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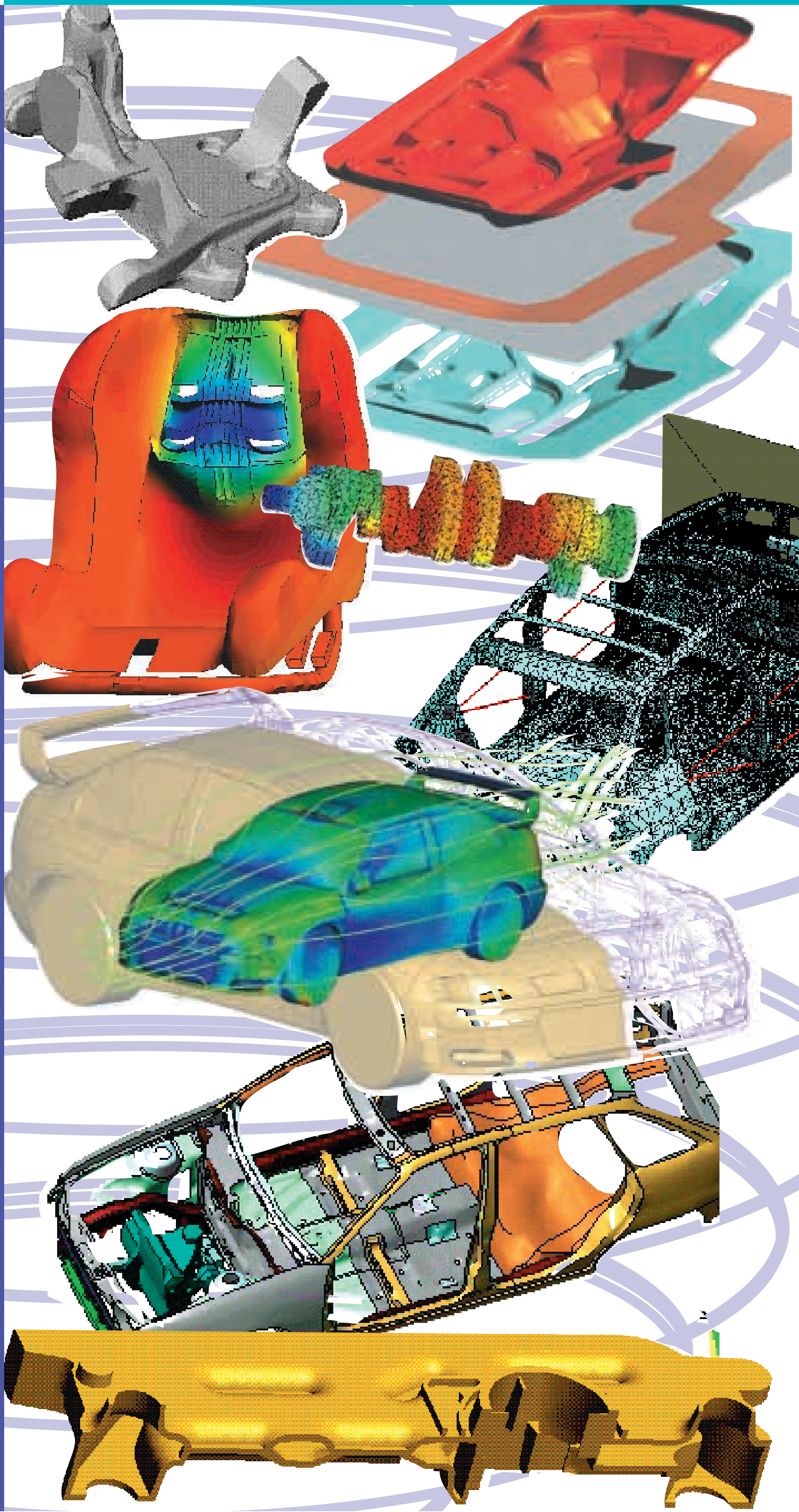

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Front Cover
Page: 12 - 15 - **The Promise of Computational Engineering and Science: Will it be kept?** *J. Tinsley Oden.* Pictures courtest of Quantech and CIMNE

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editorial

It was almost four years ago that I became IACM President and wrote my first editorial for Expressions. The future of Computational Mechanics looked bright at the time and it certainly continues to look bright today. The application and importance of computational methods to problems of engineering and science is increasing in unabated fashion. This is evidenced in many ways. One is the increasing attendance at IACM sponsored national and regional congresses, special interest conferences, and the IACM World Congress of Computational Mechanics. Over 2000 abstracts were submitted to the organizers of this year's World Congress in Vienna, which promises to be the biggest in our history.

It has been my honor and pleasure to serve these last four years. There have been challenges and accomplishments but instead of focusing on these I would like to discuss a few items that are important to all of us as we go forward.

The major meeting of IACM is the World Congress, which has been held every four years. Starting with Beijing in 2004, we will hold a World Congress every two years. We are urging our affiliated national and regional organizations to be cognizant of this schedule when planning their own meetings. A major benefit of this change is that now there will be a greater opportunity for affiliates to host World Congresses in their own geographic regions. With the four-year cycle, it took, on average, twelve years for the World Congress to return to the main geographic regions of Europe, the Americas, and Asia-Australia. With the new schedule it will take only six years. Of course, the main benefit will be for all of us to meet and exchange ideas on a more frequent basis.

The number of affiliates has increased and continues to do so. One of the major hurdles to overcome in attempting to expand membership is the development of new organizations in nations and regions in which none exist. Often, there are highly motivated individuals interested in forming an organization but there is not sufficient experience and know-how to proceed. The Secretariat in Barcelona has been intimately involved in the start-up process a number of times and is now capable of providing a template, incorporating the collective experience of its member organizations, to guide development.

Many affiliates have experienced difficulties supporting their own publications and newsletters. Our policy is to advocate Expressions as an alternative to these efforts. Affiliates such as the United States and German organizations contribute announcements and articles of general interest to these pages. We envision that in the future many member organizations will follow their lead. I believe this service will be a great help to affiliates and has the added benefit of providing international exposure to their activities.

Recurring themes of the efforts of IACM these last four years have been to place IACM at the center of international activities in the field, to develop strong relationships with existing and new affiliates, and to facilitate the growth and success of newly formed organizations. I feel IACM has succeeded admirably in these efforts and I anticipate continued progress.

I look forward to seeing you in July in Vienna and to our continued success!

Tom Hughes
IACM President

Ritz and Galerkin: the road to the Finite Element Method

by
Robert L. Taylor
Civil & Environmental Engineering
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Recently I had an opportunity to consult papers by Ritz and Galerkin concerning approximate methods for solving problems posed as differential equations and, in particular, their role in solving the clamped plate problem. The contributions of these great scientists was quite interesting and here I share a summary of their, and others, contributions on the *Road to the Finite Element Method* —the procedure we commonly use today.

Walter Ritz was born on 22 February 1878 in Sion, Switzerland and died on 7 July 1909 from tuberculosis. He started studies as an engineer at Zurich in 1897 but shortly after moved to the mathematical division where Albert Einstein was also a student at that time. In 1901 he moved to Göttingen where he continued studies in physics, mainly with the physicists Voigt and Riecke.

Figure 1:
Walter Ritz

Figure 2:
Boris Galerkin

"... he considered direct variational solutions to quadratic functionals in which he generalized finite difference concepts using linear approximation over triangles."

In December1902 he defended his thesis on spectroscopic theory, graduating *summa cum laude*. After completing formal studies he went to Leiden where he attended lectures by Lorentz. On the way passed through Hannover where he discussed spectroscopic problems with Runge. In 1903 he was also in Bonn and Paris where he participated in spectroscopic experiments within the infrared region. In 1904 Ritz's health deteriorated and he returned to Switzerland for three years during which he completed no new work. In 1907 he renews intensive work in Tubingen despite poor health. Ritz was invited to Göttingen as a lecturer in spring 1908, however, due to continued poor health he only presented an introductory lecture.

Ritz contributed his first paper on variational methods in response to a Paris Academy of Science prize for the best study on equilibrium of a plate in a rigid frame (what we know today as the *clamped plate problem*). Ritz recognised the problem as one close to those solved in his thesis. His solution was rejected by the committee. It was subsequently published in 1908 [1] and was instantly recognised by engineers as a way to solve many problems. After the paper appeared, Poincaré apologized on behalf of the Paris Academy and informed Ritz he would receive their prize for 1909, it was awarded posthumously. Ritz publishes two more papers on his method.

A shorter version on the clamped plate solution communicated by Runge to *Göttinger Nachrichten* in 1908 and an extensive paper on transverse oscillations of a square plate with free boundaries which was published in *Annalen der Physik* in 1909 [2].

Ritz then devoted the remainder of his life to studies on electrodynamics where, during 1908 and 1909, he battled Einstein on acceptable forms for a viable theory. This resulted in a final paper in which Ritz and Einstein published an ***Agreement to Disagree*** [3]}. On his death day Ritz is quoted as saying: *"Please, take good care of me nurse, —it is vital that I live a few more years for the sake of science."*

Boris Grigorievich Galerkin was born on 4 March 1871 in Polotsk, Belarus and died on 12 June 1945 in Moscow. He studied mathematics and engineering at the Petersburg Technological Institute from 1893 to 1899. After graduation Galerkin worked as an engineer at the Kharkov Locomotive Plant and the Northern Mechanical and Boiler Plant. In 1909 he began teaching at the Petersburg Technological Institute, the year when his first publication on series solution to plate problems appeared. He published the paper which defines the ***Galerkin Method*** in 1915 [4]. This is the only journal paper he ever published on the subject. The remainder of his work is mostly on series solutions applied directly to the differential equation of thin plates expressed in different coordinate systems.

By 1920 Galerkin held two chairs, one in Elasticity at Leningrad Institute of Communications Engineers and one in Structural Mechanics at Leningrad University. From 1940 until his death in 1945 he was head of Institute of Mechanics of the Soviet Academy of Sciences.

The Russian naval architect I.G. Bubnov was born in 1872 and died in 1919. Bubnov is most recognised as an early designer of Russian battleships and submarines in metals, hence his great interest in bending and buckling studies for plates. In 1913 he published a report commenting that the work of Timoshenko on stability of plates and beams (which was based on the variational method of Ritz) could be solved without constructing the energy [5, 6]. Bubnov considered the solution to the differential equation by a direct series approximation multiplied by each function in the series and integrated over area of the plate. He required the approximating functions to be orthogonal (most were trigonometric).

Let us now look in more detail at the contributions of Ritz and Galerkin in their effort to obtain approximate solutions of differential equations.

In his 1908 paper Ritz clearly established the ***direct variational solution method***. In considering solutions to the clamped plate problem Ritz suggests two approaches. For problems in which $w = 0$ at the boundary, one can construct a function $F(x,y) = 0$ at the boundary and multiply it by any series of functions to obtain an approximate solution. For clamped polygonal plates where $w = w_{,n} = 0$ one can use F^2 times a series as the approximation.

"Together (they) provided a solid 'base' for a finite element 'road'. It remained for many others to add 'pavement' on this base and complete a network of roads comprising a 'super-highway' we know today as the finite element method."

Figure 3:
I.G. Bubnov

Figure 4:
R. Courant

As a second approach, Ritz suggested using a series of separable functions each of which is a *normal mode of a beam* with similar boundary conditions to those of the plate.

The numerical solution given by Ritz for a clamped square plate with $0 \le x, y \le a$ used the normal mode approach in terms of trigonometric and hyperbolic functions —a formidable problem to solve by hand! Ritz expressed the solution as:

$$w = \sum_{m=1}^{M} \sum_{n=1}^{N} a_{mn} \, \xi_m(x) \, \eta_n(y)$$

where ξ_m and $\eta_n\,(y)$ are the normal modes of a clamped beam. He obtained solutions for *M, N* = 1, 3, & 5 as:

$$w_1 = 0.001253 \frac{qa^4}{D}, \quad w_3 = 0.001255 \frac{qa^4}{D} \quad \text{and} \quad w_5 = 0.001268 \frac{qa^4}{D}$$

Compare these to $w = 0.0012653 qa^4/D$, a converged finite element solution obtained using shape functions constructed from products of cubic beam functions [7].

In the remainder of the paper Ritz considered convergence properties, the Dirichlet principle; and solution of linear differential equations with variable coefficients.

Let us now turn to the contribution of Galerkin. As noted above the only paper he published on the method which carries his name appeared in 1915. It was translated into English in 1963 [4]. The paper presented a *method* without much rigor and applied it to solve a series of problems for bending and buckling of rods and plates. Galerkin summarizes the steps for his method very similarly to Ritz, the notable difference being the use of the differential equation multiplied by each test function and integrated over the domain instead of a variational problem directly. A main difference to Bubnov's work was the removal of the restriction on orthogonality of functions. Galerkin also used polynomials to solve the clamped plate problem resulting in simpler expressions to solve by hand.

Table 1:
Centre Displacement for Clamped Plate

	$w(0,0) \times \frac{D}{qa^4}$			
	Ritz	Galerkin	Bubnov	FEM
1	0.001268	0.001263	0.001263	0.0012653
1.5	-	0.002188	0.002197	0.0021965
2	-	0.002503	0.002530	0.0025330

His solution to the clamped rectangular plate problem used the assumed displacement (origin at centre of plate):

$$w = \sum_{k=2}^{\infty} \sum_{n=2}^{\infty} A_{kn} (a^2 - 4x^2)^k (b^2 - 4y^2)^n \quad k, n \ge 2$$

where a and b are the side lengths of the plate. Here one can recognize this as a form which Ritz suggests for $F^2 = 0$ [i.e., $F = (a^2 - 4x^2)(b^2 - 4y^2)$] is zero at the boundaries. Galerkin presented numerical solutions for $k, n = 2, 3$. A comparison of the transverse displacement at the centre of the plate for the various authors is given in Table 1 and compared to the converged finite element solution.

Galerkin also computed bending moments and shears in the plate from his approximate solution. An example is the M_y moment along the x-axis (i.e., $y = 0$) in which a comparison with the finite element solution is given in table 2 and plotted for the square plate in *Fig. 5*.

Perhaps it is worth noting one last contribution. In 1941, R. Courant (1888-1972) addressed a meeting of the American Mathematical Society [8]. In one part of this contribution he considered direct variational solutions to quadratic functionals in which he generalized finite difference concepts using linear approximation over triangles. He noted: "Such an interpretation suggests a *wide generalization* which provides great flexibility and seems to have considerable practical value." He goes on to add: "we may consider from the outset any polyhedral surfaces with edges over an *arbitrarily chosen* (preferably triangular) *net*. ... we gain the enormous advantage of better adaptability to the data of the problem and thus we can often obtain good results with very little numerical calculation."

	M_y in pa^2; $\nu = 0.25$				
b/a	$x = 0$	$x = a/8$	$x = a/4$	$x = 3a/8$	$x = a/2$
1	0.0220	0.0198	0.0102	-0.0104	-0.0510
FEM	0.0220	0.0195	0.0104	-0.0103	-0.0513
1.5	0.0302	0.0304	0.0110	-0.0224	-0.0750
FEM	0.0303	0.0320	0.0116	-0.0224	-0.0756
2	0.0390	0.0329	0.0110	-0.0267	-0.0831
FEM	0.0400	0.0336	0.0112	-0.0273	-0.0828

Table 2:
M_y along $y = 0$ axis

Courant stated an intention to apply his method with triangles to plate problems but never did.

"That Ritz was a great scientist, is indisputable."

That Ritz was a great scientist is indisputable. What is truly remarkable is that he published so much during his short lifetime. His work on plates is characterized by high scholarship and detailed studies. This is in contrast to the paper by Galerkin, which is merely an exposition of an approach that is applied to a series of problems — indeed for the clamped plate only extending slightly the earlier contribution of Bubnov. Together Ritz, Galerkin, Bubnov and Courant provided a solid "base" for a finite element method "road". It remained for many others to add "pavement" on this base and complete a network of roads comprising a "super-highway" we know today as the *finite element method*. ●

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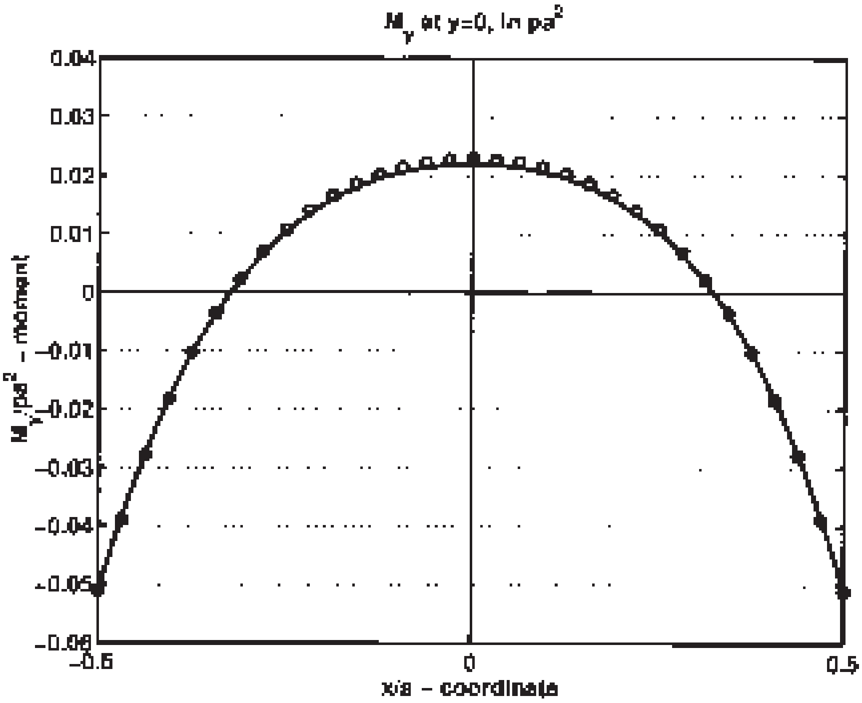

Figure 5:
Bending movement along $y = 0$ axiz

Computational Mechanics 50 Years

by
Alf Samuelsson
Chalmers University
Göteburg

Pioneering papers from 1950, 1951, and 1952

After the end of the Second World War fast computers started to become available to structural engineers. This happened at the same time as airplane structures became more sophisticated requiring high accuracy in the calculation of stresses and vibration frequences. Around 1950 swept-back wings and somewhat later delta wings were designed. They could not with sufficient accuracy be analysed with beam theory, (see Ray Clough's address to the ECCM'99 conference). The wing consisting of upper and lower skins, spars and, webs and ribs had to be studied in detail as a collection of connected structural elements.

