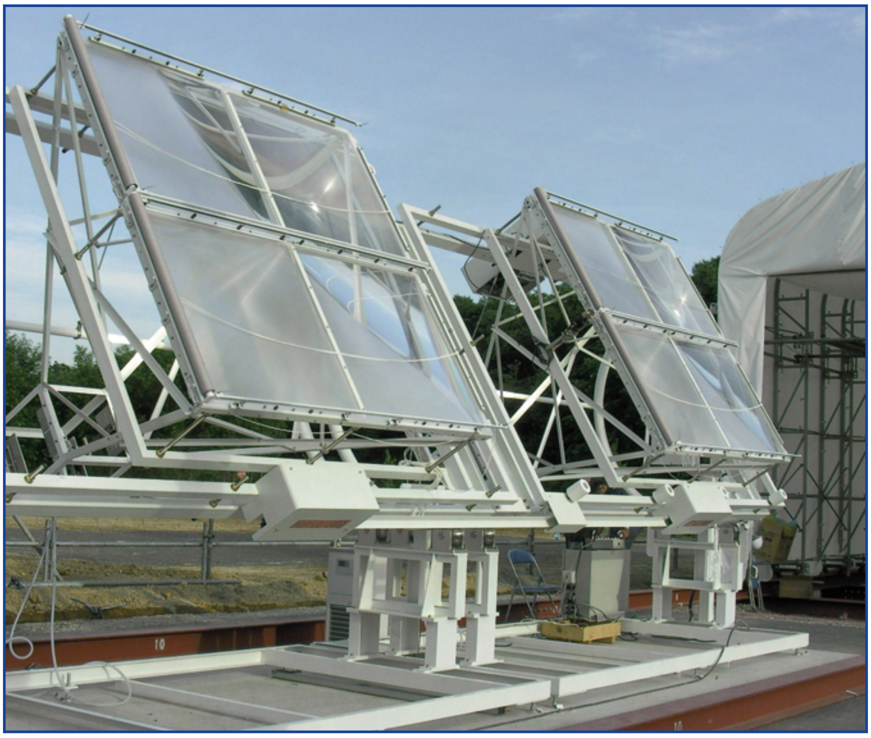


Figure1:
Solar-energy-pumped laser

with laser would make it usable as fuel again. In other words, it is possible to establish the cycle by converting energy from the sun efficiently into magnesium, a material of high portability, using the energy it contains, and after using that energy, using sunlight to generate more energy from that (*Figure 2*).

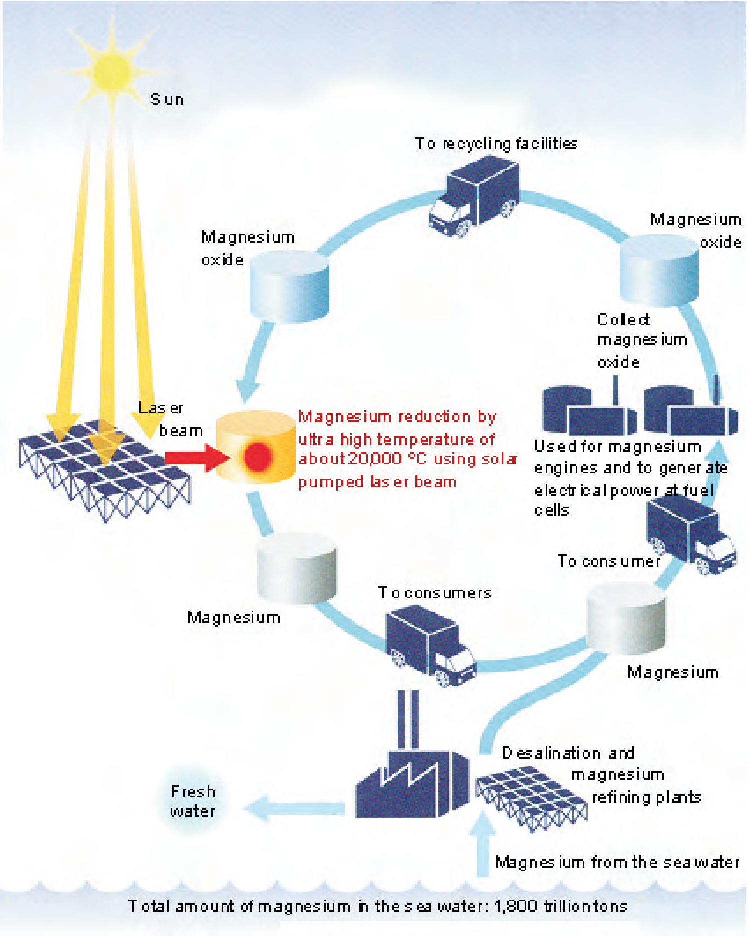


Figure 2: *Magnesium renewable energy cycle*

Magnesium cycle, at a stage just before the practical use

Anyone who hears the story of this "magnesium recycling society" for the first time expresses surprise. It is a natural response. Most people do not know that magnesium is usable as fuel. They have never heard that solar light is directly convertible into laser. Then there is extracting magnesium from seawater. However, the story I propose is not Science Fiction, and it is not a dream that will come true dozens of years later. "Solarenergy pumped laser" and "laser smelting method", which uses solar-energy pumped laser, "magnesium fuel cell" and "water conversion device", which extracts magnesium from seawater at low cost, and the research on these devices are very much in progresses, and some portions are already put into practical use. The magnesium recycling society is the story for tomorrow, not for the far-off future.

Perhaps it was totally unexpected to hear of a technology that converts sunlight into laser. I was not the first one who thought about converting sunlight into laser directly. The US Naval Research Laboratory experimented with laser oscillation by sunlight 40 years ago. The technology itself continued to be there, but it was too inefficient for practical use. The best public record is 0.7%, accomplished in Israel. This is not applicable to industrial use.

However, I am very lucky to find out that the laser medium with high conversion efficiency was already developed. Besides, it happened in a place very near where I was. Dr. Kunio Yoshida, whom I had collaborated with earlier, developed a laser medium from mixing Chromium and Neodymium (*Figure 3*) in 1995. Before that the conversion efficiency of the laser medium itself was around 7%, but Dr. Yoshida succeeded in raising that conversion efficiency substantially and Dr. Shigeaki Uchida's group achieved a conversion efficiency of 42% with a flash lamp in the laboratory.

The experiment began on a rooftop at Tokyo Institute of Technology in June 2005. In this experiment, the output for the laser generated was of the order milliwatts. Anyway, the initial stage of a research is always like this. That made me think that if I could manage increasing the light-collection performance and improving the laser medium, the conversion efficiency could rise and a practical level of output would be reached.

The next-stage experiment facility was completed in July 2007. We were able to oscillate 80 W of laser by October. I can easily cut a stainless steel plate of 1 mm thick (*Figure 3*) if I use an 80W laser. However, we do not make profit when we use it for metal smelting if it does not generate around 400 W. Ideally, it is preferable to have 1 kW of output. For such higher output, it is necessary to have both mechanical and lasermedium improvements. How to improve the device and the medium is already in sight.

Making magnesium with laser

The smelting methods currently used for metal magnesium can mainly be categorized into two, one is electrolysis and the other is thermal reduction. The electrolysis is electrolyzing magnesium chloride included in seawater and extracting metal magnesium. The electrolysis was once the lowest-cost magnesium smelting method.

Instead of electrolysis, thermal reduction, especially the Pidgeon method, is the mainstream smelting method now. In the Pidgeon method, dolomite is used as the main raw material. Dolomite is an ore that resembles limestone and is found in almost the same places as limestone. Rich in magnesium carbonate and calcium carbonate, dolomite is used as a cement ingredient. Magnesium smelted by the Pidgeon method comes with a higher purity compared to the one smelted by electrolysis. It can clearly be understood from this explanation that the Pidgeon method needs a large amount of thermal energy. It is said that approximately 11 tons of coal is used for making 1 ton of magnesium, and the reducing agent ferrosilicon cannot be collected. China lowered smelting cost markedly by introducing low-cost coal into the Pidgeon method. As a result, the main countries producing magnesium changed completely. In place of the former main countries, the USA, Norway, and Russia, China is the country with the highest magnesium production now. The world annual production of magnesium is approximately 600,000 tons, and 80% of that is from China.

To extract metal magnesium directly from a magnesium compound, energy of approximately 20,000 degrees equivalency is needed as latent heat of evaporation and as inter-atomic binding energy, but there was no method in the past to provide such a large amount of energy. Even if there was such an amount of energy available, the smelting furnace cannot tolerate it.