The question now was how to use the computer in the best way. Four pioneering papers were published 50 years ago:

Falkenheiner, H. Calcul systématique des charactéristiques élastiques des systémes hyperstatiques. *Rech. Aero.* no 17, p. 17, 1950

Falkenheiner, H. La systématisation du calcul hyperstatiques d'aprés l'hypothèse du "schéma du champ homogène." *Rech. Aero.* no 2, p. 61, 1951.

Lang, A.L., and Bisplinghoff, R.L., "Some results of swept-back wing structural studies." *J. Aero. Sci.* 18, 11, p. 705, 1951.

Langefors, B. Analysis of elastic structures by matrix transformation with special regard to semimonocoque structures, J. Aero. Sci. 19, 7, p. 451, 1952.

Falkenheiner was "Ingenieur de Recherches" at l'O.N.E.R.A. in France, Lang was engineer and Bisplinghoff Associate Professor of Aeronautical Engineering at MIT, Langefors was engineer at SAAB Aircraft Corporation in Sweden.

The two French papers and the American and Swedish papers seem to be quite independent as no references are made between them. In all four papers matrices are used in a systematic way for establishing equations in redundant forces, for solving the set of equations and for calculation of deformations and stresses in the parts of the structure.

Elastic analysis of the structure of a typical airplane wing is the target for all three authors. Lang and Bisplinghoff have built a test structure of a swept-back wing and analysed it while the other two authors have demonstrated their methods on rectangular rib-stiffened sheets. All three authors use the same idealization, following an idea from 1937 by

Ebner, H., and Köller, H., Zur Berechnung des Kraftverlaufes in versteifter Zylinderschalen. *Luftfahrtforschung* 14, 12, p 607, 1937.

They assume that the ribs take the normal forces and the sheets (skins) between the ribs take the uniform shear forces. The cross-section of the ribs are extended by parts of the sheet. This means that the Poisson effect in

Figure 1:
The LGP30 was built by Litten General Precision in the mid 1950´s. It was implemented with vacume tubes and drum memory. The instructions had 3 addresses, one for the operands and one for the next instruction.

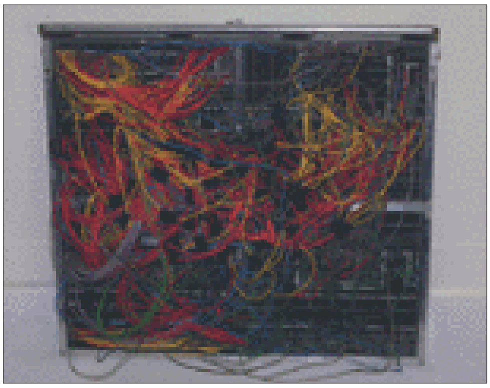

Figure 2:
IBM 073 wiring board.

the sheets is disregarded as well as the bending and torsion of the ribs. The deformation condition between bars and sheets is also violated. For structures with thin skin these assumptions are justified and Ebner and Köller states that this is verified by experiment. Even for complicated structures the statical indeterminacy stays conveniently low so that the set of equations could be solved in reasonable time with the available computers. (Ebner and Köller had no modern computer.)

The papers by Falkenheiner and Langefors are very similar. Both use the principle of deformation minimum according to Menabrea-Castigliano to deduce the matrix of influence coefficient expressing point displacements as functions of point loads. They also both describe a substructure technique.

Langefors uses forces in hypothetical cuts as redundants while Falkenheimer uses superposition coefficients of equilibrium systems as redundants. The method of Falkenheiner is then more general than that by Langefors.

Langefors follows in his paper a method due to the electrical engineer Gabriel Kron originally designed for electrical networks and extended to elastic structures in:

Kron G., "Tensorial Analysis and Equivalent Circuits of Elastic Structures," *J. of the Franklin Institute*, V238, no. 6, 1944,

Kron's method is a displacement method for 3D-elastic frames. Starting with the stiffness matrices for the beams these are collected along the diagonal of a large matrix. This large matrix is then transformed by use of connection matrices to a final matrix in joint displacements. Langefors applies the same idea to the force method. He also proves that the resulting equations he obtains is in accordance with the principle of minimum energy.

We see that Kron's method is exactly what we use today for finite element calculation.

Falkenheiner discusses and compares his and Langefors approach in a paper:

Falkenheiner, H. "Systematic Analysis of Redundant Elastic Structures by Means of Matrix Calculus". *J.Aero. Sci.* 20, 4, p. 293, 1953.

He shows that the methods give the same equations.

Lang and Bisplinghoff compare their test results with calculations. They follow a method given in:

Levy, S., "Computation of Influence coefficients for Aircraft Structures with Discontinuities", *J. Aero. Sci.*, vol 14, no 10, p. 547, 1947.

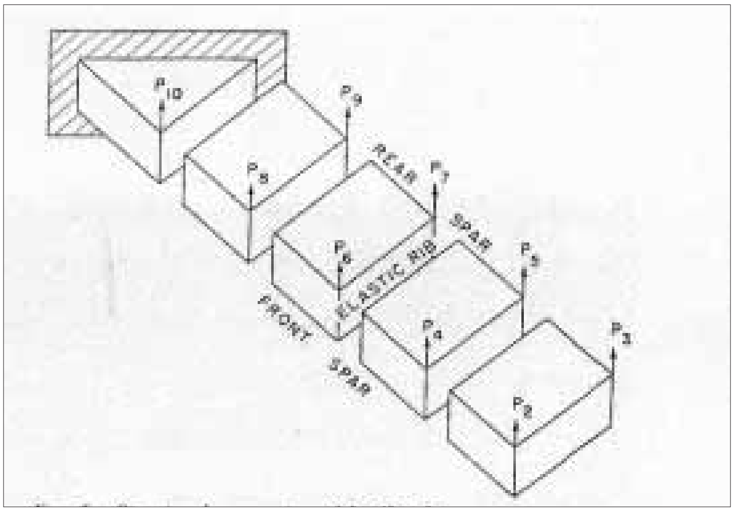

Figure 3:
Structure segments and loading for analysis of swept-back wing by the Levy method

Levy splits the structure into parts that are in local equilibrium (Figure 3 — from the paper by Lang and Bisplinghoff). He then chooses redundancies and gets them from minimum of deformation energy. Lang and Bisplinghoff systematize Levy's method by use of matrices.

They find that the agreement between experiment and theory is somewhat better in deflections than in stresses.

The papers described here are pioneering works that were soon followed in 1954 and 1955 by a series of papers in Aircraft Engineering by **John Argyris** on "Energy Theorems and Structural Analysis" and in 1956 in *J. of Aeronautical Sciences* by the famous paper by **M.J. Turner, R.W. Clough, H. C. Martin, and L. J. Topp** on "Stiffness and Deflection Analysis of Complex Structures".

The era of Computational Mechanics had started. ●

"We see that Kron´s method is exactly what we use today for FE calculations."

Figure 4:
Aeroplane from the 50´s

Fraeijs de Veubeke:

Neglected Discoverer of the "Hu-Washizu Functional"

by
Carlos A. Felippa
Department of Aerospace Engineering Sciences and Centre for Aerospace Structures University of Colorado at Boulder

"... (he) never displayed greed for priority and recognition."

This note was motivated by a "Classical Reprint Series" appearance of Fraeijs de Veubeke's Displacement and Equilibrium Models chapter in the International *Journal for Numerical Methods in Engineering* [4]. In the reprint preface Olek Zienkiewicz reminds readers of several neglected aspects of de Veubeke's seminal contributions to finite element methods. This note calls attention to an ignored fundamental contribution to variational mechanics [3]. For technical details, including a step by step review of de Veubeke's derivations, interested readers are referred to a recent technical note in the *Journal of Applied Mechanics* [2].

The Canonical Functional

The three-field canonical functional of linear elastostatics, herein abbreviated to C3FLE, is identified as the "Hu-Washizu functional" in the mechanics literature. In this functional the three interior fields: displacements, stresses and strains, are independently varied. This attribution is supported by two independent publications, which, by strange coincidence, appeared simultaneouly on March 1955 [10,14]. A four-field generalization, in which surface tractions are independently varied, will be called C4FLE.

The reprinted chapter [4] is still cited as one of the early classics in the finite element literature. That article contains the first enunciation of the limitation principle, which has since served as guide in the construction of mixed models. De Veubeke's exposition of variational methods starts from the C4FLE functional, which he calls "the general variational principle." However, it does not reference Hu and Washizu as its source but an earlier technical report, written in French [3]. This appears as the 3rd reference in that chapter.

A subsequent journal paper [5] on variational principles and the patch test is slightly more explicit. It begins: "There is a functional that generates all the equations of linear elasticity theory in the form of variational derivatives and natural boundary conditions. Its original construction [here he refers to the 1951 report] followed the method proposed by Friedrichs..."

These references motivated me to investigate whether de Veubeke had indeed constructed that functional in the 1951 report. That would confer him priority over Hu and Washizu, although of course these two contributions were more influential in subsequent work. I was able to procure an archived copy of [3] thanks to Professors Beckers and Geradin of the University of Liege, where de Veubeke was a Professor of Aeronautical Engineering from the early 1950s until his untimely death on September 1976.

Priority Established

The technical note [2] shows that in the 1951 report de Veubeke constructs not simply the canonical three-field principle, but the four-field generalization C4FLE. This is done through the "dislocation potential" transformation method of Friedrichs [1, ch. IV]. Consequently his priority is firmly established. The functional, however, appears as an intermediate result on the road from the Total Potential Energy (TPE) to the Total Complementary Energy (TCE) principle. The path also traverses a pair of two-field functionals, one being a generalization of the Hellinger-Reissner (HR) functional published the previous year by Reissner [12]. The full sequence presented in Part I of the 1951 report is in fact:

TPE -> C4FLE -> Strain-displacement dual of HR -> HR -> TCE
The report does not call special attention to C4FLE, as well as to the strain-displacement functional that appears there for the first time. This two-field functional has escaped a name; it was later rediscovered by Oden and Reddy [11].

The bulk of [3] is actually devoted to the study of energy-based approximation methods for the analysis of monocoque wing structures, rather than to the derivation of new functionals. Its title (in English: propagation of redundants in wings with coupled longerons), technology focus and target audience (structural engineers) are likely responsible for subsequent neglect. This is reinforced by its limited dissemination and the fact that the material was apparently not submitted to an archival journal.

Variations on a Name

I posed some questions in [2] as curiosities for future science historians. For example, why are the titles of Hu and Washizu's papers almost identical? Furthermore, both de Veubeke and Washizu were visitors at MIT in 1952 and 1955, respectively, while Eric Reissner was a Professor of Mathematics there; was there a MIT connection? But these tidbits are besides the point. The priority claim is solid unless a pre-1951 publication miraculously turns up.

De Veubeke does not reference Hu or Washizu in any of the papers reprinted in the Memorial volume [8]. He does acknowledge Friedrichs, Courant and Hilbert, Prager, Reissner and Pian. On the other hand, he does not explicitly claim priority for the results discussed here. Perhaps he felt that the derivation of new functionals was not the focus of the 1951 report. And indeed it was not. The tour of five variational principles takes 8 pages out of 56. In contrast, the titles of the contributions of Hu and Washizu expressly state that to be the main objective.

Renaming a functional does have a historical precedent. The name of Hellinger was prepended to the stress-displacement functional of Reissner [12] after Hellinger's 1914 contribution was brought to attention. Gurtin [9] calls it the Hellinger-Prange-Reissner functional but this longer label has not resonated. There is justification for keeping Reissner's name in this case since he gave it as a proved theorem.

Figure 1:
Fraeijs de Veubeke

Major Contributions

This discussion, plus that of Zienkiewicz in the chapter reprint [4] should make clear that Fraeijs de Veubeke's work in applied and computational mechanics has not been well appreciated. To further that point I have compiled below what I perceive as major contributions, listed in no particular order. (Note: reference is made to the Memorial volume [8] for publications not otherwise easily accessible; unfortunately [3] was left out, perhaps because of its overall length and language translation effort.)

- Two of the six canonical functionals of elastostatics, including the most general 4-field form [3]
- A novel complementary energy formulation of finite elasticity [7]
- The dual principles of elastodynamics [8, p. 295]
- The limitation principle for mixed functionals [4]
- Two-sided error bounds for FEM discretizations [8, p. 53]
- Stress function models [8, p. 663]
- The concept of what is now called the corotational frame for geometrically nonlinear analysis [6]
- The general substructuring interface conditions [8, p. 511], which now form the basis for primal and dual domain-decomposition methods.
- Equilibrium and diffusive (flux-preserving, see explanation below) models [8, p. 569]
- The 6-node quadratic triangle [4], a breakthrough that opened the doors to higher order conforming elements. Midside nodes, a truly novel idea in 1963, were likely suggested by his early research in flux-preserving models.

Clarification on the next-to-last item for younger readers: "diffusive models" are not "diffuse elements". It is de Veubeke's term for mechanical elements that satisfy equilibrium weakly. This is done by enforcing only integrated flux conservation across interelement boundaries, with the objective of arriving at stiffness-like equations for use in standard FEM codes. Higher order versions of these models are plagued by spurious mechanisms, and much effort was devoted to ingenious ways to circumvent that flaw. Simple forms of these models have been recently rediscovered under the label "Discontinuous Galerkin Methods."

"A patient, dispassionate style in his publications. Readers must search carefully for the gems; he does not highlight or hype discoveries."

Conclusion

The set of contributions is indeed impressive in breadth and depth. At this point we can relate to Truesdell's epitaph on F. Reech [13, p. 300]: "it is hard to account for the oblivion in which the tradition has buried him." Oblivion is too strong a word for de Veubeke, as long as colleagues and disciples are still around. But his contributions are rarely mentioned in newer textbooks, which is a worrisome trend. Paraphrasing Truesdell's "why so?" I offer five conjectures:

1. His personality. An aristocrat by birth and gentleman by nature, de Veubeke never displayed greed for priority and recognition. A revealing example is the low-key referencing to his derivation of C4FLE.
2. A patient, dispassionate (even flat) style in his publications. Readers must search carefully for the gems; he does not highlight or hype discoveries.
3. Distaste for "impressive examples", e.g. air planes, bridges, dams..., that catch an engineer's roving eye. In the Memorial volume [8] I could find only a handful of application examples, none of which stands out.
4. Disinterest in developing early-bird, open-source FEM software as "technology transfer toolkit" that doctoral students could take along with their diplomas. (This was, by the way, a very effective scheme used at UC Berkeley in the 1960s to propagate FEM into the civil engineering community.)
5. His untimely death before being able to organize and tie together his wide research interests into textbooks.

I am inclined to pick the first two as primary reasons for the current neglect. ●

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- FEM class of 42 -

A group of distinguished colleagues and friends in the field of finite element methods (FEM) and computational mechanics become 60 years old during 2002. The group named "FEM Class of 42 Fellows" includes Profs. H. Mang, R. Ohayon, R. Owen, K.C. Park, J. Periaux and B. Schrefler.

An informal collective celebration (on top of any other initiatives taken by other groups and institutions elsewhere) was held in the city of Ibiza (Spain) on 30 and 31 May 2002. The celebration gave the chance to meet many common friends who share close personal and professional ties with the names listed above.

The FEM Class of 42 group would also have included Prof. Mike Crisfield who tragically passed away on 19th February 2002. The meeting, therefore, celebrated Mike's life and provided colleagues and friends with the opportunity to pay tribute to the many scientific contributions he made during his career in finite element research.

The Ibiza meeting had the format of a workshop with technical sessions dedicated to each of the FEM Class of 42 Fellows. Each session included 2/3 presentations by distinguished scientists including T. Belytschko, P. Ladeveze, O. Pironneau, E. Ramm, E. Stein, R.L. Taylor, O.C. Zienkiewicz and others.

Technical sessions were complemented by an attractive social programme with a number of activities in the beautiful Mediterranean island of Ibiza.

FEM Class of 42

Participants at the meeting also contributed to the celebration via a Web Page where personal greetings were sent to each of the FEM Class of 42 Fellows. A public section of the web page includes scientific papers dedicated to each of the FEM Class of 42 Fellows. For details visit www.femclass42.com or contact Profs. G. Peric (D.Peric@swansea.ac.uk) or E. Oñate (onate@cimne.upc.es). ●

An Interview with

Bijan Boroomand

Civil Engineering Department
Isfahan University of Technology
Isfahan
Iran

Dr. Boroomand received his Ph.D. from the University College of Swansea, Wales.

This interview was recorded in September 2001 during a visit to the IACM Secretariat in CIMNE, Barcelona.

You say that Iran is relatively new to the idea of doing its own engineering research and simulations. What do you think, prompted this change?
I suppose this goes back to when industries decided to change their production routines. You may know that over the past 30 or 40 years most of our industries were imported. We not only imported the technology, but also the knowledge and sometimes the experts. Such industries are just able to duplicate the products and of course have little flexibility for adjusting themselves to local demands. New products necessitate facing new problems to be solved by internal experts who, some of them, are able to use computers for numerical simulations.

This differs a lot from Europe and the USA doesn't it?
Yes, in these countries the computer boom started from about 15 years ago. In Iran, with some delay, this began about five years ago. By the way, the mentality of using the computer is also quite different. In the developed countries the need for computer simulation is felt by industries themselves, while in the developing countries is usually on the other way round.

What helped bring about this change in thinking?
I suppose, the first step was to provide support for students to get trained in foreign countries. This started about ten years ago. Although sending students for graduate studies is not new, but in terms of number, the past decade is comparable with the other periods. Besides, those who have been sent during this period were influenced by the computer boom, and on return tried to inspire such a change in thinking.

The second step, taken by government, was to offer a series of funds for interdisciplinary projects between universities and industries. The major step, taken by industries, was to trust in internal experts and to offer complementary grants.

But with these grants and ideas, I'm sure arise new problems?
Of course I am not saying that all the problems currently being solved are state of the art engineering ones. In fact, there has been a continuous challenge for experts to prove the potential of numerical simulations. Most industries show resistance to the thought of using computers for predicting any changes. But little by little, it has emerged that they are using this technique, for instance car industries, and are successful. Most of the funds provided by industries are spent on simulation of not very new problems, but these help to prove the capabilities

How are the universities coping with these changes?
I believe there is some movement. Those who have come back from abroad are making some nucleuses to conduct researches. But these individual activities, I believe, have no general direction and appropriate structure.

You are one of the new breed of experts in your university and country. How do you see the future for your students?
Their future is highly dependent on information exchange and the links with some well-known centres in this field. Arranging international conferences or even exchanging lecturers and students, will be definitely helpful.

Do you find it easy to recruit suitable applicants to study engineering?
Our country is under construction, so engineering is still one of the attractive fields for students. This makes it easy to find good student with great potential. You may know that for entering universities in our country, there is an entrance exam that filters the students. The same mechanism exists for entering graduate courses. So generally, the best are studying in graduate and higher programs.

Would you say that students generally arrive well prepared for universities from school?
Yes –there are two major fields in high schools: experimental based and mathematical based. Of course there are some minor fields too. The experimental base graduates usually continue towards medicine fields. The mathematical based ones usually tend to enter engineering fields. ●

The Promise of Computational Engineering and Science: Will it be kept?

by
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The Promise

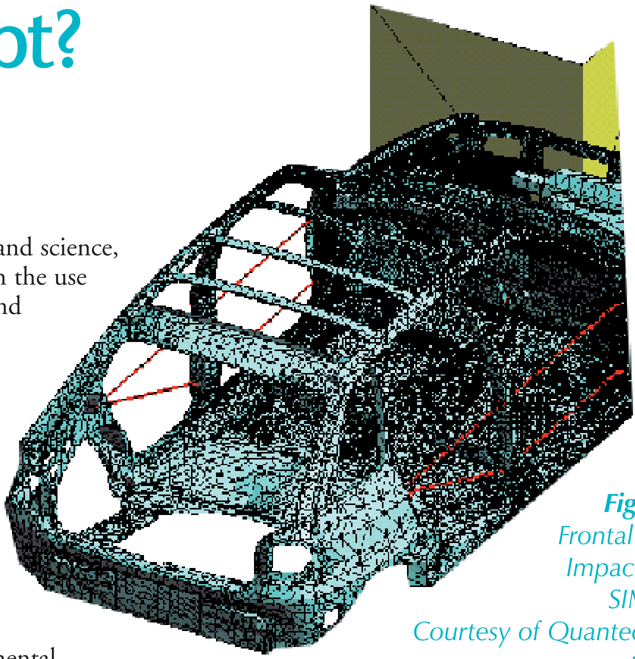


Figure 1:
Frontal Offset Impact using SIMPACT
Courtesy of Quantech ATZ
www.quantech.es

Computational engineering and science, the discipline concerned with the use of computational methods and devices to simulate physical events and engineering systems, is being heralded as one of the most important developments in recorded history. Computation is now viewed as a new pillar of science, standing beside the classical pillars of theory and observation, as a fundamental underpinning of scientific inquiry and a new component of the scientific method. It has created a revolution in engineering, dramatically expanding the scope and fidelity of engineering analysis and design. It has enabled the study and prediction of a myriad of events, including the behaviour of aircraft, ships, automobiles, trains, and space vehicles; of electrical circuits, computer chips, waveguides, and antennas; of machine parts, piping systems oil reservoirs, submicron devices, semi-conductors; of galaxies, supernova, black holes; of bio and biomedical systems, blood flow, of cellular structures; of ocean currents, geological events, the atmosphere and weather, every conceivable product in modern technology and every natural phenomena in the physical universe. It will thus impact virtually every aspect of human life, our health, communication, security, transportation, and quality of life and it will open vistas not available before to the human species. This is the great promise of computational engineering and science.

Keeping the Promise

Will this promise be kept?

An immediate answer is that the fulfillment of the great promise has the potential of being met at various levels: at the lowest, computational science will provide very qualitative information on certain events, useful, but not to be completely trusted as an alternative to more traditional approaches, testing and physical experiments.

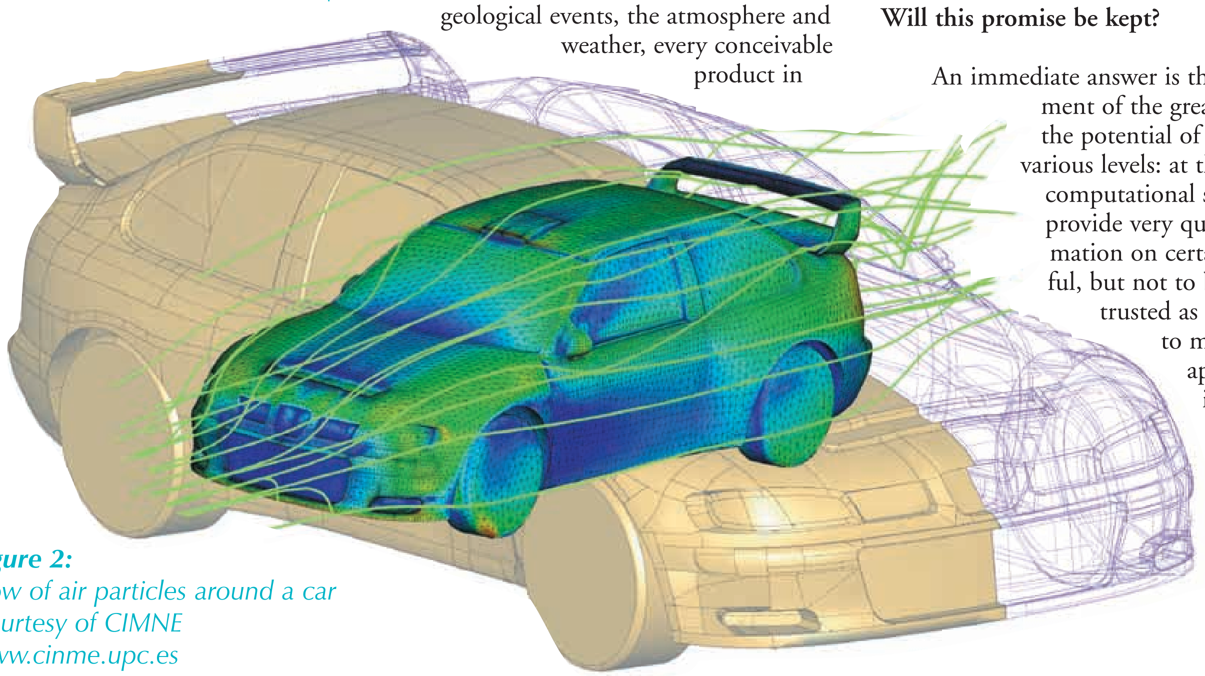


Figure 2:
Flow of air particles around a car
Courtesy of CIMNE
www.cinme.upc.es

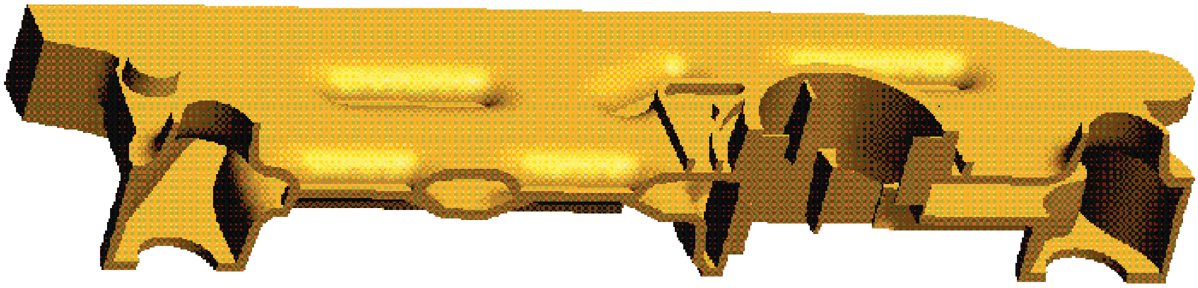


Figure 3:
Casting of Boiler Part
Courtesy of Quantech ATZ

At the highest level, it will displace countless laboratory tests and will be a major factor in making decisions that affect human life and well-being, in making possible great advancements in technology, and in furthering our understanding of the physical universe.

Which level is achieved depends upon two factors: first and most important is reliability, the measure of confidence that can be assigned to computer simulations –their accuracy and the perseverance of quality of predictions of behaviour under numerous parameter changes. Second, the level achieved will obviously dependent upon the continued development and advance ment of the subject itself and its tools of implementation. This embodies the perpetual enrichment and expansion of the mathematical theories and methods of science and engineering, on the mathematics of approximation and numerical analysis, on algorithms, data structures, architecture, on enabling computer science technologies, and, fundamentally, upon the continued development of computers and computational devices capable of treating problems of increasing size and complexity. Yet, the great promise will not be fulfilled by simply developing larger and faster computers –these are of limited value if the simulations themselves are unreliable.

Dissecting Reliability

What does reliability of computational results mean and what factors affect it? A fact that must be understood is that all computer simulations are imperfect and are, in a sense, wrong. They must be based on imperfect characteristics of nature and they contain inherent error due to the necessary rendering of these characterizations to discrete forms manageable by digital computers. Thus, reliability has to do with how much these inherent errors can be quantified and controlled. Reliability, in a real sense, should be quantifiable; it may be measured in terms of the probability that a predicted event will be actually observed in the real world. Reliability may thus be understood in the following way: given data defining a model of an event of interest, this data itself being available only in some statistical form, determine the probability or level of uncertainty of the computed outcome, its variances and confidence bounds. These provide a measure of reliability. If all data is assumed to be deterministic, then reliability reduces to a measure of the accuracy of the computed prediction; that is, the difference between the computed outcome and what is perceived to be reality based on observations, including experiments, of the natural events, the error being measured in some appropriate manner.
The reliability of a computer prediction depends upon three basic factors:
1) the particular goal or goals of the simulation,
2) the mathematical model used to depict the phenomena of interest, and
3) the accuracy with which the model is solved.

Mathematical models are the abstractions of reality characterized by mathematical formulas and operations designed to communicate and represent theories of natural events and engineering systems. Centuries of research have provided a plethora of such models, many with remarkable richness and predictive value that depict certain phenomena with amazing accuracy. They provide the language of science; they provide the vehicle with which precision is given to theory and

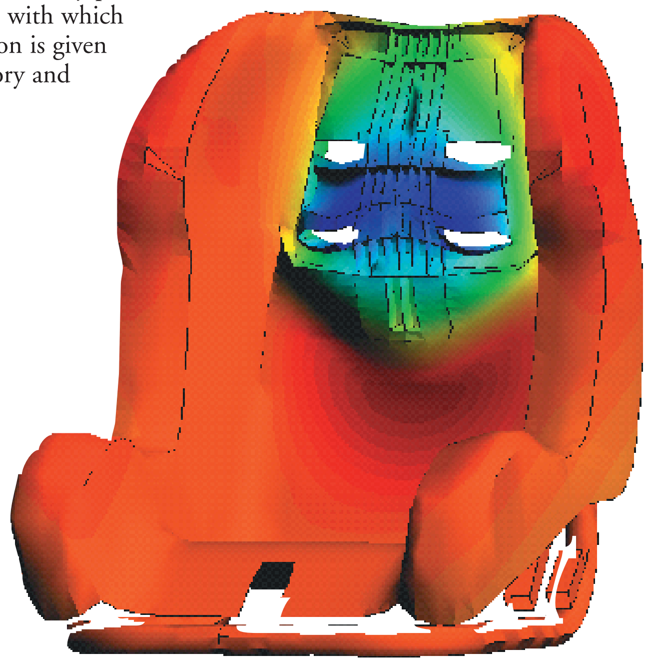
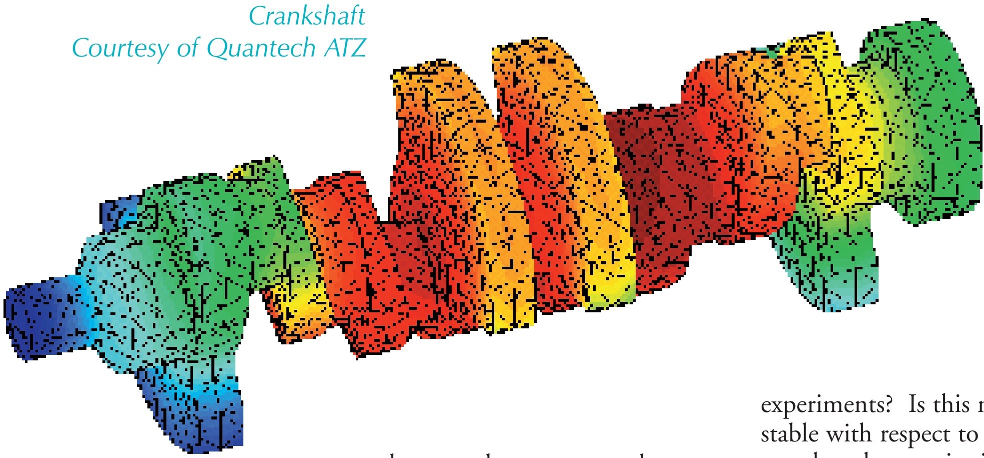


Figure 4:
Baby Car Chair
Courtesy of Quantech ATZ

Figure 5:
Crankshaft
Courtesy of Quantech ATZ



to the mental processes used to establish and perpetuate what is known in science and engineering.

Different mathematical models may be used to characterize different events, and the selection of a model is unquestionably the most important and primitive step in the entire process of computer simulation. The selection is traditionally the responsibility of the analyst and is based on experience, judgment, empirical evidence, trial and error.

The process of determining whether a selected model is appropriate for a particular computational goal is called validation. It is, in general, a physical process, often requiring careful laboratory experiments, testing of components of the theory, observations of natural events, imaging, and other observational modalities. Validation may also have a mathematical side: is the model mathematically well posed? Does it involve parameters that admit to experimental determination?

Are these determined values ducible in a series of experiments? Is this model, in other words, stable with respect to changes in the parameters that characterize it?

Also, validation is fundamentally a statistical process. The underlying parameters defining a model can only be determined within certain bounds and are thus dependent on random variables. It is in this sense that the ultimate predictions of the model are themselves random events and can only be interpreted within some probabilistic sense. Validation stands as a process crucial to the success of computer simulation. Advances in validation will be necessary if the great promise of computational engineering and science is to be fulfilled.

Once a goal of computations has been identified and a mathematical model is selected and validated to the satisfaction of the analyst, the reliability of the computation is still far from assured.

Next comes the third component of reliability: the degree with which the model selected is solved correctly. This step is called verification. Verification is essentially a mathematical subject embracing approximation theories, numerical analysis, and, to many practitioners, software engineering, the technology dealing with the production of reliable software.