However, the circumstances change completely if we use a laser. It is possible to focus energy at a small point instantly and create big action. Suppose around 200 degrees can be generated by a laser that irradiates a point of 1cm in diameter, if I could focus the same laser with a lens to a point of 1mm in diameter, that makes it possible to generate a hot spot of 20,000 degrees equivalency by concentration of energy. Some might question this. Does a smelting furnace that can tolerate thermal energy of 20,000 degrees equivalency exist? It is the big advantage of a laser that it can concentrate energy at one point. Even if I concentrate a laser at a point of 1mm in diameter to make it 20,000 degrees, it reaches only around 200 degrees 1cm away from there.

Figure 3:
Chromium co-doped Neodymium YAG laser

We are now advancing our research to improve the smelting efficiency of the laser irradiation. We can extract 60-80% of metal magnesium from magnesium that vaporizes. We install 60,000 solar-energy pumped laser generators that cost 6 billion yen. The area necessary for 60,000 lasers would be only 500 meters x 500 meters. Then, the annual metal magnesium production will be 10,000 tons. The construction expense part of the cost price becomes 21 yen per kg according to our quick calculation. However, with the laser smelting method, there is almost no running cost. The laser oscillated directly from sunlight is used for smelting. In our test calculation, the final cost price would be a one tenth of the Pidgeon method, 20-40 yen per kilogram, even including the running cost.

Burning magnesium

All of you already know that the competition for the development of the next generation car replacing the current gasoline car intensified. The internal combustion engine car, including the hybrid car, has problem with both the supply of fossil fuel and the exhaust gas. The shift to cars with electric motor would be unavoidable in the future. There are many advantages in the electric car, but at the same time there are many problems. Though the performance of the lithium ion battery is improving, the driving mileage remains around 160km. It still takes 30 minutes even when using a special rapid battery charger.

> *"The shift to cars with electric motor would be unavoidable in the future."*

> *".... it is not necessary at all for the existing infrastructure to be changed, ... only .... switching the fuel from coal or oil to magnesium."*

Furthermore, the lithium ion battery has a disconcerting aspect in terms of raw-material supply. It is said that cars usually need 100 kWh (= 360 MJ) of energy to run 500 km. How much lithium will be necessary to generate 100 kWh of energy with lithium ion battery?
Because lithium has a specific capacity of 3.83 Ah/g and the output voltage is around 3 V, its energy is 3.83 x 3 = 11.5 Wh/g. Therefore, 8.7 kg of lithium is necessary to generate 100 kWh (assuming 100% of the lithium energy is usable). Because more than 900 million cars are running in the world now, 7,800,000 tons of lithium would be necessary to equip every car with a lithium ion battery. However, lithium reserves is 11 million tons (proven reserves is 4,100,000 tons, data from United States Geological Survey), and that is not enough even if lithium is used only in cars. Lithium is contained in seawater and research on lithium extraction is in progress but it is problematic that the amount is less compared to magnesium. The magnesium concentration in seawater (3.5% salt) is 1.29 g per kg, but the lithium concentration is 1.7 x 10-4 g per kg.

The hydrogen fuel cell is superior in terms of the environmental performance, but the hydrogen used as the fuel becomes the obstacle in the same way as it does in a hydrogen engine car. Fundamentally, the problems in transportation and storage are not easily solved.

How can I realize the next generation car that is high in running performance and low in infrastructure maintenance and does not release greenhouse gases? The answer is simple: the reaction of magnesium with oxygen. "The air battery" that uses metal and air oxygenation existed for a long time. Separating the magnesium at the negative electrode from the main body of battery makes it exchangeable. In other words, the fuel called magnesium is replaceable.
That way an air battery becomes the fuel cell. Recently, one Japanese company succeeded in producing a new magnesium battery of 90% efficiency.

Although not with magnesium, testing of an air battery car using a similar reaction is has already been performed and achieved results. In 2003, Mr. Sadeg Faris, an American inventor, remodeled "Insight" from Honda and made a zinc air battery car experimentally. Separating the electrode from the main body of the battery and enabling its replacement, the idea I described earlier, was his. Mr. Faris had a test run in Malaysia and succeeded in a continuous run of 524 km. This zinc air battery has an output that is 2.5 times the output of the current lithium ion battery. The zinc deposits of the whole world are estimated to be approximately around 460 million tons, and it is not enough as an alternative fuel for oil and coal that have 10 billion tons of annual consumption.

How about magnesium? Although the price of magnesium is a lot higher than that of zinc, it has an energy density that is 3 times that of zinc, and the estimated output is 7.5 times the output of the lithium ion battery. Magnesium as fuel can be sold at convenience stores and can be replaced in about the same amount of time it would take for refueling at a gas station. Magnesium oxide is generated when the magnesium air battery is used. It would be nice to have a system to receive this magnesium oxide when you buy a new fuel pack. Because magnesium oxide can be returned to metal magnesium with solarenergy pumped laser, there are less problems with recycling.

It is not only for a car that a magnesium air battery is available. There is a possibility that it can be used in all transportation modes currently running with electricity or oil. The present railroad supplies electricity with a power transmission line and drives the motor, but the magnesium air battery can replace this. The railroad in the past used a fuel that could be carried, like how it is in a steam or diesel locomotive. If trains start running with the magnesium air battery, the familiar power transmission lines and pantographs will disappear. Because the train would have its own fuel and power source, large-scale infrastructure would become unnecessary and this may largely lower the construction cost of the railroad. I think that it can be an effective solution for mass transportation in an area or a country that is not yet equipped with transportation infrastructure.

Similarly, we can use the magnesium air battery in a ship. Of course the advantage of having clean exhaust gases is an important issue, and furthermore using also the laser technology, a ship can move long distances at high speeds. Putting laser smelting furnace on a ship is our idea. We run the ship with the magnesium air battery, and the magnesium oxide produced is deoxidized to metal magnesium with a laser. If we have a laser, it is not necessary to refuel on the way.

How we can manage a laser that can be used for smelting to get fuel? The answer is converting sunlight to laser with a device on the ground, irradiating it toward a satellite, and reflecting it on the satellite mirror to hit the lens on the moving ship (*Figure 4*). It sounds like an extremely strange idea, but in fact technically it is not that challenging. For a laser with one GW output, it would take only a few hours to smelt sufficient amount of magnesium for running a cargo ship, several hundred thousand tons class, for one week. Though one GW is an enormous output, it can be achieved by spreading laser generator with 40% conversion efficiency all over an area of 2.5 m2. The laser generated is irradiated towards the satellite, reflected on the satellite mirror and received by the lens on the ship.

What would it be like if we could produce magnesium more abundantly, like one or ten million tons? We can use magnesium as an alternative fuel for oil and coal. Because a thermal power station is the biggest carbon dioxide emission source, switching its fuel to magnesium would be the most effective way of reducing the carbon dioxide. Then how will you use magnesium at a thermal power station? In this case we will use a chemical reaction that is different than the one in the air battery. As you already know, hydrogen is generated if metal magnesium and water react. The reaction speed becomes remarkably higher if we make the magnesium grain small. Hydrogen starts burning when the reaction speed becomes higher. Magnesium and water react, hydrogen comes out, hydrogen reacts with oxygen, and we get water coming out as steam.

Turning a turbine with steam at elevated temperature and pressure to generate electricity is the principle of the magnesium thermal power station. In this case because it is magnesium oxide that is finally produced, as it is in the air battery, it can be deoxidized to metal magnesium by laser smelting. It takes an enormous construction cost to build a new thermal power station, but the magnesium thermal power station does not have that problem. The current thermal power station using coal or oil makes steam with the heat of the burnt fuel to turn a turbine that generates electricity. In other words, it is not necessary at all for the existing infrastructure to be changed, and the only thing required is switching the fuel from coal or oil to magnesium. ●

This article is the essence of the book written in Japanese and is translated by Tomoko and Tayfun Tezduyar into English which will be published soon.