However, verification is not totally concerned with the computational model –the discretized or digitalized version of the basic mathematical

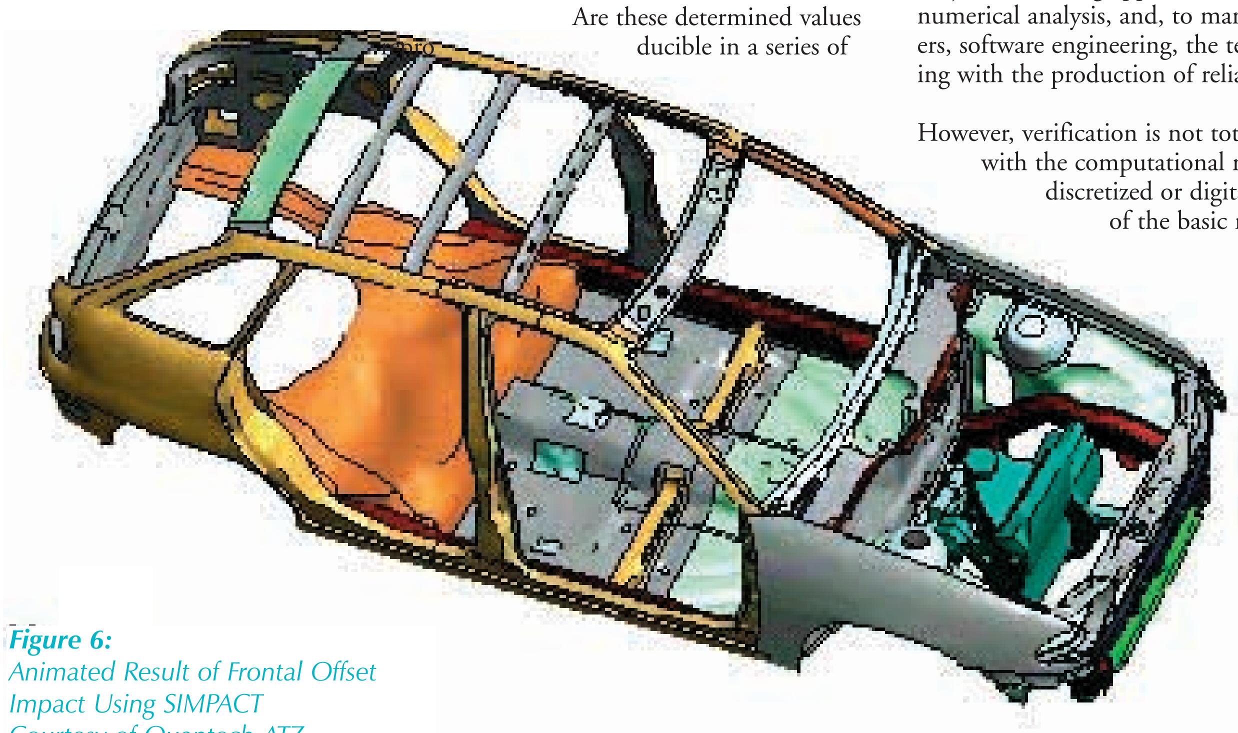


Figure 6:
Animated Result of Frontal Offset Impact Using SIMPACT
Courtesy of Quantech ATZ

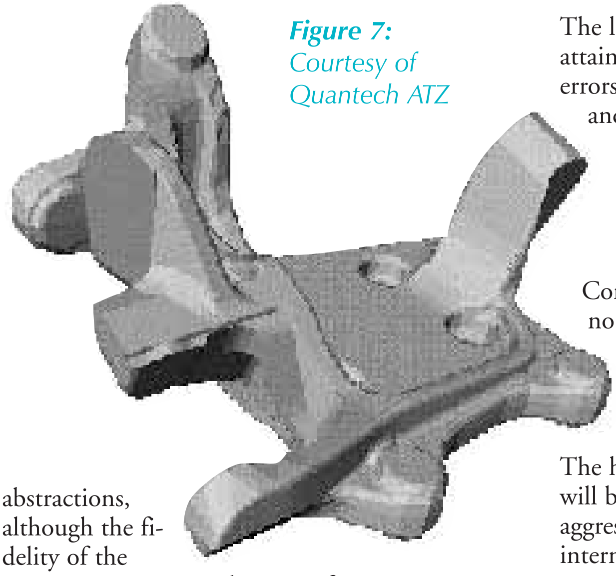


Figure 7:
Courtesy of Quantech ATZ

abstractions, although the fidelity of the computation is viewed as a verification concern by some analysts. It is, as defined above, a discipline aimed at determining if the mathematical model has been reliably solved. It too must necessarily deal with error, as the computer is incapable of delivering results which exactly agree with the solution provided by the model. But even if the computational model is solved with infinite precision, the results may be unrelated to those predictable by the mathematical model.

The goal of verification is to quantify, control, and, when possible, minimize the approximation error, that is, the difference between the possible predictions of the model and the computed predictions.

Thus, the great promise of computational engineering and science depends upon the reliability of computer simulation which in turn depends upon the assessment and control of errors inevitable in the computational process –modeling errors due to the impossibility of capturing all of nature with mathematical abstraction and approximation error due to the impossibility of solving exactly the mathematical models of science and engineering.

The level which the subject can ultimately attain depends upon how well these intrinsic errors can be measured, estimated, controlled, and minimized.

Computation as a Pillar of Science

Computational engineering and science is no more independent of theory and experiment than is a successful scientific theory independent of observation.

The highest levels of achievement and value will be attained only through an ambitious, aggressive program of research that intermingles all components of computer simulations that affect reliability. This suggests that testing, observations, and computation must be ultimately integrated into some unified effort that can dynamically assess error, and make changes in the modeling and the computation to control it. Already, primitive versions of such systems exist in weather prediction and in other areas. These issues represent challenging but very worthwhile goals for science and engineering. Any progress toward meeting them will move us closer to fulfilling the great promise at the highest level. ●

Figure 8:
Virtual Press for Sheet Stamping
Courtesy of Quantech ATZ

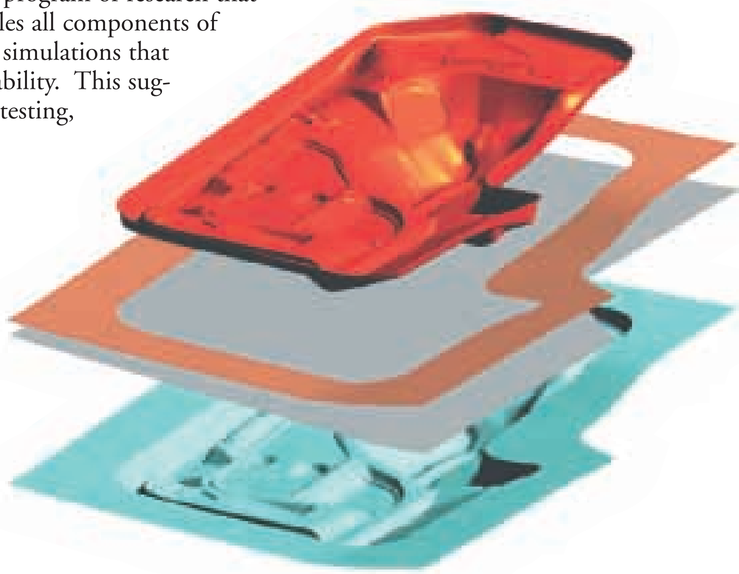


Figure 9:
Contours of wave elevation around a ship
Courtesy of CIMNE

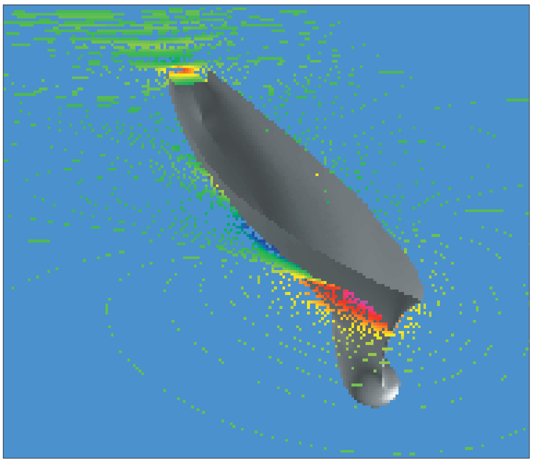
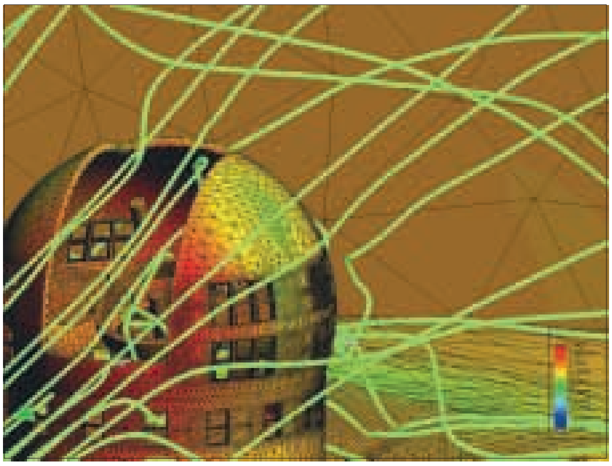


Figure 10:
Flow of air particles around a telescope building - La Palma, Spain. Courtesy of CIMNE



Modelling of Concrete as Multiphase Porous Material, with Application to Fires

by
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[a]Department of Structures and Transportation Engineering, University of Padova, Italy
[b]Department of Building Physics and Building Materials, Technical University of Lódz, Poland

Introduction

In several situations it is necessary to model concrete as a multiphase material [1-5], i.e. a material made up of a solid phase and pores which are filled with water (capillary and physically adsorbed), vapour and dry air. Typical cases deal with concrete performance in the high temperature range, e.g. during fire [1,2,4,5], with early stages of maturing of massive concrete structures [1,2,6], with shotcrete in tunnelling [7], and with durability [8].

We present here a general model for chemo-hygro-thermo-mechanical analysis of concrete applicable to the above situations. All the important phase changes of water, i.e. adsorption-desorption, condensation-evaporation, and chemical reactions, e.g. hydration-dehydration, as well as the related heat and mass sources (or sinks) are considered. Changes of the material properties caused by temperature and pressure changes, concrete damage or carbonation, fresh concrete hardening, as well as coupling between thermal, hygral, chemical and mechanical phenomena are taken into account. This model further allows to incorporate sorption hysteresis [3].

Figure 1: *St. Gotthard Tunnel fire*

An application of this general model to concrete structures subjected to fire is shown here. Recent major fires in key European tunnels (e.g. Channel, Mont-Blanc, Great Belt Link, Tauern, St. Gotthard), Fig. 1, emphasised the serious hazards they represent in human and economic terms. Present design procedures against fire have been shown by these incidents to be seriously insufficient. In the cases referred above, the duration and extent of the fire were longer than expected and, in some cases, the temperatures regimes were much more severe than those considered in the codes. Moreover, the inspection after the fire showed extensive damage to the concrete elements. In the affected sections of the Channel Tunnel the concrete lining was almost completely removed by spalling, Fig.2. All these accidents have shown that a new model of concrete, allowing for predicting of performance of the concrete structures at high temperature, especially explosive spalling, is needed.

Physical and Chemical Phenomena at High Temperatures

When moisture is present, a very complex analysis may be required to deal with the coupled heat and mass transfer in concrete pores, involving both liquid mass transfer and vapour mass transfer. In general, moisture transport may include airvapour mixture flow due to forced convection, and infiltration through cracks and pores; vapour transport by diffusion; flow of liquid due to capillary action, surface diffusion or gravity; further complications are associated with phase changes due to condensation/evaporation, freezing/thawing, ablimation/ sublimation, and adsorption/desorption.

For concrete, particularly at high temperature, one cannot predict heat transfer from just the traditional thermal properties: thermal conductivity and volumetric specific heat (or, under some conditions, one of these properties plus thermal diffusivity). Movement of air, water, and possibly carbon dioxide through the concrete is accompanied by significant energy transfer, particularly associated with the latent heat of water and the heats of dehydration and decarbonation. Because of the high pore pressures that result when highstrength concrete is exposed to a fire, it is necessary to consider forced advection as well as diffusion.

Creep, shrinkage, thermal deformations, i.e. time dependent deformations caused by mechanical load, deformations related to moisture content and temperature changes, respectively, are coupled. This coupling is magnified in the case of concrete at high temperature.

At the beginning of a fire, the temperature of the exposed side of the concrete slab will rise rapidly. Free moisture, both liquid and vapour, will migrate toward the cold side of the concrete. Initially, this moisture movement occurs by diffusion and advection processes, where the driving force may be considered to be the gradient in vapour content (commonly expressed as partial vapour pressure, relative humidity, molar or mass fraction) and the pressures of the liquid and gas phase, respectively. As the temperature of the fire-exposed side increases, any free liquid water will evaporate and migrate toward the colder side where some of it will condense. The latent heat required to evaporate the liquid water will retard the rate of temperature rise at that location. When water vapour is transported into a colder region, some of it condensates or is absorbed into the concrete pores, with a significant amount of heat of condensation or sorption being released. As moisture moves into the slab and the interior temperature rises towards 100° C, portions of the slab may experience additional hydration (conversion of free water to chemically bound water), with an connected release of heat. Hydration takes place at room temperature and the process increases with temperature in the presence of moisture up to 80° C or more resulting in an increase in the mass of the solid skeleton. It should be noted that if cement paste is heated above 100° C in the presence of moisture under hydrothermic conditions that, depending upon the C/S ratio, a chemical transformation of tobermorite will take place to produce $C_2SH(A)$ hydrate [9] which is a weak, porous and crystalline material. Further chemical changes take place at higher temperatures under hydrothermal conditions. In addition, reactive silica in the concrete (aggregate or cement replacement) would also react beneficially with water and CH to produce CSH phases [10].

When the temperature of any portion of the concrete slab exceeds (roughly) the boiling point of water (at the local pressure) some dehydration (release of chemically bound water) will begin to take place, with a simultaneous absorption of heat. Dehydration from the CSH becomes significant above about 110° C [11], while the dehydration of the calcium hydroxide [12] takes place at about 500° C producing CaO and H_2O. Both produce a reduction in the solid skeleton mass of the cement paste. The dehydration reactions continue up to temperatures in excess of 800° C.

The free water present in the pores of concrete flows toward the cold side. However, high-strength concrete is not very permeable for water vapour and is even less permeable (by, say, roughly two orders of magnitude) to liquid water. Thus the moisture cannot escape as rapidly as it is being released and the pore pressure in the concrete will rise substantially.

Finally, liquid water may fill the concrete pores at a location ahead of the temperature front, creating a condition known as moisture clog, where the liquid water blocks the transfer of water vapour toward the cold side of the slab. Under such conditions, the existing pore pressure will result in forced advectional mass transfer of superheated steam and air to the heated side of the slab. This situation is particularly emphasized in high performance concrete with low porosity and low permeability and could contribute to explosive spalling.

"...the inspection after the fire showed extensive damage to the concrete elements."

Figure 2:
Spalling in the vault of the tunnel

For concrete with carbonate aggregates, the situation is further complicated. The α-β transformation of quartz occurs at 573° C in aggregates and sands containing quartz [12]. This is an endothermic reaction during heating, and exothermic during cooling when the transformation is reversed.

"...high-strength concrete is not very permeable for water vapour and is even less permeable to liquid water."

Moreover, decarbonation [12] occurs at temperatures above 650° C whenever $CaCO_3$ is present in the aggregate (e.g. limestone & carbonate aggregates). This produces lime (CaO) and Carbon dioxide (CO_2). All these chemo-physical phenomena have an effect on hygro-thermal behaviour of concrete structures at high temperature.

Mathematical Model

To analyse hygro-thermal phenomena in porous media two different approaches are used: phenomenological- and mechanistic ones. In the phenomenological approach moisture and heat transport are described by diffusive type differential equations with temperature- and moisture content- dependent coefficients. The model equations are often obtained by means of Irreversible Phenomena Thermodynamics. The model coefficients are determined by inverse problem solution, i.e. using known results of experimental tests, to obtain the best agreement between theoretical prediction and experimental evidence (e.g. in the sense of the least square method). Models of such a kind usually give very accurate predictions when applied to phenomena similar to those used to adjust model parameters and often very inaccurate for different situations (e.g. similar, but not exactly the same materials, different element sizes, different moisture and temperature ranges, etc.). In other words, they are very accurate for interpolation and rather poor for extrapolation of known experimental results. Another shortcoming of this approach is the highly non-linear character of equation coefficients, which requires performing of numerous and time consuming experimental tests. Moreover various physical phenomena are lumped together and model parameters often have not clear physical interpretation. Further, in this approach often there is no distinction between different phases of water, e.g. [13,14], which are generally treated as a moisture, hence phases changes cannot be taken into account in a proper way.

In the mechanistic models, governing equations are usually more complicated formally, but their coefficients have clear physical meaning and often are related to classical material parameters, like for example porosity, intrinsic permeability, diffusivity of vapour in air, etc. When some relations between structure parameters and transport properties are found (e.g. effect of water degree of saturation on relative permeability for water flow), usually they are valid for a class of similar materials, e.g. cellular concrete, ceramic materials, etc. Models of this group are generally obtained from microscopic balance equations written for particular constituents of the medium, which are then averaged in space, e.g. by means of volume averaging theory or homogenisation theory. Mass and energy fluxes are usually expressed by means of gradients of thermodynamic potentials causing them, e.g. temperature, capillary pressure, water vapour concentration etc. Phase changes and mass and energy sources (sinks) related to them are usually taken into account. Moreover, some additional couplings, e.g. effect of material damaging on intrinsic permeability or capillary and vapour pressures (moisture content) on skeleton stresses, can be considered.

Nowadays, most practically used models of hygro-thermal phenomena in concrete at high temperature are based on a phenomenological methodology [13,14]. In the framework of the Brite "HITECO" project [15] a new, mechanistic model of mass and energy transport in deforming concrete at high temperature has been developed, [4,5].

Moist concrete is modelled as a multi-phase material, which is assumed to be in thermodynamic equilibrium state locally. The voids of the skeleton are filled partly with liquid water and partly with a gas phase. The liquid phase consists of bound water, which is present in the whole range of moisture content, and capillary water, which appears when water content exceeds the upper limit of the hygroscopic region. The gas phase is a mixture of dry air and water vapour, and is assumed to be an ideal gas. The chosen primary variables of the model are: gas pressure p^g, capillary pressure $p^c = p^g - p^w$

p^w denotes water pressure, temperature T, displacement vector of the solid matrix $\boldsymbol{u}$, as well as degree of cement hydration Γ_{hydr}, when hydration or dehydration phenomena are analysed, or carbon dioxide concentration ρ^d and degree of carbonation Γ_{carb}, when carbonation is considered. One may assume that the degree of dehydration depends on the maximum value of temperature reached during heating [1,2,4,5]. In the case of decarbonation, the mass balance equation of carbon dioxide, [8], and the evolution equation for the process are needed.

Hence, the general mathematical model of chemo-hygro-thermo-mechanical processes in concrete consists of five balance equations:

mass of solid skeleton (dehydration process and related density changes are regarded),
mass of dry air (considering both diffusional and advectional molecules transport mechanism),
mass of the water species (both in liquid and gaseous state, taking into account phase changes, i.e. evaporation -condensation, adsorption–desorption, and dehydration process, as well as diffusional and advectional transport mechanism for gas molecules),
enthalpy of the whole medium (latent heat of phase changes and heat effects of dehydration processes, as well as energy transport due to conduction and convection are considered),

linear momentum of the multiphase system (taking into account elastic deformation, thermal expansion and material damaging).

These equations are completed by an appropriate set of constitutive and state equations, initial and boundary conditions, as well as some thermodynamic relationships. For a full description of the model and its mathematical formulation, see [1, 2, 4, 5].

Temperature, capillary pressure and gas pressure dependence of several material parameters (e.g. porosity, pore structure, thermal conductivity and capacity, intrinsic and relative permeability, Young's modulus, Poisson's ratio, effective vapour diffusivity), as well as physical quantities (e.g. specific latent heats of vaporisation and adsorption, water and gas viscosities) are taken into account.

During analysis of concrete behaviour at high temperature the material damage caused by development of cracks is considered following the theory of non-local scalar isotropic damage [17]. This theory defines a modified effective stress σ_{eff} and takes into account the damage D $(0 \leq D \leq 1)$ as a parameter measuring the reduction of resistant area due to cracks development, and considers the different performance of concrete in traction and compression by means of coupling of damage in traction D_t and in compression D_c [17].

Furthermore, because of significant increase of concrete intrinsic permeability at high temperature mainly generated by arising micro-cracks and by changes of the inner structure of the material, as well as by crack-opening due to high values of gas pressure, coupling between intrinsic permeability and mechanical damage has been considered in the description of changes of concrete physical properties during complex hygro-thermal and mechanical phenomena at high temperature [1, 2, 4, 18].

Application of the Model

The finite element code HMTRA, based on the theory presented in the previous sections, was successfully applied for the analysis of several problems concerning hygro-thermal behaviour and deformations of building materials [1], soils [16], concrete elements taking into account capillary hysteresis [1, 3], fresh concrete components [1] and concrete structures at high temperatures [2, 4, 18]. Below one application of the code in the latter situation, which is rather difficult from the theoretical and numerical point of view, is shown.

Concrete in high temperature environment

The following example deals with a square column (30 x 30 cm), made of High Performance Concrete subjected to a fire. This simulation allows for studying the behaviour of a real scale structure in such conditions, in particular as far as mechanical behaviour and residual load bearing capacity are concerned.

Initial conditions for concrete are: p^g=101325 *Pa* (atmospheric pressure), φ=60 % RH, T=298.15 K. Mixed radiative-convective and purely convective boundary conditions on the heated sides of the column, for heat and mass exchange respectively, are used, with the coefficients α_c=18 W/m^{2}K and β_c=0.18 m/s, as well as the surface absorption coefficient $\sigma_0 e$=5.1 10-8 W/m^{2}K^4. The main characteristic parameters of the material employed in the calculation are shown in Table 1.

"...often there is no distinction between different phases of water."

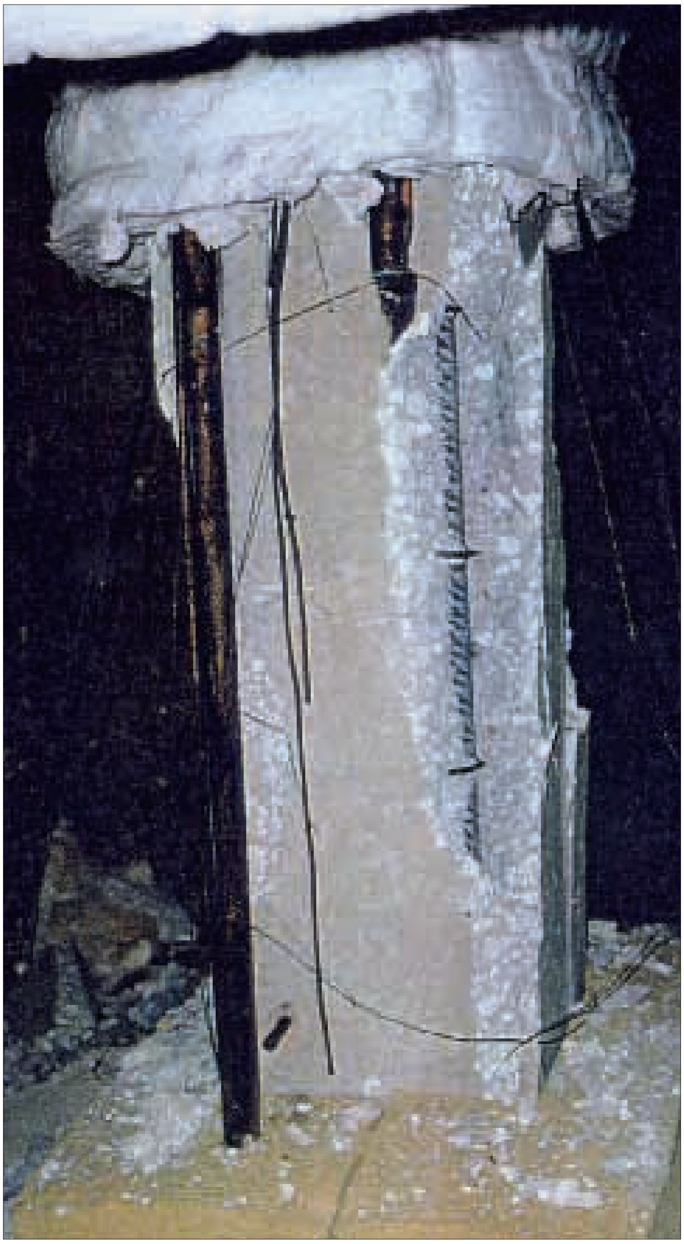

Figure 3:
Corner spalling in a C60 column [15]

Parameter	Units	Value
Porosity	[-]	0.082
Intrinsic permeability	[m^2]	2×10^{-17}
Apparent density	[kg/m^3]	2564
Specific heat	[J/kgK]	855
Thermal conductivity	[W/mK]	1.92
Young's modulus	[GPa]	34.52
Poisson's coefficient	[-]	0.18
Compression strength	[MPa]	60
Tensile strength	[MPa]	6.0

Table 1:
Characteristic properties of concrete at ambient temperature

Experimentally this kind of geometry often is endangered by a spalling phenomenon close to the corner with a possible exposure of steel bars to the fire, Fig.3, and a consequent collapse of the structure. These phenomena are clearly visible in Figures 4 and 5, where damage, vapour pressure, temperatures and relative humidity distributions are shown. The most damaged zone of the cross section is localized close to the corner (Fig. 4a) where the simultaneous presence of a peak of pressure (Fig. 4b) can explain the separation of this part of the column.

This high value of vapour pressure is mainly due to pore water evaporation and thermo-diffusion processes, that take place in the zone immediately behind the corner because of temperature increase (Fig. 5a), and condensation phenomenon, which can lead to arising of moisture clog, (Fig. 5b), as explained in section 2.

The mathematical model and the code have been extensively validated within the Euram Brite "HITECO" programme and many more examples can be found in [1,2,4,5,6,18]. ●

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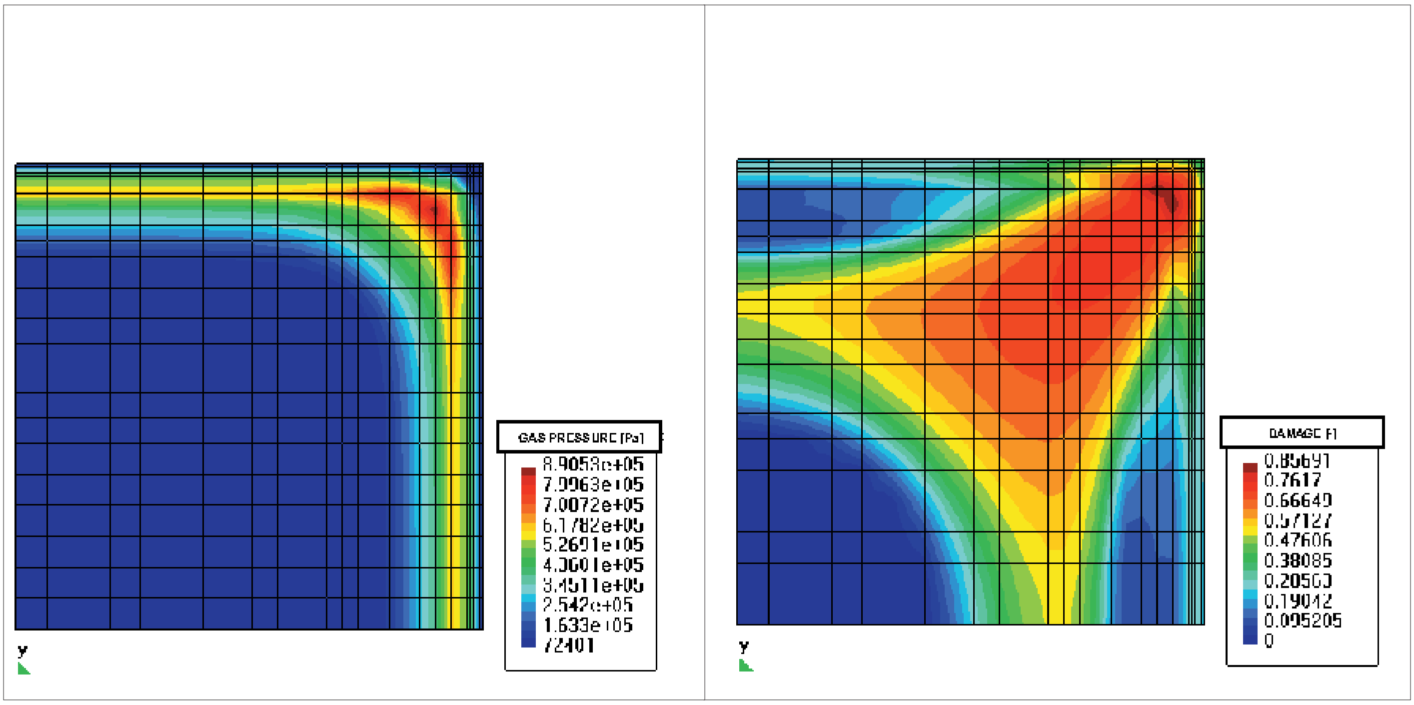

Figure 4:
Temperature
(a) and relative humidity
(b) distribution in the cross section of the column at 8 minutes

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"All these chemo-physical phenomena have an effect on hygro-thermal behaviour of concrete structures at high temperature."

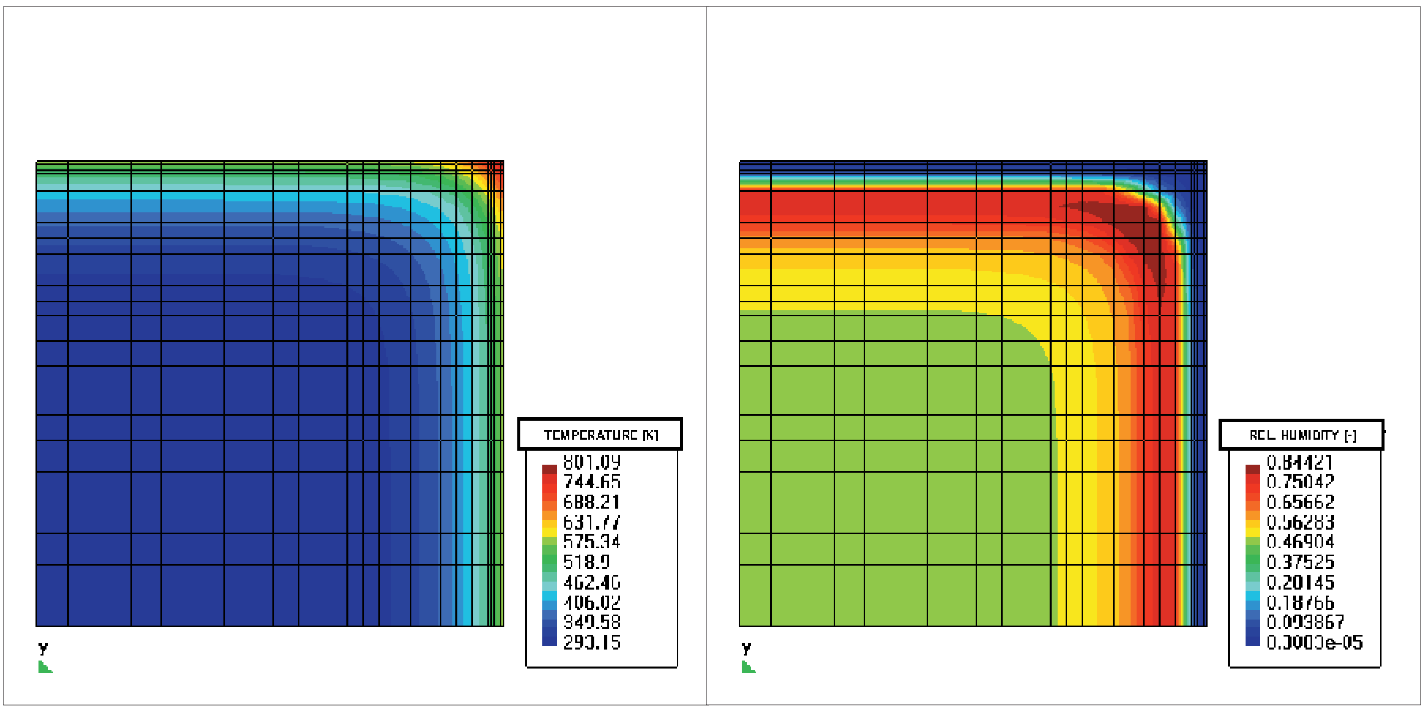


Figure 5:
gas pressure
(a) and total damage

(b) distribution in the cross section of the column at 8 minutes

WCCM V

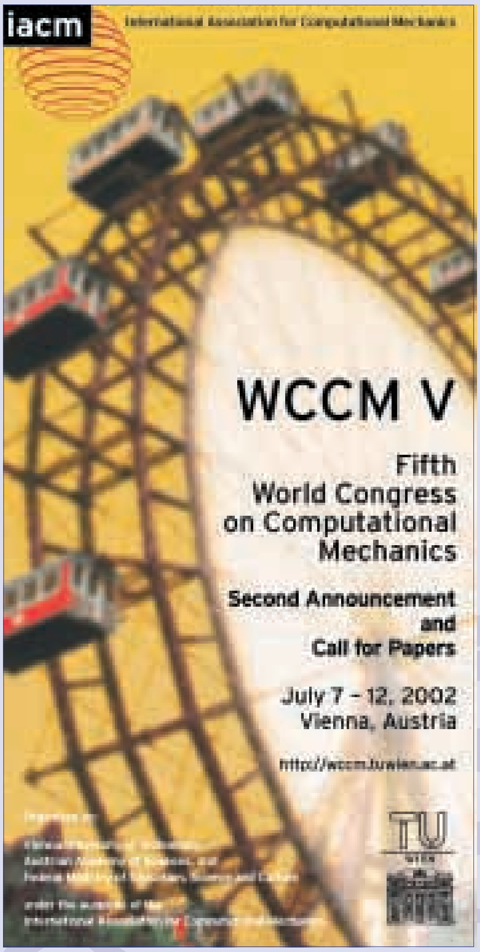
Fifth World Congress on Computational Mechanics

July 7-12, 2002, Vienna, Austria

http://wccm.tuwien.ac.at

The Fifth World Congress on Computational Mechanics will be held from July 7 to 12, 2002, in Vienna, Austria

Details concerning the scientific goals of the congress were reported in an article on WCCM V in a previous issue of this magazine. An up-to-date list of the topics and of the organizers of minisymposia is available on the WCCM V website (http://wccm.tuwien.ac.at). The organization of the scientific programme is an incremental procedure with several iteration steps per increment. Great efforts are being made to ensure that a very good approximation of the Final Programme will be ready in May 2002. Because of the overwhelming response to the Call for Papers and the great interest in organizing minisymposia as well as industrial minisymposia, this is a nontrivial task. World-famous scientists in the field of computational mechanics have accepted the invitation to present plenary and semi-plenary lectures as well as keynote lectures.



As of January 31, 2002, the number of minisymposia is 68 and the one of industrial minisymposia 9. Even if eventually some of them must be cancelled by their organizers, the number of speakers in the category of minisymposia is respectable. The same holds for the regular sessions and the poster sessions. All submissions for presentation in these sessions were reviewed by two peers. Selectivity concerning the acceptance of such submissions was deemed necessary, keeping in mind that World Congresses on Computational Mechanics are the scientific flagships of the International Association for Computational Mechanics. On the basis of this principle it has turned out that the number of presentations in regular and poster sessions will be in the range of the number of presentations in minisymposia and industrial minisymposia. This seems to be a reasonable compromise between different views on the optimal distribution of presentations to the aforementioned categories in different geographic areas of the globe.

Figure 1
Main Building of Vienna University of Technology

The internationallity of IACM is reflected by submissions for presentation of papers at WCCM V from approximately 70 countries from all over the world. More than 100 (accepted) papers from Japanese researchers and close to 100 (accepted) papers from Brazilian scientists indicate that large geographic distances from

Vienna did not necessarily have a negative influence on the decision to attend WCCM V.

The venue of WCCM V is the Vienna University of Technology. The opening ceremony, including historical remarks on the development of the FEM by Prof. O.C. Zienkiewicz and the introductory plenary lecture by Prof. J.T. Oden, will take place in the "Hofburg", the residence of the Emperors of Austria from 1804 to 1918.