Reference:

[1] *T. Yabe et al.*, **Demonstrated Fossil-Fuel-Free Energy Cycle Using Magnesium and Laser**, Appl. Phys. Lett. 89, (2006), 261107.
[2] *T. Yabe et al.*, **High-efficiency and economical solar-energy-pumped laser with Fresnel lens and chromium codoped laser medium**, Appl. Phys. Lett. 90, (2007), 261120.
[3] *T. Ohkubo et al.*, **Solar-pumped 80 W laser irradiated by a Fresnel lens**, Opt. Lett. 34, (2009) 175

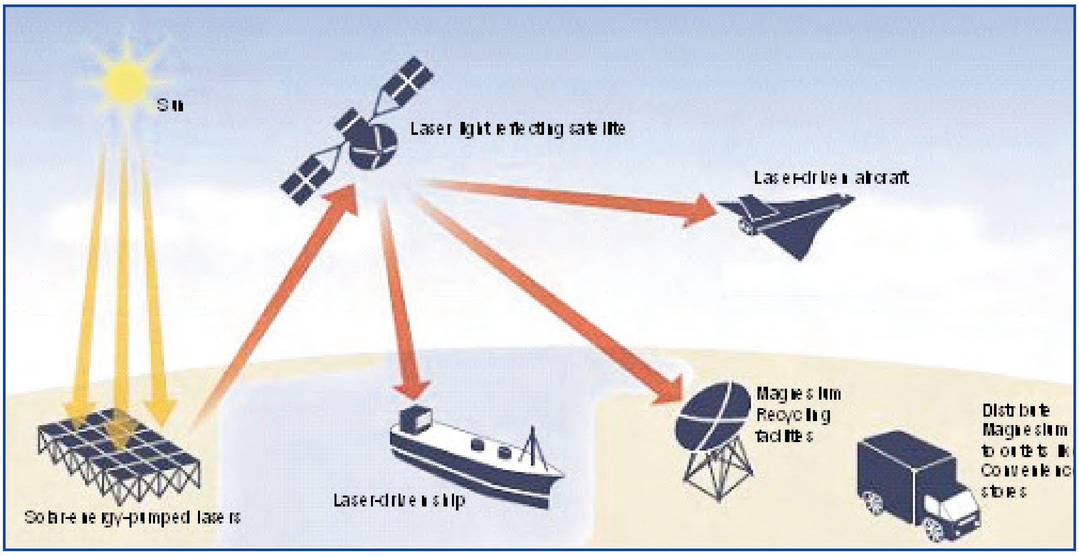
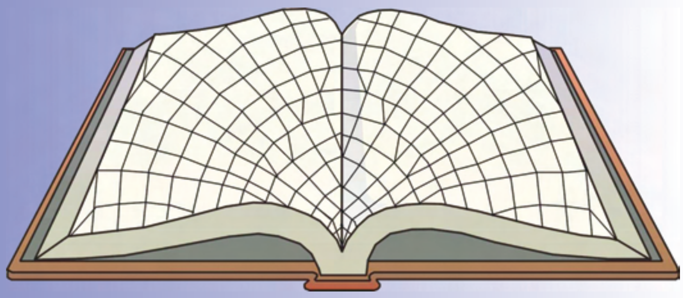


Figure 4:
Laser can deliver energy for a long distance

BOOK REVIEW



NUMERICAL METHODS IN SCIENTIFIC COMPUTING VOLUME I

Germund Dahlquist and Åke Björck
SIAM, Philadelphia, USA, 2008

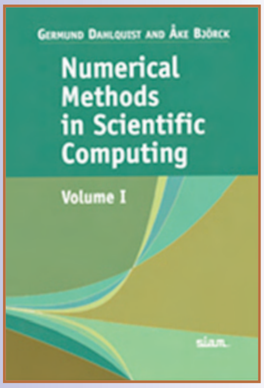
ISBN: 978-0-898716-44-3, 717 pages, hard cover,
US $109 (List Price).
Contents: Preface;
Chap. 1: Principles of Numerical Calculations;
Chap. 2: How to Obtain and Estimate Accuracy;
Chap. 3: Series, Operators, and Continued Fractions;
Chap. 4: Interpolation and Approximation;
Chap. 5: Numerical Integration;
Chap. 6: Solving Scalar Nonlinear Equations;
Bibliography;
Index.

I first encountered the name Dahlquist when I was a graduate student and took a class discussing the numerical solution of linear dynamic systems, in the context of the Finite Element Method. I was fascinated by the power and beauty of Dahlquist's Theorem on Linear Multistep (LMS) methods, asserting that (for more, see, e.g., T.J.R. Hughes, The Finite Element Method, Dover, 2000):

1. An explicit A-stable LMS method does not exist.
2. A 3^{rd}-order accurate A-stable LMS method does not exist.
3. The 2^{nd}-order accurate A-stable LMS method with the smallest error constant is the trapezoidal rule.

I imagine that when this theorem was first published in 1963, the community must have regarded the first two statements above with the same amazement as that expressed by the public, many years before, in response to the evidence showing that alchemy (producing silver and gold from other materials) was impossible.

Germund Dahlquist (1925–2005) was a Swedish mathematician known for his ground-breaking contributions to the theory of numerical analysis as applied to differential equations. In 1974 the book by Dahlquist and Åke Björck, simply called "Numerical Methods" was published by Prentice-Hall, and became one of the most successful titles of this publisher. In the mid 1980's the two authors started to prepare a much extended three-volume version of the book.


Germund Dahlquist and Åke Björck
Numerical Methods in Scientific Computing
Volume I
siam

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When Dahlquist passed away in 2005, Björck continued to work on the first two volumes and has brought them to a successful completion. The book under review here is the first volume. The second volume is promised to appear in the very near future.

This is an excellent book, encyclopedic in its capacity, on classical subjects in numerical analysis. I think it would be fair to say that this book concentrates on surveying, explaining and analyzing in depth a large part of the *infrastructure* of numerical methods that can be used as basic tools in scientific computing. The bread and butter of the field is covered here thoroughly – interpolation, integration, solution of linear and nonlinear systems of algebraic equations and matrix eigenvalue problems – but the very heart of scientific computing, namely the numerical solution of ODEs and PDEs, is hardly discussed in this book.

> “ Far better an approximate answer to the right question than an exact answer to the wrong question.”

This is equally true regarding the second volume, judging from its announced list of contents. Stability is discussed mainly in the context of algebraic systems. I must admit that at first I was somewhat disappointed to realize this, but of course this was just the result of my own expectation from the title and from the celebrated theorem mentioned above.

On this matter, Björck writes in the Preface: “*… the emphasis is on traditional and well-developed topics in numerical analysis. Obvious omissions in the book are wavelets and radial basis functions. Our experience from the 1974 book showed us that the most up-to-date topics are the first to become out of date.*” I am willing to accept this view, but surely the treatment of ODEs and PDEs cannot be regarded as too contemporary.[1]

Having overcome my initial disappointment, I found an outstanding book that can serve as an invaluable reference on numerical analysis for any researcher of computational mechanics. In what follows I will try to point to a few things that I found especially appealing in it.

The first chapter gives an overview of the numerical methods that are going to be discussed in the following chapters, including many examples. I think this is an excellent (and not so common) idea, and is especially beneficial for student readers, since such overview provides the reader with immediate motivation and a “tip of the finger” feel to what the subject is all about.

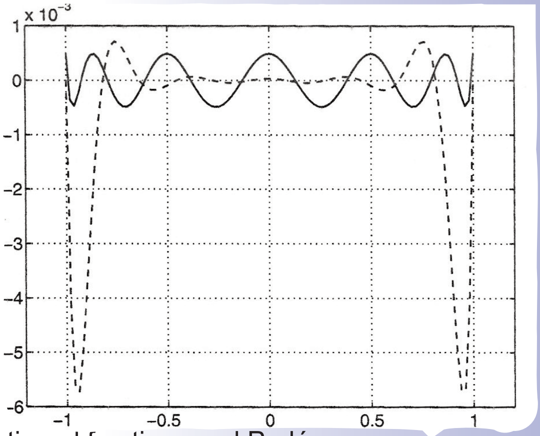

Figure 1:
The Runge phenomenon; this is Fig. 4.2.1 in the book.

After reading this chapter, the reader already has basic understanding of fixed-point iteration, Newton’s method, LU factorization, iterative solvers, least squares, singular value decomposition, Euler’s method (which is the only place in the book where the solution of an ODE is discussed; there is no mention of stability), Monte Carlo methods, and other topics. Basic algorithms are provided, and the reader can already write down simple codes to implement them.

Chapter 3 devotes a lot of space to subjects like continued fractions and Padé approximants. These are classical topics, but ones that are not studied a lot in the context of computational mechanics, and they probably should be, since they play an important role in high-order methods (e.g., certain p- and spectral elements and high-order absorbing boundaries).

Chapter 4 discusses at length topics related to interpolation and approximation, among them the two extremely important numerical phenomena called the Runge phenomenon and the Gibbs phenomenon. The Runge phenomenon is related to the

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[1] *Apparently it was the authors' original plan to cover methods for ODEs and PDEs in the third volume.*

difficulties in convergence when interpolating a function using a high-degree polynomial and equidistant interpolation points. This is demonstrated in *Figure 1* (which is Fig. 4.2.1 in the book, p. 378), which shows the error of interpolation of the function x^{12} using polynomials of degree 11 with equidistant (dashed line) and Chebyshev (solid line) points. (Incidentally, there are no color figures in this book.) *Figure 2*, which I produced using MAPLE, shows the Runge phenomenon for interpolations of the function $f(x)=1/(1+x^2)$ (blue curve) using 5th (green curve) and 10th (red curve) degree polynomials with equidistant points.