An exhibition concerning life and work of the famous philosopher, mathematician, natural scientist, and engineer, G.W. Leibniz (1646-1716) will be opened on July 7, 2002, in the festival hall of the Old University, serving as the administrative building of the Austrian Academy of Sciences. Prof. E. Stein, one of the organizers of the Leibniz exhibition, will give a brief account of the concept of this exhibition. The eminent German philosopher Prof. J. Mittelstraß will deliver the festive lecture.

In addition to the scientific programme an attractive social programme has been organized for the participants and the accompanying persons. It includes a "Heurigen" evening, the congress banquet, given by the Mayor of the City of Vienna, at which Prof. R.W. Clough will speak about the early history of the FEM from the viewpoint of a pioneer, and the opening of the Leibniz exhibition. (Because of lack of space, admission to the latter will be handled on a "first register first serve" basis.)

Several sightseeing tours will be offered to get acquainted with the history and beauty of Vienna and the Danube valley.

A Post Congress Tour to Salzburg, W.A. Mozart's birthplace, has been organized.

The organizers of WCCM V are looking forward to welcome scientists, engineers, and accompanying persons from all over the world at the Congress. They are trying hard to make WCCM V an unforgettable scientific and social event.

Herbert A. Mang
Franz G. Rammerstorfer
(Co-chairmen)
Josef Eberhardsteiner
(Secretary General)

Figure 2: *City Hall*

Figure 3: *Festival Hall of the Academy of Sciences*

Figure 4: *Danube Valley*

USNCCM VI
Sixth U.S. National Congress on Computational Mechanics

USNCCM VI, chaired by Gregory Hulbert of University of Michigan, Ann Arbor, was held in **Dearborn, Michigan July 31 - August 4, 2001**. Since the first USNCCM, held in 1991, the Congress has continued to grow and has developed into an international event, with participation from Europe, South America and the Pacific Rim.

More than 820 people attended, with participants from more than 30 countries. Up to 19 parallel technical sessions were offered during the three days of the Congress. There were 153 technical sessions distributed amongst 52 minisymposia.

Wing Kam Liu opened the Congress with the plenary lecture "Multiple Scale Meshfree Simulation Methods." Eugenio Onate presented the plenary lecture, "Possibilities of Finite Calculus in Computational Mechanics." The plenary lecture, "Shell Structures - The Challenge of the Third Dimension," was delivered by Ekkehard Ramm. "Parallel Finite Element Method Using Multi-Sited Computers Worldwide," was the plenary lecture presented by Genki Yagawa. The plenary lectures concluded with Franco Brezzi offering "Discontinuous Galerkin Treatment of Diffusive Terms."

The short course on "Verification and Validation in Computational Mechanics," taught by William Oberkampf, was a sellout, with 40 people attending this pre-Congress event. The post-Congress short courses comprised "Meshless Particle Methods," presented by Wing Kam Liu, J. S. Chen, and Hirohisa Noguchi, and "Design Optimization," presented by Zafer Gurdal and Uwe Schramm. The post-Congress event attracted more than 60 registrants.

This Sixth Congress expanded the student and young investigator fellowship program. Krishna Garikipati had the difficult task of selecting 25 students and 10 young investigators to receive these awards from the 75 applicants. That 219 students were registered for the Congress bodes well for the future strength of computational mechanics.

Many people contributed to the success of the Congress, including the minisymposia organizers and the Congress presenters. Special thanks are offered to the following people for their extraordinary contributions: Len Schwer, for organizing the Verification and Validation short course and the well received exhibitor booths; Ren-Jye Yang for organizing the post-Congress short course on Design Optimization; Krishna Garikipati, for administering the fellowship program; Karl Grosh for assisting wit the audio-visual arrangements; J.S. Chen, as technical program co-chair; Noboru Kikuchi as technical program co-chair. Finally, the financial support of Altair Engineering, Inc. and Toyota Motor Corporation is gratefully acknowledged. ●

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ASME & USACM

The American Society of Mechanical Engineers (ASME) Council on Codes and Standards, at their meeting of 21 Sep 01, endorsed the V&V Committee's Charter:

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

The Committee reports to the ASME Board on Performance Test Codes (PTC) and the Committee's official title is:

PTC 60 Committee on Verification and Validation in Computational Solid Mechanics

The ASME web site for the Committee is

www.asme.org/cns/departments/performance/public/ptc60/

but the more information about the Committee is currently available on: www.usacm.org/vnvcsm/ ●

USACM NEWS

The Committee on Meshfree Methods (CMM), chaired by J. S. Chen of UCLA, has developed a web page (http://www.usacm.org/MeshFree) to foster the research, development and application of meshfree methods. In addition to the pages describing related background, events, resources, and members information, a Preprint Server has been developed to provide an interface for the user to submit and/or download meshfree methods related preprints. The CMM web site is developed and maintained by Dr. Tom Voth of Sandia National Laboratories. ●

The **ICMM** (Integration on Computational Mechanics and Manufacturing) committee, chaired by **Jian Cao of Northwestern University**, intends to create a common interaction platform among computational mechanics basic research scientists, manufacturing and product engineers, and application practitioners. ●

This **USACM Verification and Validation Specialty Committee**, chaired by **Len Schwer**, has achieved one of its original objectives: to become an **American National Standards Institute** (ANSI) approved standards committee ●

NATIONAL sCIENCE fOUNDATION AND usacm

Workshop on Composite Sheet Forming

On **September 5-7, 2001**, the National Science Foundation and USACM sponsored a two-day workshop entitled **"Workshop on Composite Sheet Forming"** held at the **University of Massachusetts - Lowell**.
The workshop was attended by 35 representatives from 1 material supplier, 4 commercial software companies, 2 government agencies, 5 other private companies and 14 universities. The participation was international with nearly 30% of the attendees from Europe and Asia. In addition, 10 graduate students from University of Massachusetts - Lowell and Northwestern University attended the workshop to enrich their professional experience.

Over the course of the two-day workshop, four keynotes in the areas of materials testing (Andrew Long - Univ. of Nottingham), numerical simulation (Noboru Kikuchi - Univ. of Michigan, Ann Arbor), stamping applications (Martyn Wakeman, Swiss Federal Institute of Technology), and verification and validation (Len Schwer, Schwer Associates) were given, together with 21 other short presentations.

The workshop organizers and attendees alike share the view that the event had succeeded in its objectives of exchanging information and establishing a base for organizing future benchmark tests.
The workshop report is available at http://www.mech.northwestern.edu/fac/cao/nsfworkshop.

Future workshops and conference gatherings to continue this effort were highly recommended.
The first of these is likely to take place at the 5th International European Scientific Association for Material Forming Conference on Material Forming in Kraków, Poland, in April 2002, where there will be a dedicated symposium on Composites Forming Processes (details can be found at http://esaform.cma.fr/events/annconf2002.html) to discuss the benchmark results of material testing.

The 7th U.S. National Congress on Computational Mechanics at Albuquerque, New Mexico, from July 27 - August 1, 2003, is considered to be a good choice for the following discussion on the results of

Figure 1: *Group of delegates attending the workshop*

The Materials Modeling technical committee of USACM (CAMM)

The Materials Modeling technical committee of USACM (CAMM), chaired by Professor Somnath Ghosh, is actively trying to
(a) establish a link between computational mechanics and computational materials science,
(b) identify similar activities in other groups and join with them in promoting themes of common interest,
(c) act as a liaison between Computational Mechanics developers and Materials and applications industry and provide a forum to assess the needs of the materials industry and establish directions for researchers developing novel modeling/design tools and implementation in commercial software.

The committee sponsored 3 symposia on *(i) Computational Mechanics of Heterogeneous Materials: Modeling, Simulation, and Experimental Verification, (ii) Numerical Simulation of Plasmas and (iii) Phase Transformation and Microstructure Evolution*, at the 2001 USNCCM in Dearborn, MI.

The symposia involved researchers, outside of the conventional `Computational Mechanics' community, e.g. from Materials Science & Engineering, Physics, Chemistry, Chemical Engineering, Electrical Engineering. In February 2002, the committee co-sponsored an Army Research Office sponsored workshop on Analysis and Design of New Engineered Materials and Systems with Applications to identify new research directions concerning engineered materials and systems. This successful workshop was attended by researchers from universities, national laboratories, Army Research laboratories, industry and other government organizations. CAMM is cosponsoring the 2004 Numerical Methods In Industrial Forming Processes (NUMIFORM), a reputed international conference that will provide a platform for demonstrating the important role of Computational Mechanics in the integration of materials with manufacturing. ●

USNCCM 7

27 - 31 July 2003

Albuquerque
New Mexico

7th U.S. National Congress on Computational Mechanics

Planning and organization are underway for the 7th U.S. National Congress on Computational Mechanics (USNCCM 7), to be held July 27 - 31, 2003 in scenic Albuquerque, New Mexico. Sandia National Laboratories will host the Congress which will highlight the latest developments in all aspects of computational mechanics --- from new applications in nanotechnology and bioengineering to recent advances in numerical methods and high-performance computing. Thomas Bickel and Jacob Fish are the General Chairs of the meeting; Mark Christon and Robert Haber are the Technical Program Chairs.

All USACM and IACM members are welcome to participate by organizing a minisymposium or by presenting a technical paper (please see the call for participation in this issue of IACM expressions). New web-based procedures for proposing and organizing minisymposia and for submitting and reviewing paper abstracts will facilitate the organization of USNCCM 7.

Complete information about the meeting is available at the Congress web site,
http://www.esc.sandia.gov/usnccm.html ●

The Sixth World Congress on Computational Mechanics

WCCM IV

The Sixth World Congress on Computational Mechanics (WCCM VI) and Asia-Pacific Congress on Computational Mechanics'04 are combined and to be held in Beijing, Capital of P. R. China, in September of 2004. Professor Mingwu Yuan (yuanmw@pku.edu.cn) of Peking University is the General Chairman of the Organizing Committee. Planning of WCCM VI is underway and several committees are being established, including invitations of Plenary and Keynote Lectures. USACM has been invited to work closely with WCCM VI.
If you are willing to contribute to this important Congress, I shall be happy to forward your idea to Professor Yuan. ●

- USACM Texas Student Chapter -

The Texas Student Chapter of USACM was established in Spring 2000 and has since reached a total membership of 19 graduate students and post-doctorate fellows from the Colleges of Engineering and Natural Sciences of The University of Texas at Austin. For the 2001-2002 term, Albert Romkes and Jennifer Proft were elected as the Chapter's President and Vice-President, respectively. Prof. J. Tinsley Oden is the acting Faculty Advisor to the Student Chapter, which is a registered student organization at The University of Texas at Austin.

The Student Chapter has primarily organized meetings with invited guests from both academia and industry. Typically these meetings involve a short and conceptual presentation by the invited speakers on such topics as their professional career, research and teaching experience, and views on future developments within the field of computational mechanics itself. The informal format of the meeting following the presentation is designed to encourage open discussion between the guest and the students.

Recently, Dr. Armando Duarte from the Texas office of Altair Engineering in Austin was guest speaker for a December 12 luncheon meeting organized by the Student Chapter. Dr. Duarte discussed his motivations for choosing a career in the industrial sector, such as the potential impact on design improvements of real-world applications this company explores.

Prof. Franco Brezzi of the Univeristy of Pavia

On February 8, 2002, the Chapter invited Prof. Franco Brezzi from the University of Pavia, Italy, to participate in a luncheon meeting. Prof. Brezzi shared some of his experiences as a world-renowned scientist in the field of applied mathematics, and in particular, how he was drawn into numerical analysis as a career. These two examples clearly demonstrate the international character of invited guests and the broad range of their professional background: from academia to industry.

For all involved, the activities over the past two years have been a positive experience, resulting in a strengthened membership and a growing evolvement of the Chapter's activities. The Texas Student Chapter hopes that this initiative will encourage the establishments of more USACM Student Chapters throughout the United States, thus fostering the growth of computational mechanics in general. ●

USACM Nanotechnology Committee

Since the announcement of the National Nanotechnology Initiative (NNI) in early 2000, nanotechnology has become a research focus area in many academic disciplines. There have been exciting developments in nanoscale science over the last two decades since the invention of STM in 1981.

However, most of the researches during 1980-2000 can be described as nanoscience rather than nanoengineering, since they are mainly focused on nanoscale materials and proof-of-concept demonstrations of novel nanoscale devices. These researches are mainly performed in Physics, Chemistry and Materials Science communities. However, successful industrial applications of nanotechnology will require a technological innovation in nanosystems integration.

Nanostructure patterning and self-assembly processes are emerging as promising enabling technology to achieve this goal. USACM has organized a Nanotechnology Committee to address the key modeling issues of computational mechanics in nanoscale patterning technology. KJ Cho at Stanford University chairs the Nanotech Committee, and Deepak Srivastava at NASA Ames Research Centre is serving as a co-chair. Rod Ruoff and Wing Kam Liu at Northwestern University are serving as the committee members, and the Committee plans to invite more members from nanotech industry and investment community.

The Committee envisions its role as to facilitate and guide the development of computational nanomechanics modeling methods into CAD tools for nanosystem design applications. ●

Honorary Doctoral Degree for Prof. R.L. Taylor at the Faculty of Civil Engineering and Surveying at the University of Hannover

For all inclusions under GACM please contact:

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Figure 1: *During the ceremony*

On Thursday, November 1, 2001, Prof. Taylor received a honorary doctoral degree at the Faculty of Civil Engineering and Surveying at the University of Hannover. The title "Dr.-Ingenieur ehrenhalber" was awarded to Bob Taylor in order to acknowledge a long term scientific collaboration with the Department of Civil Engineering in Hannover, in which several young scientists went over the last 20 years as post doctoral fellows from Hannover to Berkeley, and his scientific achievements in the field of Computational Mechanics.

Bob Taylor's insight and intuition lead to many developments in the area of Computational Mechanics. Parts which had long lasting impact in the community of finite element people are related to "reduced integration", "finite element technology" or "consistent tangents for plasticity" to name a few which had a considerable effect on the future developments and are amongst the landmarks of the finite element progress.

The ceremony took place in the "Leibniz Haus" of the University of Hannover. The photographs document this highlight of a festive afternoon and evening. ●

Prof Peter Wriggers
University of Hannover

Figure 2:
Robert Taylor receives the Honorary Doctoral degree from the President of the University of Hannover, Prof Schaetzl.

Computational Mechanics
On the Top

On August 7th, 2001 Professors Robert L.Taylor (Berkeley) and Ekkehard Ramm(Stuttgart) had the chance to visit the north tower of the Golden Gate Bridge in San Francisco.

The Golden Gate Bridge and in particular its approaching viaducts are currently under an intensive retrofit operation strengthening the construction to withstand an earthquake equivalent to a magnitude of 8.3 occurring on the nearby San Andreas Fault.

The individual retrofit measures are backed up by sophisticated computer modeling and simulation including geophysical and structural models.

Thus "Computational Mechanics" did play an important role to study the vulnerability of the bridge and to lay out the tuning elements and the design of the new retrofit measures. ●

Figure 1:
View from the top with the typical fog near the south tower

Figure 2:
Bob Taylor leaving the tower to reach the platform

Figure 3:
Ekkehard Ramm and Robert L.Taylor on top the north tower of the Golden Gate Bridge,in the back San Francisco

For all inclusions under AMCA please contact:

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http://venus.arcride.edu.ar/AMCA

Call for papers
MECOM 2002

The Argentinean Association for Computational Mechanics and the Brazilian Association for Computational Mechanics announce the First South American Congress on Computational Mechanics, together with the Terceiro Congresso Brasileiro de Mecânica Computacional and the Séptimo Congreso Argentino de Mecánica Computacional, which will be held in the cities of Santa Fe and Paraná (Argentina) on October 28-31, 2002.

Background - The Argentinean Association for Computational Mechanics (AMCA) was created during the first MECOM Congress, which took place in 1985 in Santa Fe-Paraná. Repeating the success of this first MECOM, subsequent congresses were held in Córdoba (1988), Santa Fe-Paraná (1991), Tucumán (1996) and Mendoza (1999). On the other hand, the Brazilian Association for Computational Mechanics (ABMEC) was created in 1997. The first ABMEC Congress was held in Rio de Janeiro in 2000, and the second one in Campinas, in 2001.

Both Associations decided to share the organization of MECOM' 2002 as the First South American Congress on Computational Mechanics, which will include the Terceiro Congresso Brasileiro de Mecânica Computacional and the Séptimo Congreso Argentino de Mecánica Computacional. They also agreed on appointing the International Centre for Computational Methods in Engineering (CIMEC) as local organizer of the Congress.

Figure 1:
San Francisco Church at Santa Fe

Objectives - The aim of MECOM 2002 is to bring together engineers, mathematicians, physicists, researchers, and other professionals, as well as students, who develop numerical methods or use them as part of their professional practice. The meeting is carried out in order to exchange experiences and to assess the state-of-the-art in the application of innovative computational methods to problems arising from industry.

Conference Topics - Application of numerical methods in engineering problems, including some topics as: Fluid mechanics, Algorithms and software development, Heat transfer, Computational mathematics, Solid mechanics, Mesh generation and error estimation, Structural analysis, High performance computing, Multiphysics problems, Innovative computational methods, Multiscale modeling, Inverse problems and optimisation, Biomechanics, Industrial applications

Figure 2:
Congress location, Mayorazgo Hotel, Paraná

Location - Santa Fe and Paraná are two cities separated by the Paraná River, one of the broadest and longest rivers of the world.

Important Dates

Deadline for presenting a one-page abstract	May 15, 2002
Acceptance of the paper	June 30, 2002
Deadline for submitting the full length paper	July 31, 2002
Deadline for early payment	August 31, 2002
Congress	October 28-31, 2002

Information - http://venus.ceride.gov.ar/mecom2002
e-mail: cimec@ceride.gov.ar

AMCA Awards 2002

AMCA is opening the period for nominations to the AMCA Awards for 2002.

These awards have been instituted as a recognition of the scientific trajectory in the field of computational mechanics and are granted in three categories:
- Young Researcher
- Scientific, Professional and Teaching Trajectory; and
- International Scientific Trajectory.

The AMCA Awards 2002 will be granted during MECOM 2002 at Sante Fe in October 2002.
The basis and guidelines for these awards can be found at the ACMA website:
http://venus.ceride.gov.ar/AMCA
Nominations can be sent until March 31 ●

Election of AMCA Authorities

During ENIEF 2001, the annual assembly of the AMCA, the new authorities for the period 2001-2003 were elected.

The Executive Committee for this period is formed by:
President: Sergio Idelsohn
Secretary: Victorio Sonzogni
Treasurer: Mario Storti

and also by:
Fernando Basombrio, Enzo Dari,
Eduardo Dvorkin, Carlos García Garino,
Luis Godoy, Guillermo Este, Angel Menéndez,
Marta Rosales and Marcelo Venere. ●

ENIEF 2000XII

Congress on Numerical Methods and their Applications

October 30th-November 2nd 2001 - Córdoba, Argentina

From October 30 to November 2, 2001, the ENIEF 2001: XII Congress on Numerical Methods and their Applications was held at the city of Córdoba, Argentina.

Córdoba is an important tourist centre in Argentina, with lakes and mountains of great beauty. It also has a remarkable historical and architectural heritage reflecting a Spanish past, and some of this has been declared as a cultural patrimony of humanity. Cordoba has an important tourist infrastructure, which may be enjoyed throughout the year.

ENIEF 2001 had over 100 participants mainly from Argentina, but also from Chile, Brazil, USA, Spain, Germany and Australia. The ENIEF proceedings are edited as a book of the Series Mecánica Computacional. It contains 89 papers (in Spanish and English), in 693 pages and was compiled by Fernando Flores.

Invited lecturers at ENIEF 2001 were: Jason Antenucci (University of Western Australia), Ricardo Burdisso (Virginia Polithecnic Institute and State University), José Longo (German Aerospace Centre), Dean Mook (Virginia Polithecnic Institute and State University) and Sergio Oller (Universidad Politécnica de Cataluña).

The ordinary annual assembly of AMCA took place during the Congress. ●

Figure 3:
Participants at ENIEF 2001

For all inclusions please contact:

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First Asian-Pacific Congress on Computational Mechanics

The First Asian-Pacific Congress on Computational Mechanics was held in Wentworth Hotel, Sydney, Australia from November 20-23, 2001. The first Congress was in fact the continuation of a series of Asian-Pacific Conferences (APCOM) held successfully in Hong Kong (1991) Sydney (1993), Seoul (1996) and Singapore (1999). By the end of the last millennium, it was decided to change the title from 'Conference' to 'Congress' to be in line with the other two regional congresses organized under the auspices of the International Association for Computation Mechanics – US National Congress and European Congress.

The theme of the First Asian-Pacific Congress on Computational Mechanics in the new millennium was 'New Frontiers for the New Millennium'. To reflect this theme, the two volumes of the Congress Proceedings contain about 270 papers covering such new frontiers as micromechanics, contact mechanics, environmental geomechanics, chemo-thermo-mechanics, inverse techniques, homogenization, meshless methods, smart materials/smart structures and graphic visualization.

The Congress was attended by about 240 delegates from 22 countries. There were 46 technical sessions over 4 days which included 2 plenary lectures, 43 invited lectures and the rest being contributed papers. One significant aspect of this Congress was that there were about 40 papers written and presented by graduate students and young researchers.

At the opening ceremony, Professor Valliappan, Secretary-General of the Asian-Pacific Association for Computational Mechanics, who is also the Chairman for the first Congress welcomed the delegates. The opening address was delivered by Dr. John Yu, the Chancellor of the University of New South Wales, Sydney. His thought provoking address which was based on a general review of human relationship especially the cultural diversity existing not only in Australia and Asia but in other parts of the world and the necessity for understanding and tolerance towards each other was very much appreciated by all the delegates.

His address also included what research and technology are capable of contributing to the welfare of the people and the important role of scientists in communicating and exchanging ideas, knowledge and information through internet as well as the role of business community in globalisation so that great access to world's resources can be made. He concluded in emphasizing that 'to make the world better is to serve the community better'.
The Congress Program also included a

Figure 1:
Front Cover of Brchure

Figure 2:
Cocktail reception - Sydney Harbour Cruise in Magistic Catamaran
Chairman of APCOM´01 (S. Valliappan) with Chairman-elect of APCOM´04/WCCM VI (Ming-wu Yuan)

Figure 3:
Prof. S. Valliappan introducing the aboriginal dancers at the Congress Banquet

number of social functions such as the Sydney Harbour Cruise in 'Magistic' Catamaran for the cocktail reception and the congress banquet in Wentworth Hotel. During the congress banquet, the 'Yadiki Didge' aboriginal dancers performed 'welcome dance' as well as other dances. The delegates were also entertained by the Indian dancers performing the classical 'Bharatha Nattiyam' dances which were enjoyed very much by all the delegates.

The successful first Congress, APCOM'01 will be followed by the second Congress, APCOM'04 combined with World Congress, WCCM VI in Beijing, China during 2004 under the Chairmanship of Professor Ming-wu Yuan of Beijing University.

Figure 4:
Opening Ceremony, Wentworth Hotel, Sydney

Figure 6:
Indian dancer at the Congress Banquet

Figure 5: *At the Conference Banquet -*
Sitting: *Mrs Cheung, Mrs. Valliappan, S. Valliappan (President AACM), E. Oñate (Secretary General IACM), G. Yagawa (President JSCES)*
Standing: *Mrs. Mang, H. Mang (Vice-President IACM), Y.K. Cheung (Vice-President IACM), C.K. Choi (President KACM), Ming-wu Yuan (President CACM)*

MICHAEL (Mike) ANTHONY CRISFIELD
1942-2002

Mike Crisfield passed away, at home, on 19th February 2002 after a long struggle against illness, which he fought with great courage, optimism and dignity. All of us who knew him mourn the loss of an extraordinary researcher but, at the same time, remember his buoyant personality, unconventional character and unique sense of humour. Mike's funeral took place on 1st March, followed by a reception to celebrate his life, which was held at the London Welsh Rugby Club. Mike would have approved of this venue, as he was passionately devoted to the sport of Rugby football and was a keen player. As with everything else in life, he threw himself wholeheartedly into the game and was a ferocious competitor. His enthusiasm knew no bounds and Mike suffered more broken bones, black eyes and bruises than the average player. However, he obviously enjoyed the pains and pleasures as he continued playing well into his mid-forties. Late at night he would tell everyone that, as a scrum-half, he had an excellent "dive spin pass".–So please remember that.

Mike received his initial education at Hailbury Public School-which had Rudyard Kipling, amongst others, as a former pupil – and which ensured that he became quite "anti-establishment" in later life. He subsequently chose to pursue his university education at Queen's University in Belfast where he undertook both his initial degree and Ph.D. He once told me of an incident with his Ph.D. supervisor. After giving Mike a good dressing down for allegedly undermining his position with regard to his views on the stiffness method, said with great feeling as Mike reached the door "And what's more Crisfield, I notice you don't call me Sir".

After brief periods with Taylor Woodrow and the Ministry of Development in Northern Ireland, Mike joined the Transport & Road Research Laboratory (TRRL) in 1971, where he remained until 1989 rising to the grade of "Individual Merit Deputy Chief Scientific Officer". Over this period, he largely worked alone (except for the strong support of John Wills) and produced some remarkable pieces of research that are still heavily cited today–notably his work on solution procedures for snap-through problems. He also wrote his first textbook *Finite Elements and Solution Procedures for Structural Analysis* at this time. In 1989 he decided to leave TRRL to take up a Chair in the Department of Aeronautics at Imperial College, London. This necessitated some change of direction in his research as he quickly recognised that "there is no future in concrete and steel structures in an aeronautics department". As ever, he took up the challenge with enthusiasm and, in addition to original research on nonlinear dynamics and composite fracture problems, produced a further classic textbook on the *Non-linear Finite Element Analysis of Solids & Structures* which is, again, frequently cited.

Mike was an innovative thinker who adopted a "hands-on" approach to research and loved to work closely with his students. In fact, the universal comment of students and young researchers who met him was they were amazed how much time he was prepared to spend with them and how he never criticized their efforts other than through helpful suggestions. On the other hand, his academic peers were not so fortunate as he did not suffer research fools gladly and hated any form of pretentious behaviour. He had an inquisitive mind and his attitude to research can be best summed up by a late night comment: "But, damn it, I'm only interested in things that don't work".

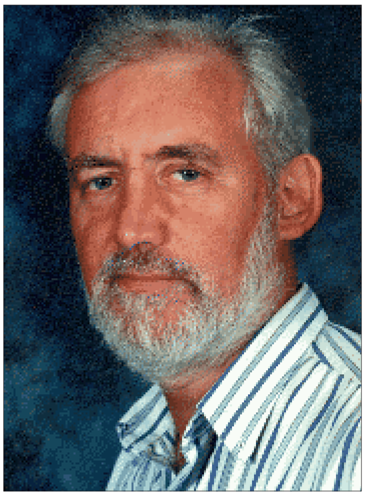
In the short time we have had to reflect on Mike's life, a host of images and memories have come flooding back. I knew Mike for some thirty years and for the last twenty I had a close personal and research relationship with him. I will never forget the many visits he made to Swansea for Ph.D. exams and seminars, which would always follow the same pattern. Firstly a phone call to decide the date– after discussing all suitable days, Mike would always eventually choose Friday. The exam would take place on Friday morning and finish in time for lunch. Mike would then return to London - usually on Sunday (normally staying with Djordje Peric) after many hours of late night discussion (which were often heated), tennis, swimming or long walks on the Gower peninsula and, of course, extended visits to several pubs.

Mike's performance at conferences was peerless. He would instantly brighten up a meeting both with his presentation and his social contribution. He would draw large audiences of delegates who were intrigued by the "Crisfield school of presentation" that comprised a selection of badly hand written overheads, much arm waving and humorous comments (and, of course, excellent academic content). I remember once that when following a particularly slick and glossy presentation involving colour animation and video clips with sound track, etc., Mike's response was that "I too have a multimedia presentation, I have three coloured pens".

To chronicle Mike's social contributions would take far too long. We would have to include the "Fountain night" and other incidents, but Mike's capacity for enjoyment can be surmised from his performance as Chairman at a conference in Barcelona. The session begun at nine o'clock in the morning and, after introducing the speaker, Mike was fast asleep on the platform by ten past nine – which was not surprising as we had returned to the hotel only an hour earlier. Unfortunately, the speaker, who was the late Juan Simo, was interrupted by a delegate, who shall remain nameless, who leapt up shouting "Stop the lecture, stop the lecture, this formulation is not objective". It is a tribute to Mike that he managed (a) to wake up and (b) restore some semblance of order with old-fashioned English aplomb.

I also remember at a meeting in Gothenburg when the city was hit by a freak blizzard walking with Mike who had cut a hole in the canvas conference bag and was wearing it on his head with the handles around his ears. We heard at least three thuds as people slipped and fell turning to look at him. I wish I could say that this occurred when Mike was young and foolish, but it was only about five years ago at Alf Samuelsson's sixty fifth birthday celebration.

It would be impossible to conclude thoughts on past occasions without mentioning Barcelona. Over a period of twenty years Mike and I visited Barcelona on a regular basis to participate in courses and conferences with Eugenio Onate. Over the period, the "Complas Courses" that we taught and the series of conferences of the same name became a tradition and were Mike's favourite events. They generally entailed long lunches, late dinners, swimming days at Sitges and many outdoor bars. In fact, the seventh conference in the Complas series will be held in April next year in Barcelona and will be dedicated to Mike's contributions to the field of computational plasticity.



It is sad that we should lose Mike at this stage of his life. He was beginning to receive the recognition that he so richly deserved. For example, a recent list of the most cited engineering researchers in the UK (not just in the field of computational mechanics) included Mike in the top twenty. Also, he recently received an IACM Research Achievement Award in recognition of his extraordinary achievements in the field of nonlinear computational mechanics. I am sure that there would have been many further awards to mark his contributions to research in the coming years.

Finally, and most importantly, Mike was definitely a member of the human race. He greatly valued his social life and placed this above any academic achievement. Mike was multi-dimensional. He had a keen interest in the arts and, as most of us know, he could bludgeon a piano in a most impressive style. Lately, he had taken up watercolour painting and was looking forward to developing his talents in this direction. Also, he had started writing a novel based on his experience of academic life and the conference community. He reckoned that by simply reporting the current academic and administrative environment at universities he could write a black comedy without the need for much embellishment. Several of his characters were drawn from his friends and colleagues. Perhaps fortunately, it remains unfinished!

Many of us will miss contact with Mike and the loss will be particularly acute when we attend the next conference. Mike was great fun; but he was also an eminent researcher and a true scholar. We all mourn his passing, but at the same time we should rejoice in the life and achievements of a remarkable person that we were all privileged to know. ●

Roger Owen
March 2002

SHOHEI NAKAZAWA
(1949-2001)
a Man of Many Parts

On 23 December 2001, Dr. Shohei Nakazawa passed away after a prolonged battle with cancer. All those who knew him and benefited from his humor and charm will miss him greatly and regret his early death, cutting short what promised to be a spectacular career.

Shohei was born in Kanazawa, Japan, on 16 April 1949 and received his early education in the Japanese traditions. He completed his Bachelor of Science degree in 1972 and Master of Science degree in 1974 at Keio University where he also began his study of finite element methods. For some years he worked closely with Professor Kawai and later at Chuou University before venturing "west" to Swansea where he completed his PhD. Degree under the direction of Professor O.C. Zienkiewicz in 1982. During the period of 1978 to 1983 he worked with Professors Zienkiewicz and John Pittman on many problems of common interest in metal and plastic forming. Here for the first time we had the opportunity of benefiting from his lively mind and research excellence, as well as, from his good humor and friendship.

In Swansea he made his first mark by introducing many interesting and useful computational procedures to the subject of metal and plastic forming and to the general field of computation. His papers on use of penalty methods for incompressible flow solutions are well known. The general method of solution of mixed problems, which he introduced and which for the first time utilized in an imaginative way the Uzawa algorithm, has proved something of permanent value. Here we also find the first full understanding of mixed problems through his contributions to the mixed patch test. During his stay in Swansea Shohei established many friendships with a large group of research workers who were then present and who since have moved to other countries universities.

In 1983 Shohei went to the USA where he joined the computer software firm of Marc Analysis Research. This gave him an opportunity of dealing with practical problems in injection molding and of exercising his ingenuity in the writing of computer codes and of introducing many variants of solution into industrial applications.

In his quest to attain yet further independence Shohei moved to Texas for a short period before returning to California to establish his own computer software firm in 1989 named "The Finite Element Factory". This name became well known both in the US and in Japan and much of the activity of the firm was devoted to the interchange of computer software and ideas between the two countries. Later the firm moved into other fields than finite elements thus utilizing in additional ways the various ideas ever present in Shohei's mind. These firms exist today with expansions into many areas of engineering, software development and management.

Shohei devoted considerable effort to bring together Japanese and western scientists in the field of finite elements. Many from the west visited Japan through the contacts he established and benefited much from his organization of such visits and his understanding of the way progress could be best made in social relations with Japan. We believe the description of Shohei as a "Japanese man with a western mind" is probably a fair summary of his ability and understanding of both cultures.

His death leaves a big gap in the scientific community of research workers in finite elements methods. Those us in the field who knew him well always treasured his charm and directness. He will be missed by all of us and, even more, by his wife Naoko and daughter Seri who were the mainstays of his all too short life. ●

O.C. Zienkiewicz and
R.L. Taylor

Book Report

Computational Fluid Dynamics: Principles and Applications

J. Blazek (Ed.)
www.elsevier.com/locate/isbn/0080430090
Elsevier

Computational Fluid Dynamics (CFD) is an important design tool in engineering and also a substantial research tool in various physical sciences.

The objective of this book is to provide a solid foundation for understanding the numerical methods employed in today's CFD and to raise awareness of modern CFD codes through hands-on experience. The book will be an essential reference work for engineers and scientists starting to work in the field of CFD or those who apply CFD codes.

The accompanying CD-ROM contains the sources of 1-D and 2-D Euler solvers as well as grid generators. •

Book Report

Inelastic Analysis of Structure

Milan Jirásek & Zdenék P. Bazant (eds.)
www.wiley.co.uk
Wiley

The modeling of mechanical properties of materials and structures is a complex and wide-ranging subject.

This book presents a comprehensive treatment of the most important areas of plasticity and of the time-dependent inelastic behaviour (viscoplasticity of metals, and creep and shrinkage of concrete).

Inelastic Analysis of Structures is a textbook for basic and advanced courses on plasticity, with a slight emphasis on structural engineering application, but with a wealth of material for geotechnical, mechanical, aerospace, naval, petroleum and nuclear engineers. The text is constructed in a very didactical way, while the mathematics has been kept rigorous. •

ECCOMAS CFD 2001

Swansea

4-7 September 2001

In September 2001, the ECCOMAS CFD Conference was held on the campus of the University of Wales Swansea. The Conference aimed to bring together researchers, practical engineers and students working in the general area of computational fluid dynamics. Previous Conferences in the series had been held in Stuttgart (1994) and Athens (1998). In addition, computational fluid dynamics was a major topic at the ECCOMAS Congresses held in Brussels (1992), Paris (1996) and Barcelona (2000).