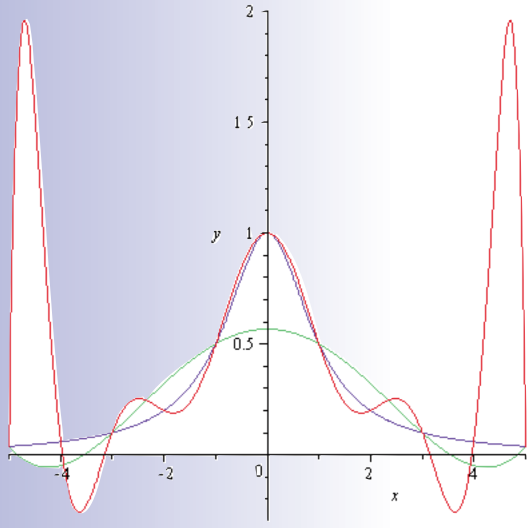


Figure 2:
The Runge phenomenon; two equidistant interpolations

The Gibbs phenomenon is demonstrated in *Figure 3*, which I also produced using MAPLE. This is related to the overshoot and undershoot obtained in the Fourier-series approximation near a discontinuity. The height of this overshoot and under-shoot converges to a fixed nonzero value. *Figure 3* shows the approximation of a square signal using Fourier series with 25 terms (upper plot) and 125 terms (lower plot).

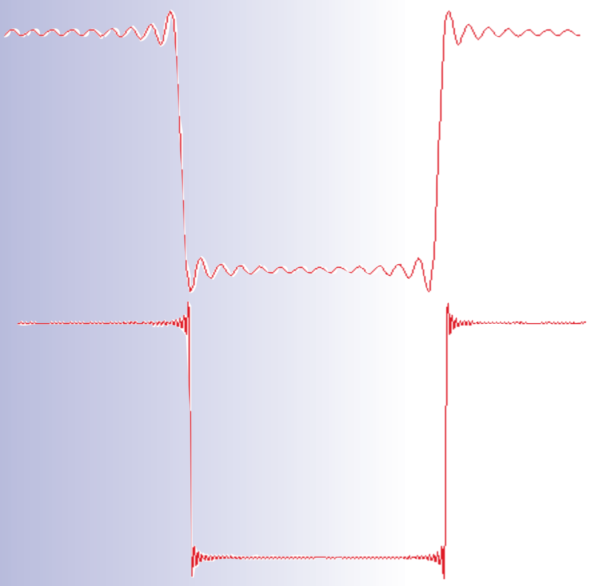


Figure 3:
The Gibbs phenomenon

Some aspects of the editing of this book could be improved. Most importantly, the index suffers from many omissions. Two typical examples out of very many are:

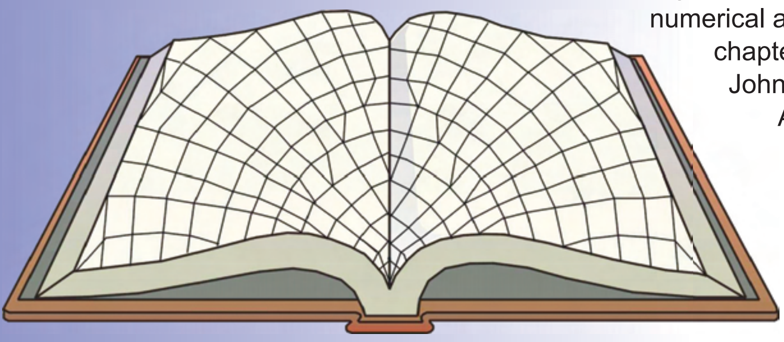
(1) FFT (fast Fourier transform) appears in the index and points only to p. 194 (where the concept is first discussed), but the fact that the FFT algorithm is discussed in detail on pp. 503-516 is not mentioned in the index;

(2) adaptive schemes are discussed in various places in the book, but “adaptive …” does not appear in the index.

The format in which algorithms are presented in the book is not uniform: some are assigned an “algorithm number” and are written down as Matlab codes (e.g., bisection) and some are not (e.g., Newton), in a way which looks arbitrary.

Despite this, it is clear that the authors gave a lot of attention to the educational role carried by the book. Many worked out examples are included. Each section ends with a number of “Review Questions” and “Problems and Computer Exercises.” Each chapter ends with some historical notes and pointers to the bibliography that appears at the end of the book. All these are very helpful and no doubt have been designed extremely carefully. Other features that I find refreshing are the footnotes that appear throughout the book with three-line biographies of important numerical analysts, and the famous quotes which open each chapter. The one I like most is the quote by John W. Tukey, opening Chapter 4 on Interpolation and Approximation (brought here with some omissions):

> *“Far better an approximate answer to the right question than an exact answer to the wrong question.”* ●



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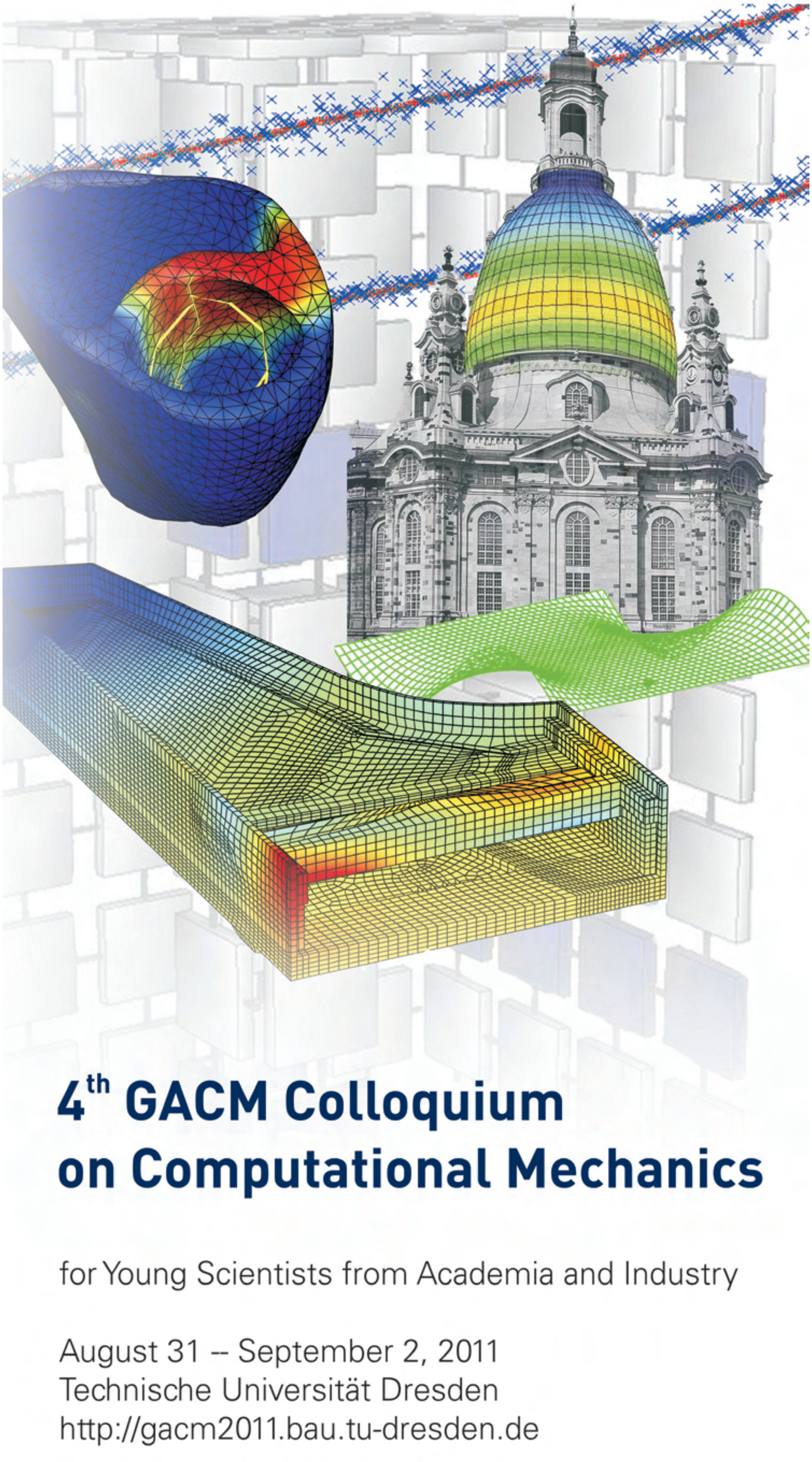
GACM Colloquium for Young Scientists Working on Computational Mechanics

In 2005 the series of GACM Colloquia on Computational Mechanics was started with the objective to provide a forum for young scientists. They may present their latest research results and exchange ideas. Thematically arranged sessions and organized minisymposia in combination with a poster session and social events provide an environment for lively discussion in a productive atmosphere.