The Swansea Conference covered the full spectrum of topics in computational fluid dynamics and also addressed related areas, such as computational electromagnetics and multidisciplinary applications. Organised jointly by the Institute of Mathematics and Its Applications and the Department of Civil Engineering at the University of Wales Swansea, in association with the UK Association for Computational Mechanics in Engineering (ACME), the conference attracted almost 350 delegates from 32 different countries. The Conference programme took the form of 8 invited lectures, 30 special technical sessions and 33 contributed sessions.

On the eve of the Conference, a special session was organised to recognise the contributions of Professor Olek Zienkiewicz on the occasion of his 80th birthday. The evening began with the official opening of the O. C. Zienkiewicz Library in the Engineering Building at the University of Wales Swansea. The Library was established by the Department of Civil Engineering and is a source of books and papers devoted to the topic of computational engineering. Olek has kindly donated all his texts and manuscripts to the Library so that it is able to provide a unique record of the development of the finite element method. The Library was officially opened by Professor Bob Taylor, who is a close friend of Olek.

The dinner that followed the opening was attended by many guests drawn from the research community, the University of Wales Swansea, ECCOMAS, the IMA and the publishers John Wiley and Sons, who had kindly sponsored the evening. In addition, all of Olek's former doctoral students, who were in Swansea for the Conference, were also present. It is an old Welsh tradition that celebrations such as this are marked by the reading of an englyn, which is a short poem written according to strict rules, and the following englyn was was written by Ken Morgan and dedicated to Olek on this occasion:

Yn wyth deg oed, cewch oedi 'ma heno;
mae ennyd 'da'r cewri
yn adeg i ail-nodi
dawn a sgil eich ymchwil chi.

A rough translation would be:

At 80 year of age, you may relax here tonight;
a short time with the leaders in the field
is an opportunity to note, once again,
the cleverness and the skill of your research.

Following the dinner, the guests joined the delegates for the special session of the Conference. This session was admirably chaired by Professor Tom Hughes, who began by providing details of some of his past encounters with Olek. Professor David Williams FRS, a mathematician from Swansea, then presented a lecture, entitled Random Thoughts of a Probabilist, and he was followed by Professor Tinsley Oden, who had travelled to Swansea in order to be present at this special evening. The title of Professor Oden's talk was "Terascale Computing: the Nemesis or Grail of Computational Engineering and Science?" On the eve of the ECCOMAS CFD Conference it was particularly appropriate for Professor Oden to conclude his technical presentation with the following thoughts: 'Computational science and engineering can fulfil the great promise I mentioned earlier, but to do so will require the finesse, intellectual energy, and scientific breakthroughs that make the subject viable and challenging and a worthy addition to that discipline that lies in the huge intersection of mathematics, engineering science, and computer science and technology.'

Professor Oden finished his presentation on a light-hearted note by reading a poem that he had written and had dedicated to Olek. A copy of the poem is now mounted on the wall of the O. C. Zienkiewicz Library, but is published here for the first time.

OCZ

Cigar smoke wafts down the hall
Knarled cane raps upon the wall
Bewhiskered man with features bright
Flashes through with mane so white.

Who is this king with aura white,
With carriage full of strength and might,
Who causes crowds to hush their noise
With his forbearance, words, and poise?

The man is Olek, standing tall
Cecil Zienkiewicz, if you know it all.
He's recognised as OCZ,
Professor from Swansea by the sea.

Four score years have come and gone
Since OCZ first came along
And in the intervening years
He surpassed the best among his peers.

With Southwell's lessons well in hand
He launched a school known cross the land
On FEM's and methods new
That changed forever what we do.

If one could list as best he can
What we owe to this great man
The list unravelled would be long
Of great insights and ideas strong.

And, in the list, we're first to see
Field problems, then CFD
There's isoparametrics and the rest
Then penalty and the patch test.

There's then integration, reduced too low
And adaptive meshing to and fro
And ZZ methods, last but best
Alphabetically on our list.

There's then the method for all the seasons
Defying lesser mortal's reasons.
There's many more, too much to say
To recount on this special day.

We thank the lucky stars we see
For all the work of OCZ.
For work that opened paths to view
By others in this field so new.

Four score years have come and gone
Since OCZ first came along
We wish him here four score and ten
To befriend and guide us once again.

Cigar smoke wafts down the hall
Knarled cane raps upon the wall
Bewhiskered man with features bright
Flashes through with mane so white.

At the conclusion of the session, Professor Hughes presented Olek with a folder containing messages from his former doctoral students and research assistants.

Those who were present agreed that this intellectually stimulating and friendly evening dedicated to Olek Zienkiewicz, 80 years young, was to set the tone for the remainder of the Conference. If you are interested in the theme of the Conference, and if you could be in Swansea in September, the Conference Book of Abstracts and a CD-ROM of the Proceedings are available from the IMA, Catherine Richards House, Southend-on-Sea, UK. ●

K. Morgan and N. P. Weatherill
Swansea, January 2002

Figure 1:
The opening of the O. C. Zienkiewicz Library.
Pictured, from left to right are Professor J. Tinsley Oden, Professor N. P. Weatherill (hidden), Professor T. J. R. Hughes, Professor Zienkiewicz and Dr J. Z. Zhu.

Conference on Numerical Methods on Engineering and Applied Sciences

Guanajuato, Mexico *17-19 January 2002*

Figure 1: R. Owen, B. Schrefler, T. Belytschko, T. Hughs, M.C. Márquez, E. Oñate and T. Oden overlooking the hills of Guanajuato

A conference on Numerical Methods in Engineering and Applied Sciences was held in the city of Guanajuato, Mexico on 17-19 January 2002. The conference follows a successful similar event held in the city of Concepción, Chile on 16-20 November 1992.

The Guanajuato conference was organised by IACM in cooperation with the University of Guanajuato, the Center for Research in Mathematics of Guanajuato (CIMAT) at the National Autonomous University of Mexico (UNAM). The conference was attended by some 220 delegates from Mexico and other Spanish speaking countries worldwide (including members from IACM affiliated organisations). The plenary speakers included the following USA, Mexican and European representatives: G. Ayala, T. Belytschko, I. Herrera, T. Hughes, T. Oden, E. Oñate, R. Owen and B. Schrefler.

The papers of the Guanajuato conference have been jointly published by CIMNE (Barcelona) and CIMAT. Details of the conference and the content of the papers can be visited in www.cimne.upc.es/congress/gto2002

Delegates at the Guanajuato conference enjoyed an interesting scientific meeting complemented with a number of social events in the historical and beautiful city of Guanajuato.

The Guanajuato conference was taken as the opportunity to formally create the Mexican Association for Numerical Methods in Engineering which has also become a new affiliated organisation to the IACM. The new Mexican association will be chaired by Prof. I. Herrera and includes as officers S. Botello (Vicepresident), G. Ayala (Secretary General), F. Zárate, S. Gallegos, M.A. Moreles, H. Madrid, J. L. Marroquín, A. Hernandez and F. García

Details of the activities of the new Mexican Association for Numerical Methods in Engineering can be visited at: www.cimat.mx/smmni/ ●

Figure 2:
Prof. S. Botello, Prof. and Mrs Carteleus, Profs, T. Oden, T. Hughrs, I. Herrera, E. Oñate and Mrs Botello at the conference banquet

conference notices

FEF -03
Finite Elements in Fluids - 03
Meijo University, Nagoya, Japan
2 - 4 April 2003

As the conference of the Finite Elements in Fluids enters its 27 years of existence, this is a great opportunity to look back and try to assess the progress made during that time and use it to look at the future. The purpose of this conference is to provide a forum for the discussion and exchange of information and create strong working relationships among researches, engineers and scientists engaged in all aspects of computer simulations of problems involving fluid flow. This will also be a good opportunity to continue making remarkable progress in the flow analysis of FEM, extend it's application area along with the development of computer.

The FEM is a basic numerical method in engineering and a key methodology to solve nonlinear flow problems, mechanics, civil engineering, architect, ship building, aerospace and astronautics, applied chemistry, nuclear engineering, electric, and also mathematics, environmental, medical, meteorological, ocean etc.

While papers on all aspects of FEM are welcomed, contributions are invited on the following themes: Adaptive Meshing, Aeroacoustics, Aerodynamics, Atmospheric Dynamics, Bio Fluid Dynamics, Combustion, Compressible Flows, Crystal Growth, Electromagnetics, Error Estimation, Flow Control, Flow in Porous Media, Fluid Structure Interaction, Free Surface Flows, Gas Dynamics, Geomechanics, Heat and Mass Transfer, High Performance Computing, Incompressible Flows, Lubrication, Magnetohydrodynamics, Mathematics of Finite Elements, Mesh Generation, Multiscale, Multiphase/Multiphysics, Non Newtonian Fluids, Ocean Engineering, Optimization, Parallel, Process, Reacting Flows, Seepage, Shallow Water Circulation, Solver, Transonic Flows, Transport, Turbulence, Wave Propagation.

Web Site, information, and instructions for can be found on the conference web page http://cmlabtp.meijo-u.ac.jp/fef03/index.html Or contact: Y. Taki on tel. - 81-52-832-1151 ext. 5166 or E-mail:taki@meijo-u.ac.jp ●

FEF-03
Finite Elements in Flow Problems '03

USNCCM 7
Seventh U.S. National Congress on Computational Mechanics
Albuquerque, New Mexico, U.S.A.
July 27 – 31, 2003
http://www.esc.sandia.gov/usnccm.html

Background and Scope
The biannual Congresses of the U.S. Association for Computational Mechanics are major scientific events that attract an international audience. The seventh U.S. Congress, hosted by Sandia National Laboratories, will highlight the latest developments in all aspects of computational mechanics—from new applications in nanotechnology and bioengineering to recent advances in numerical methods and high-performance computing. The technical program features invited plenary lectures by distinguished experts as well as minisymposia that focus on topics of current scientific interest. Participants will have a special opportunity to experience the unique scientific environment of Sandia National Laboratories through interactions with research staff and to envision its future in initiatives such as the Center for Integrated Nanotechnologies (CINT) and the Microsystems and Engineering Sciences Applications Complex (MESA). A number of short courses and vendor exhibits are planned, and the social program will take advantage of the numerous recreational and cultural offerings of the scenic Albuquerque region.

Call for Participation
The Congress organizers welcome proposals from individuals interested in organizing minisymposia as well as abstract submissions for technical papers. All minisymposium proposals and paper abstracts should be submitted *via* the electronic forms available at the Congress web site, http://www.esc.sandia.gov/usnccm.html, where up to date information about deadlines, registration, and accommodations can also be found. ●

Shohei Nakazawa (1949-2001)
Dr. Shohei Nakazawa passed away on 23 December 2001 after a prolonged battle with cancer. All those who know him and benefited from his humour and charm will miss him greatly and regret his early death, cutting short what promised to be a spectacular career.

Michael Anthony Crisfield (1942-2002)
Mike Crisfield passed away at home on 19th February 2002 after a long struggle against illness. We mourn the loss of an extrodinary researcher but, at the same time, remember his boyant personality, unconventional character, and unique sense of humour.

Prof. Michael Kleiber appointed new Minister for Poland

Prof. Michael Kleiber, currently the Director of the Institute of Fundamental Technological Research of the Polish Academy of Sciences has been recently appointed Minister of Science of the Polish Government. Prof. Kleiber is also a Corresponding Member of the Executive Council of the IACM.

Thematic Conferences and workshops promoted by ECCOMAS

The European Community for Computational Methods in Engineering has launched a new initiative to promote thematic conferences and workshops in specialized and emerging new fields. A number of meetings are already planned for 2003. These include so far the following conferences:
- VII International Conference on Computational Plasticity (also an IACM Special Interest Conference). See www.cimne.upc.es/congress/complas
- International Conference on Textile Composites and Inflatable Structures (www.cimne.upc.es/membranes03)
- Advances in Computational Multibody Systems (jorge@dem.ist.utl.pt)
- Workshop on Smart Materials and Structures (http://smart.ippt.gov.pl/, smart@ippt.gov.pl), and
- Advances in Error Estimation and Adaptivity (pedro.diez@upc.es)

Information on these events can also be found in the ECCOMAS web page (www.cimne.upc.es/eccomas).

WCCM 2004 to be held in Beijing, China

Following the recent decision of the IACM Executive Council to change the periodicity of the World Congress of Computational Mechanics to a two year interval, the next WCCM to follow the meeting in Vienna on July 7-12 2002, will be held in the city of Beijing on 2004. The WCCM 2004 will be organised by the Chinese Association for Computational Mechanics. Prof. M. Yuan, from Beijing University, will be the chairman of the congress in cooperation with relevant scientists from China and the Asian-Pacific region.

Further details will be issued on the next IACM Expressions. For information please contact Prof. M. Yuan (yuanmw@pku.edu.cn)

New Mexican Association Affiliations to IACM

The recently created Mexican Association for Numerical Methods in Engineering has become affiliated to the IACM. The Mexican Association was formally created at the Conference on Numerical Methods in Engineering and Applied Sciences held in the city of Guanajuato, Mexico on 17-19 January 2002 (see page 39). The formal constituent act of the new Mexican association was attended by a number of IACM officers including T. Hughes, E. Oñate, T. Oden, B. Schrefler, T. Belytschko and R. Owen.
For details on the new IACM affiliated organisation in Mexico visit www.cimat.mx/smmni/

Honourary Doctoral Degree for Prof R.L. Taylor

Prof Robert Taylor was presented the title "Dr.-Ingenieur ehrenhalber" at the Faculty of Civil Engineering and Surveying at the University of Hannover, Germany, acknowledging a long term scientific collaboration with the department as well as his outstanding scientific achievements. (More details on page 28.)

conference diary planner

24 - 28 June 2002 — **International Symposium on Lightweight Structures in Civil Engineering**
Venue: Warsaw, Poland
Contact: Tel: (4822) 0 601 827 287, Email: jobrebski@poczta.onet.pl
WWW: http://www.fema.net.pl/symp2002

7-12 July 2002 — **WCCM V - Fifth World Congress on Computational Mechanics**
Venue: Vienna, Austria
Contact: Fax: (43) 1 586 - 91 85, Email: registration@wccm.tuwien.at
WWW: http://wccm.tuwien.ac.at

14-16 July 2002 — **IABMAS'02 - First International Conference on Bridge Maintenance, Safety and Management**
Venue: Barcelona, Spain
Contact: Tel: (34) 93-401 70 16, Fax: (34) 93-401 65 17, Email: iabmas02@cimne.upc.es
WWW: http://www.cimne.upc.es/iabmas

21-26 July 2002 — **b'02 IFAC - 15th World Congress**
Venue: Barcelona, Spain
Contact: Tel: (34) 93-401 64 87, Fax: (34) 93-401 65 17, Email: secretariatnoc@b02.ifc2002.org
WWW: http://www.ifac2002.org

2-5 September 2002 — **XVII Jornadas Argentinas de Ingenería Estructural**
Venue: Rosario, Argentina
Contact: Email: info@aiearg.org.ar WWW: http://www.aierg.org.ar

9-11 October 2002 — **3rd DIANA - World Conference on Finite Elements in Civil Engineering Applications**
Venue: Tokyo, Japan
Contact: Tel: (31) 15 284 21 81,
Email: tokyo2002@bouw.tno.nl

21-25 October 2002 — **NUMISHEET 2002**
Venue: Jeju Island, Korea
Contact: Tel: (82) 42-869 32 82, Fax: (82) 42-869 52 14, Email: webmaster@numisheet2002.org
WWW: http://www.numisheet2002.org

28-31 October 2002 — **MECOM 2002 - 1st South American Congress on Computational Mechanics**
Venue: Sante Fe and Paraná, Argentina
Contact: Email: amca@ceride.gov.ar
WWW: http://venus.ceride.gov.ar/mecom2002

2-4 April 2003 — **FEF 03 - 13th International Conference on Finite Elements in Flow Problems**
Venue: Miejo University, Nagaya, Japan
Contact: Email: fef03@cmlab.meijo-u.ac.jp
WWW: http://cmlabtp.meijo-u.ac.jp/fef03/index.html

7-10 April 2003 — **Complas 2003 - VII International Conference on Computational Plasticity**
Venue: Barcelona, Spain
Contact: Email: complas@cimne.upc.es
WWW: http://www.cimne.upc.es/congress/complas

30 June-3 July 2003 — **Structural Membranes 2003 - International Conference on Textile Composites and Inflatable Structures**
Venue: Barcelona, Spain
Contact: Tel: (34) 93 - 401 74 41, Email: membranes03@cimne.upc.es
WWW: http://congress.cimne.upc.es/membranes03

27-31 July 2003 — **USNCCM VII - 7th U.S. National Congress on Computational Mechanics**
Venue: Albuquerque, New Mexico
WWW: http://www.escc.sandia.gov/usnccm.htlm

24-28 July 2004 — **ECCOMAS 2004 - International Congress on Computational Methods in Applied Science and Engineering**
Venue: Jyväskylä, Finland
WWW: http://www.mit.jyu.fi/ECCOMAS2004

September 2003 — **Adaptive Modeling and Simulation**
Venue: Chalmers University
Contact: Pedro Díez, Email: pedro.diex@upc.es

2004 — **WCCM VI - 6th World Congress on Computational Mechanics**
Venue: Beijing, China
Contact: Prof. M. Yuan Email: yuanm@pku.edu.cn

IACM Expressions

Bulletin for the International Association for Computational Mechanics

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