In the meantime, the series includes three successful GACM Colloquia which took place in Bochum (2005), in Munich (2007) and in Hannover (2009). The fourth Colloquium on Computational Mechanics for Young Scientists will take place at the Technische Universität Dresden on 31 August – 2 September 2011. Young researchers who wish to participate at and contribute to the colloquium will find further information at **http://gacm2011.bau.tu-dresden.de/**



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USACM and IACM Sponsored
NEMB2010:
A Multidisciplinary Success

Co-sponsored by USACM, the American Society of Mechanical Engineers (ASME) 2010 First Global Congress on NanoEngineering for Medicine and Biology (NEMB2010) was held Feb. 7-10, 2010 in Houston, TX. NEMB2010 was the result of an inaugural partnership between the ASME NanoEngineering Council and the Alliance for NanoHealth in Houston, TX. NEMB2010 provided a forum for idea exchange and learning to members of the engineering community, scientists and clinicians involved in the development of new tools and materials in nanomedicine, experts from industry in the field of life sciences and all those investigating the potential of future emerging technologies. The Congress focused on the integration of Engineering Sciences, Mechanical Engineering and Nanotechnology in addressing fundamental problems in Biology and Medicine and in developing devices for the early detection, imaging and cure of diseases. The three program chairs were Mauro Ferrari, Thomas J. R. Hughes (USACM), and Wing Kam Liu (USACM).

Approximately 300 abstracts in 10 tracks (Table 1) were selected for presentation and discussion at NEMB 2010 and 475 individuals registered to attend. This is the model envisioned for future Congresses, that is approximately 1:2 ratio of speakers to attendees. The conference also featured an opening speech from U.S. Congressman John Culberson, nine plenary lectures, Nobel Laureates and Distinguished Scientists for the NEMB opening reception, a student poster competition, and four tutorial lectures (Table 2). Feedback on the event indicated a successful start and encouragement for further activities in this emerging field. For more information on NEMB2010 and other NanoEngineering Council activities please visit the ASME Nano Institute site: **www.nano.asme.org**

As summarized in the five-year study 2006 Simulation-Based Engineering Science NSF report and the 2009 NSF World Technology Evaluation Center (WTEC) report on Simulation Based Engineering Science, modeling and simulations play an important role in

Figure 1:
Distinguished Scientist Panel featuring Nobel Laureates (from right) Robert F. Curl Jr., Nobel Prize in Chemistry (1996), Ferid Murad, Nobel Prize in Physiology or Medicine (1998), Rebecca Richards-Kortum, Fazle Hussain, Nicholas A. Peppas.

the discovery and development of new materials, life science and medicine, and energy and sustainability. It is evident that tomorrow's interpretation of computational science and engineering will include all types of bodies at any scale – electrons, molecules, continents, galaxies, living tissue, biological and medical systems, etc. In this regard, future science and engineering students, professors, and researchers might be trained in a truly interdisciplinary research environment for tackling the challenging problems of the 21st century. The creation and founding of NEMB2010 in collaboration with ASME, is an important step in impacting the future directions of NanoEngineering in Biology and Medicine. Planning has already begun for the first NanoEngineering for Energy and Sustainability Congress. USACM and IACM members' participation and suggestions for endeavors in these areas are welcomed.

One of the notions that had great prominence in this meeting is that all of our disciplines are merging together. We in computational mechanics have been involved in engineering and life sciences for quite a while now, and we like to see computer simulation as a major component in this integration.

USACM will continue to promote, foster, organize and coordinate various activities concerning computational mechanics in multidisciplinary areas that have profound impact on science and technology.

Table 1 Technical Tracks

- Track 1 NanoEngineering for Medical Diagnostics
- Track 2 NanoEngineering for Medical Therapeutics and Imaging
- Track 3 Nano-/Micro-fluidics for Medical Diagnostics and Therapeutics
- Track 4 NanoEngineering for Regenerative Medicine
- Track 5 Manufacturing and Materials for NanoMedicine
- Track 6 Multiscale Modeling in Biological Systems
- Track 7 Biological NanoMechanics
- Track 8 Poster Session
- Track 9 Plenary Sessions
- Track 10 Tutorials

Table 2 Tutorial Lectures

1. Nanoengineering Tools for Biomedicine.
   Speakers: J. DeSimone, P. Decuzzi, M. Ostoja-Starzewski, T. Thundat, J. West, C. Li
2. Challenges in Biomedicine for Engineers.
   Speakers: G. Lopez-Berestein, D.D McPherson, R. Pasqualini, A.K. Sood
3. Regulation and Commercialization of NanoEngineered Medical Devices and Materials
   Speakers: C. Anzalone, R. Goodall, S.E. McNeil, W.R. Sanhai
4. NanoEngineered Therapeutics I & II
   Speakers: D. Ho, W. K. Liu, E. Osawa, M. Teitell. ●

By
J. S. Chen,
UCLA
and
Wing Kam Liu
Northwestern University

Figure 2:
Plenary lecture

for all inclusions under SEMNI please contact:

Xavier Oliver
xavier.oliver@upc.edu

SEMNI/APMTAC
Celebrated its Bi-Annual Conference on Numerical Methods in Barcelona

During June **29th to July 2nd 2009**, the Spanish Association for Numerical Methods in Engineering (SEMNI) celebrated its bi-annual conference in the Technical University of Catalonia (UPC) main campus, located in Barcelona. Since the conference held in Madrid in 2002, the conference is organized jointly with the Portuguese Association on Theoretical, Applied and Computational Mechanics (APMTAC).

Figure 1: *A view of the auditorium during the plenary conference of Prof. Peraire*

More than four hundred people attended the conference, of which more than 150 came from Portugal. Plenary lectures were given by G. Ayala (UNAM Mexico), F. Chinesta (EC Nantes, France), B. Cockburn (U. Minnesota), R. Delgado (U. Porto, Portugal), C. Fiolhais (U. Coimbra, Portugal), and J. Peraire (MIT, on the photo).

The social programme included a gala dinner in the magnificent Codorniu caves, where the bi-annual SEMNI and APMTAC prizes were awarded to the recipients.

This year, **Dr. S. Fernández-Méndez** was awarded the **J. C. Simo prize** for young researchers, while **Prof. S. Idelsohn** received the **SEMNI prize** recognizing his career. ●

Figure 2: *Gala dinner: from left to right, X. Oliver (president of SEMNI), S. Idelsohn (secretary of IACM), C. Mota Soares (president of APMTAC), E. Oñate (president of IACM) and M. Casteleiro (former SEMNI president)*

SEMNI has Renewed its Executive Council

The Spanish Society for Numerical Methods in Engineering has renewed its executive council in the last year. The council is formed by the following members, after the elections:

Xavier Oliver (Universitat Politècnica de Catalunya, president), José M. Goicolea (Universidad Politécnica de Madrid, vice-president), Antonio Rodríguez Ferran (Universitat Politècnica de Catalunya, general-secretary), Eugenio Oñate (Universitat Politècnica de Catalunya) and Manuel Casteleiro (Universidade da Coruña) as former presidents and Jesús María Blanco (Universidad del Pais Vasco), Miguel Cervera (Universitat Politècnica de Catalunya), Ignasi Colominas (Universidade da Coruña), Elías Cueto (Universidad de Zaragoza), Rafael Gallego (Universidad de Granada), Antonio Huerta (Universitat Politècnica de Catalunya), Fermín Navarrina (Universidade da Coruña), José Luis Pérez Aparicio (Universidad Politécnica de Valencia) and Benjamín Suárez (Universitat Politècnica de Catalunya). ●

Figure 3:
From left to right
A. Rodríguez-Ferran (general-secretary),
X. Oliver (president),
M. Casteleiro (former president),
E. Cueto, M. Cervera,
E. Oñate (former president),
A. Huerta, J. L. Perez Aparicio,
J. M. Goicolea (vice-president),
I. Colominas and F. Navarrina
during a meeting of the
SEMNI executive council in Barcelona

SEMNI Awards
- 2010 -

The Spanish Association for Numerical Methods in Engineering (SEMNI) established in its 1999 conference its prizes. The **Juan C. Simo prize** for young researchers is awarded annually to outstanding researchers under the age of 35. This year, **Santiago Badia**, from the Technical University of Catalonia, has been awarded for his short but outstanding career in the field of numerical methods for flow problems. Dr. Badia did his Ph.D. thesis under the advice of Prof. Ramon Codina, on numerical methods for fluid-structure interaction and has been visiting researcher in Sandia laboratories and the Politecnico di Milano, under the advice of Prof. Quarteroni.

On the other hand, the annual prize for the **best Ph. D. Dissertation in the field of numerical methods in engineering** has been awarded *ex aequo* to **Dr. Xesus Nogeira** (U. de la Coruña), for his thesis on *Moving Least Squares approximations and high-order Finite Volume methods for compressible flows*, advised by Prof. I. Colominas and Prof. L. Cueto-Felgueroso, and to **Dr. Rubén Sevilla** (UPC) for his thesis on *NURBS-enhanced finite element method,* advised by Prof. A. Huerta and Dr. S. Fernández-Méndez.

In addition, SEMNI awards each two years the **SEMNI prize** to an outstanding researcher with an important relationship with the Spanish community on numerical methods. The next prize will be announced in the next 2011 APMTAC/SEMNI Conference, to be held in Coimbra, Portugal 14-17 June ●.

For all inclusions under APACM please contact:

Genki Yagawa
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Report on the 2nd International Symposium on Computational Mechanics (ISCM) and the 12th International Conference on the Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC)

- 30 November to 3 December 2009 -

Hong Kong and Macau

Organized by **The International Chinese Association for Computational Mechanics (ICACM)** and the Conference Board for the **Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC)**, the **Second International Symposium on Computational Mechanics (ISCM II)** and the **Twelfth International Conference on the Enhancement and Promotion of Computational Methods in Engineering and Science (EPMESC XII)** was successfully held in Hong Kong and Macau during 30 November – 3 December 2009.

The conference included two sessions. Session I was held in Hong Kong during 30 November – 1 December 2009 and Session II in Macau during 2-3 December 2009.

Following the first ISCM conference held and the official formation of The International Chinese Association for Computational Mechanics (ICACM) in Beijing in 2007, the ICACM board decided to hold the International Symposium on Computational Mechanics every two years. The second International Symposium on Computational Mechanics (ISCM) was held in Hong Kong in 2009.

The first EPMESC conference was held in Macau in 1985 and, thereafter, held alternately in Macau and a city elsewhere, including Guangzhou, Dalian, Shanghai, and Sanya, the EPMESC Board decided to have the host city of the conference outside China, and the conference to be jointly organized with other congress of similar stature to expand its impact; hence the last EPMESC meeting was held in conjunction with APCOM'07 in Kyoto in 2007.

This time, the conference came back to Macau and it was held in conjunction to the ISCM II in Hong Kong to continue the tradition. This joint conference dealt with problems on the development and application of computational methods in all aspects of engineering and science with special emphasis on mechanics. Plenary lectures and mini-symposia, special sessions that highlight the latest trends in different scientific areas were delivered. In addition, five best paper awards for young researcher and student were presented.

The conference had attracted 341 participants in total from 26 countries worldwide including 237 full participants, 93 student participants, and 11 accompanying Persons. These proceedings to be published by AIP are in two volumes and contain 285 papers of about 1700 pages that have been reviewed by members of the Organizing Committee, the International Scientific Advisory Board and other experts. These papers have been written by researchers in the field of Computational Mechanics, Computational Methods, and the relevant applications and collectively they represent the most recent advances in the field worldwide.

We are very grateful to the valuable help and enthusiasm received from members of the Programme and Organizing Committee, the work of the members of the International Scientific Advisory Board and the generosity of the Sponsors and the Supporting organizers.

by
AYT Leung
City University of Hong Kong

CHILEAN SOCIETY FOR COMPUTATIONAL MECHANICS

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SCMC
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or
Diego Celentano
dcelentano@ing-puc.cl

National and international professionals and faculty members attended the **VIII Workshop on Computational Mechanics** (JCM 2009, acronym in Spanish) hosted by the **Universidad de la Frontera** (UFRO) at Pucón, Chile. This annual meeting of the Chilean Society for Computational Mechanics (CSCM) was chaired by Prof. Juan Möller of the Mechanical Engineering Department. The Organizing Committee also comprised Profs. Renato Hunter and Alejandro Omón. The Workshop was officially opened by Prof. Dr. Plinio Durán García, Dean of the Engineering School of UFRO. The closing speech was made by the current president of CSCM, Prof. Diego Celentano.

This two-day Workshop encompassed different activities such as two Plenary Lectures, two Technical Parallel Sessions and the Annual CSCM Members Meeting.Dr. David Field, retired from the General Motors Research and Development Center (USA), presented a relevant talk as Plenary Lecture titled “Manufacturing, Robotics and Computational Geometry”. The Plenary Lecture “Component optimization in engineering problems” by Prof. Pierre Beckers from the Université de Liège (Belgium). The CSCM warmly thanks the participation of both speakers.

Participants from different countries and Chilean universities presented 34 works from several areas of computational mechanics. Moreover, a collection of 17 full written papers were reported in the journal of the CSCM “Cuadernos de Mecánica Computacional, Vol. 7”. The CSCM specially acknowledged the active participation of under and post graduate students.

Finally, the CSCM cordially invites to participate in the next version of the Workshop (**JMC 2010**) to be held in La Serena at the **Universidad de La Serena** during **September 2-3, 2010**. Contact Profs. Carlos Garrido or Mauricio Godoy (cgarrido@userena.cl, mgodoy@userena.cl) for further information on this next meeting or visit the the web page of the **CSCM: www.scmc.cl** ●

Figure 1:
Participants of the VIII Workshop on Computational Mechanics

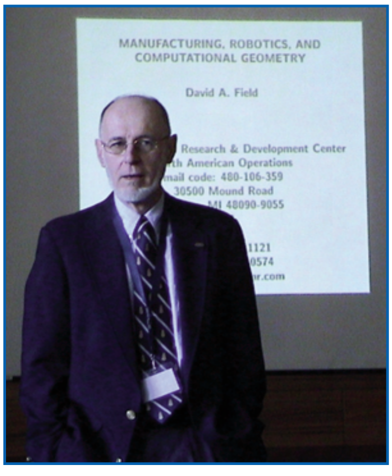

Figure 2:
Dr. David Field during his Plenary Lecture

25 years of the AMCA

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http://amcaonline.org.ar

We are celebrating in 2010 the first 25 years of the Argentine Association of Computational Mechanics (AMCA).

While applied numerical methods were in the way of consolidating as a powerful engineering technique in the 60's, several Argentine engineers begun to study this new promising subject. I remember the names of Carlos Prato, Carlos Felippa, Agustin Ferrante, Carlos Brebbia, among others.

In the seventies, we began to study these methods at the universities and the activity in this subject was growing all over the country. In 1977 Guillermo Marshall organized the First Symposium on Numerical Methods in Continuum Mechanics. The next landmark, I think, happened at the Centro Atómico Bariloche, with a course of Richard Gallagher on the Finite Element Method, in 1983. This was the first national meeting of a long series which continued until now. This First National Meeting of Researchers and Users of the FEM (ENIEF) was followed by the second one in 1984, and so on. The beautiful city of Bariloche hosted the early ENIEFs.

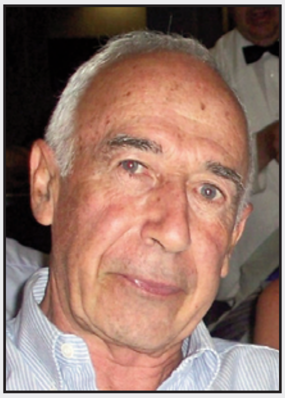
These meetings resulted very attractive for the computational mechanics Argentine community, and it was decided to constitute an Association which was given birth in 1985, during the First Argentine Congress on Computational Mechanics (MECOM). Sergio Idelsohn had a crucial role in promoting the constitution of our Association and was elected as its first president conducting it through many years and contributing greatly to its international insertion.

ENIEF changed to be a Congress on Numerical Methods and its Applications, with a wider scope, and took place annually at different venues in our country. With a periodicity of three years, the MECOM Congress alternates with the ENIEF. MECOM usually has a more extended coverage giving place to a South American Congress in this subject.

Figure 1:
Participants at the first ENIEF in Bariloche, in 1983

Prof. Edgardo Omar Taroco Aliano

16/12/1935 - 17/02/2010



Prof. Edgardo Taroco born on December 16, 1935, in Tacuarembó, Uruguay, passed away on February 17, 2010 making significant contributions in the development of the Theoretical, Applied and Computacional Mechanics. Before getting the Engineering degree, Edgardo had already manifested his interest for a better understanding of the behavior of shell structures and its applications in the civil and naval engineering. This motivation led him to Mexico in order to join Dr. Porfírio Ballesteros (Northwestern University) specialist in the design and construction of this kind of structural components. After being graduated and already in Uruguay he applied his knowledge in naval engineering and, in particular, in civil engineering collaborating with Architect Eladio Dieste in the project and construction of shell structures. Its interest for a deeper understanding of structural mechanics takes him to *COPPE-Coordenação dos Programas de Pós-Graduação em Engenharia, Federal University of Rio de Janeiro*, Brazil, obtaining his PhD in the modeling and computational simulation of elasto-viscoplastic plates and shells. In the 80s Edgardo plays a fundamental role in the foundation and consolidation of the National Laboratory for Scientific Computing *(LNCC-Laboratório Nacional de Computação Científica)* one of the most important research institutions in Brazil. As Full Professor of this institution Edgardo made outstanding contributions to the development of Theoretical, Applied and Computational Mechanics and to the variational formulation of Fracture Mechanics as a Shape Sensitivity problem being one of the protagonists of what was later called "Brazilian School of Shape and Topological Sensitivity Analysis". Edgardo's contribution to these fields was not limited to his

AMCA was one of the first national Associations to integrate the IACM and has an active collaboration with the international and many other national associations of computational mechanics. It has participated in the organization of several international congress, such as the IV WCCM of the IACM in 1998; the CILAMCE (Iberian Latin American Congress of Computational Methods in Engineering) in 1985, 1991, 1998 and 2010; and the Fourth PACAM (Pan American Congress of Applied Mechanics) in 1995.

The AMCA Awards have been stated since 2000 with the aim of recognizing outstanding work of researchers within the Computational Mechanics field.

Beside the already mentioned people, the research groups leaded by Fernando Basombrio, Eduardo Dvorkin, Patricio Laura, Juan C. Ferreri, Gustavo Sanchez Sarmiento, Marta Rosales, Carlos Garcia Garino, Luis Godoy, Gustavo Buscaglia, Pablo Jacovkis, Marcelo Venere, Angel Menendez, Alberto Cardona, Guillermo Etse, Mario Storti, among many others, contributed to the growing activity of Computational Mechanics in our country. We remember, at this point, those pioneers in our association who passed away: Patricio Laura, Pablo Bignon, Agustin Ferrante and Edgardo Taroco.

AMCA has developed a sustained task in promotion of the activity and diffusion of information, beginning with the edition of a regular bulletin in 1985 which was latter replaced by the electronic bulletin NotiAMCA and the AMCA website and calendar. Proceedings from all AMCA congress are available through the electronic journal **www.amcaonline.org.ar/ojs**.

We are very proud of our national association. Beside the active work developed towards the consolidation of Computational Mechanics in our region, we must recognize that all these activities gave place to a very nice group of people sharing common interests, friendship and cooperation.

Can we ask for more? ●

Victorio Sonzogni
President

Figure 2:
Participants at ENIEF 2009 in Tandil.

own original research. He was also involved in a wide range of other research activities which included the collaboration with the activities of scientific associations in Brazil such as ABCM (Brazilian Association of Engineering and Mechanical Sciences), ABMEC (Brazilian Association of Computational Methods in Engineering) and SBMAC (Brazilian Society of Applied Mathematics and Computation) and, particularly, was one of the first members and permanent collaborator of AMCA (Argentinean Association of Computational Mechanics). He also coordinated a large number of research projects, international research cooperation projects with scientific institutions in countries such as Italy, United Kingdom, Argentina, Uruguay and Chile, taught and supervised several MSc and PhD students as well as played an active part in the organization of scientific meetings and international symposia. In this last aspect it is worthwhile to stand out the fundamental role played by Edgardo in the organization of the "Theoretical, Applied Mechanics and Computational Courses". The focus in the first of these courses (1982-1983) was the Theory of Shells and its Applications in Engineering, the second (1984-1985) covered the Foundations of the Finite Element Method. The third in 1986-1987 dealt with Structural Optimization and Sensitivity Analysis. Through these courses more than 600 post graduate students as well as university professors and researchers from Brazil and Latin-American countries had the opportunity to attend advanced lectures delivered by Edgardo and also by internationally renowned researchers specially invited by Edgardo. Among them we can mention Paul Germain, Warner T. Koiter, James Croll, John Spence, Iain Le May, D.R.J. Owen, Giulio Maier, Giampietro Del Piero, Giovani Romano, James Boyle, Alan Ponter, J. B. Martin, Roger Valid, Jean Céa, M. Bernardou, B. Rousselet, Mohamed Masmoudi, Jan Sokolowski. All these Edgardo's activities allowed to all who had the luck to meet him to enjoy and learn from his remarkable sharpness of mind, intelligence, righteousness, generosity and friendship which made him a colleague that will always be reminded with recognition, gratitude and great affection. ●

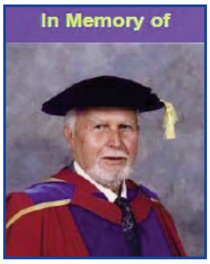
Raul Feijoo
April 2010

1st African Conference on Computational Mechanics (AfriCOMP09)

Sun City, South Africa, January 7 – 11, 2009

The First African Conference on Computational Mechanics was held in Sun City, South Africa between 7th and 11th January 2009. The objective of this new conference series is to provide a forum for researchers and students in computational mechanics on the African continent to interact with members of the computational mechanics community from around the world. In this way the conference series is seen as a key initiative aimed at promoting computational mechanics in Africa.

This IACM supported event was well attended by delegates from all continents. The conference was officially opened by Prof. Daya Reddy, the conference chairman. This was followed by the Zienkiewicz Lecture, delivered by Prof. Thomas Hughes, on the subject 'Isogeometric Analysis'.



Delegates heard at the conference, and some just before, of the passing of Professor O. C. Zienkiewicz on 2 January 2009. The conference was thus the first gathering at which members of the computational mechanics community were able collectively to pay tribute to this giant. Professor Hughes preceded his lecture with a moving tribute in which he captured something of the personality of Professor Zienkiewicz through a number of charming and sometimes amusing anecdotes, in addition to highlighting his many seminal achievements as a leader, researcher and mentor.

The conference technical sessions were organised into plenary lectures and contributed talks delivered in parallel sessions. Plenary lectures were presented by Professors David **Davidson** (South Africa), Charbel **Farhat** (USA), Sergio **Idelsohn** (Argentina), Pierre **Ladeveze** (France), Wing-Kam **Liu** (USA), Ken **Morgan** (UK), Roger **Owen** (UK), Ekkehard **Ramm** (Germany), Daya **Reddy** (South Africa), and Bernardo **Schrefler** (Italy). In addition to the invited lectures, over 125 contributed papers were presented by delegates, many of them students, from all over the world.

The conference co-chairs have initiated an AfriCOMP Award, to be made at each of the Africaomp meetings, and to recognise the achievements of an internationally outstanding computational mechanics researcher from Africa. The Award consists of a diploma and a prize of 1500 Euros. The first AfriCOMP Award went to Professor Daya Reddy, and was made at a truly African-style banquet held at Sun City.

Figure 1:
Professor Daya Reddy with the conference co-chairs after accepting the best African computational mechanics researcher award.

It has been agreed that the series of Africomp meetings will be biennial events. Preparations are underway to organise the second meeting. AfriCOMP11 is to be held at the **University of Cape Town**, South Africa, between **5 and 8 January 2011**. The co-chairs of AfriCOMP11 are Arnaud Malan, Perumal Nithiarasu and Daya Reddy. A First Announcement will be distributed imminently.

The organisers of AfriCOMP11 are planning an exciting meeting, and look forward to welcoming members of the IACM family to Cape Town.

Arnaud Malan, Perumal Nithiarasu (co-chairs, AfriCOMP09)
www.africomp.com

Figure 2:
At the conference banquet

IGA 2011

Isogeometric Analysis Integrating Design and Analysis

A workshop on Isogeometric Analysis will be held at the Institute for Computational Engineering and Sciences at The University of Texas at **Austin**, **January 13-15, 2011**.

The purpose of this workshop is to bring together experts in geometry and analysis interested in developing a new generation of analysis procedures based on modern developments in computational geometry.

Organizers are Yuri Bazilevs and David Benson, U.C. San Diego, and Thomas Hughes, The University of Texas at Austin.

Contact: Ruth Hengst, **info@usacm.org**

V Conference on Textile Composites and Inflatable Structures

Structural Membranes 2011,
Barcelona, Spain,
5 – 7 October 2011

The objectives of **Structural Membranes 2011** are to collect and disseminate state-of-the-art research and technology for design, analysis, construction and maintenance of textile and inflatable structures. The conference will address both the theoretical bases for structural analysis and the numerical algorithms necessary for efficient and robust computer implementation.

In summary, **Structural Membranes 2011** aims to be a forum for discussing recent progress and identifying future research directions in the field of textile composites and inflatable structures.

The deadline for presenting a one page abstract is **13 February 2011.**
Further information is available at **http://congress.cimne.com/membranes2011/frontal/Dates.asp**

AfriComp11

5 to 8 January 2011
Cape Town, South Africa

We are pleased to announce the Second International, African Conference on Computational Mechanics (Africomp).
Africomp is a biennial conference series whose main objective is to provide a forum for researchers and students in computational mechanics on the African continent to interact with members of the computational mechanics community from around the world. In this way the conference series is seen as a key initiative aimed at promoting computational mechanics in Africa.
Technical papers are invited on topics from any area of computational mechanics.

The conference will take place at the University of Cape Town in South Africa.
www.africomp.com

Euromech Fluid Mechanics Conference - 8

September 13-16, 2010

The **8th Euromech Fluid Mechanics Conference** will be held at the Altes Koenigliches Kurhaus, **Bad Reichenhall, Germany.**

Organised jointly by the Institute of Aerodynamics and the Institute for Computational Mechanics of Technische Universitaet Muenchen

EUROMECH - European Mechanics Society - is an international non-governmental non-profit scientific organization.
The 8th Euromech Fluid Mechanics Conference will be held at the Technische Universität München, organised jointly by Institute of Aerodynamics and the Institute for Computational Mechanics, from 13 to 16 September 2010. This conference is the eighth in the series started in Cambridge in 1991. The conference aims at covering the whole field of Fluid Dynamics, comprising from most fundamental aspects to recent applications. It provides a world-wide forum for scientists to meet each other and exchange information of all areas of fluid mechanics.
veranstaltung@tumtech.de

28 Conferences on Computational Mechanics held world wide in 2009

28 Conferences on Computational Mechanics and adjacent fields in computational engineering and sciences took place in the world in 2009.
The list of the conferences can be found in www.iacm.org and www.eccomas.org

ECCOMAS 2009 Awards

The following distinguished scientists have received the Awards of the European Community on Computational Methods in Applied Sciences (ECCOMAS) in 2010:

- *Prandlt Medal in Computational Fluid Mechanics:* **Roger Ohayon**, from Conservatoire National des Arts et Métiers, France

- *Euler Medal*: **B. Schrefler**, from Univ. of Padova, Italy

- *O. C. Zienkiewicz Award* to Young Investigator: **Marino Arroyo**, from Technical Univ. of Catalonia, Spain

- *J. L. Lions Award* to Young Investigator: **Sonia Fernández-Méndez**, from Technical Univ. of Catalonia (UPC), Spain and **José Ramón Fernández García**, from University of Santiago de Compostela, Spain

ECCOMAS Award to the best Ph.D. Thesis in Europe:
- **Rubén Sevilla Cardenas**, from SEMNI, Spain
- **Elie Hachem**, from SMAI/GAMMNI, France

Congratulations to all the awardees.

Emerald Literati Network 2010 Awards for Excellence

The article entitled *"Multi-scale modelling of heterogeneous structures with inelastic constitutive behaviour: Part II - software coupling implementation aspects"* published in Engineering Computations [vol. 26, pp. 6-28, 2009, with co-authors: **R. Niekamp, D. Markovic, H. G. Matthies, R.L. Taylor]** was chosen as a **Highly Commended Award Winner** at the Literati Network Awards for Excellence 2010.

Further information regarding the Awards for Excellence can be found at the following site: www.emeraldinsight.com/literati

E. Oñate received the Ted Belytschko Applied Mechanics Award

E. Oñate received the *Ted Belytschko Applied Mechanics Award* of the American Society for Mechanical Engineering (ASME). The Award was delivered on November 17th, 2009 during the ASME conference held in Lake Buena Vista, Florida, USA.

Bernhard Schrefler was awarded honorary doctorate at the ENS Cachan

Our congratulational goes to **Bernhard Schrefler**, who on the 9th April 2010, was awarded an honorary doctorate at the Ecole Normale Superieure a Cachan.

ENS Cachan is a prestigious public institution of research and higher education. It is one of the French "Grandes Écoles" which are considered to be the pinnacle of French higher education. The ENS Cachan is also a highly active research centre: over 600 researchers including 250 doctorate students work in 12 nationally and internationally recognised research laboratories.

conference diary planner

6 - 9 Sept. 2010 **EngOpt2010 - 2nd International Conference on Engineering Optimization**
Venue: Lisbon, Portugal *Contact*: http://www.engopt.org/

6 - 10 Sept.2010 **XXXIV Jornadas Sudamericanas de Ingeniería Estructural**
Venue: San Juan, Argentina *Contact*: http://www.jornadas2010.unsj.edu.ar/

13 - 16 Sept. 2010 **8th Euromech Fluid Mechanics Conference**
Venue: Bad Reichenhall, Germany *Contact*: *veranstaltung@tumtech.de*

14 - 17 Sept. 2010 **ECT2010 - 7th International Conference on Engineering Computational Technology**
Venue: Valencia, Spain *Contact*: http://www.civil-comp.com/conf/ect2010.htm

19 - 24 Sept. 2010 **ICAS 2010 - International Council for the Aeronautical Science Congress**
Venue: Nice, France *Contact*: http://www.icas.org/

5 - 7 October 2010 **Structural Membranes - V Conference on Textile Composites and Inflatable Structures**
Venue: Barcelona, Spain *Contact*: http://congress.cimne.com/membranes2011/

26 - 28 October 2010 **2nd Aircraft Design Conference**
Venue: London, U.K. *Contact*: http://www.aerosociety.com/conference/

28 - 30 October 2010 **ICMOC 2010 - International Conference on Modeling, Optimization and Computing**
Venue: Durgapur, India *Contact*: icmoc2010secretariat@rediffmail.com

3 - 5 Nov. 2010 **FLUIDOS 2010**
Venue: Sacramento, Uruquay *Contact*: http://fluidos2010.fisica.edu.uy

15 - 18 Nov. 2010 **Bicentennial MECOM - MECOM 2010 IX Argentine Congress on Computational Mechanics and II South American Congress on Computational Mechanics CILAMCE 2010 XXXI Iberoamerican Congress of Computational Methods in Engineering**
Venue: Buenos Aires, Argentina *Contact*: http://www.mecom2010.net

5 - 8 January 2011 **Africomp11 - 2nd Conference on Computational Mechanics**
Venue: Cape Town, South Africa *Contact*: www.africomp.com

13 - 15 January 2011 **IGA 2011 - Isogeometric Analysis Integrating Design and Analysis**
Venue: Austin, U.S.A. *Contact*: info@usacm.org

12 - 15 April 2011 **PARENG 2011 - 2nd Int. Conference on Parallel, Distributed Grid and Cloud Computing for Engineering**
Venue: Corsica, France *Contact*: http://www.civil-comp.com/conf/pareng2011.htm

28 - 30 June 2011 **ICCS/16 - 16th International Conference on Composite Structures**
Venue: Porto, Portugal *Contact*: ferreir@fe.up.pt

25 - 29 July 2011 **USNCCM Congress 11 - US National Congress on Computational Mechanics**
Venue: Minneapolis, Minnesota *Contact*: http://usnccm.org/

7 - 9 Sept. 2011 **COMPLAS XI - XI Int. Confrerence on Computational Plasticity Fundamentals & Applications**
Venue: Barcelona, Spain *Contact*: http://congress.cimne.com/complas2011

5 - 7 October 2011 **V Conference on Textile Composites and Inflatable Structures**
Venue: Barcelona, Spain *Contact*: http://congress.cimne.com/membranes2011

26 - 28 October 2011 **II Conference on Particle Based Methods, Fundamentals & Applications**
Venue: Barcelona, Spain *Contact*: http://congress.cimne.com/particles2011

10th World Congress on Computational Mechanics

8-13 July 2012 • São Paulo • Brazil

Images: Convention Bureau, Paulo M. Pimenta e Stock.xchng

See you in Brazil

www.wccm2012.com