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Front Cover
Parallel adaptive simulation of incompressible Nacier-Stokes equations
Figure 3 of Computational Mechanics, an area of blossom in Brazil *by P.R.B. Devloo, A.L.G. Coutinho and E.B. de las Casas.* Pages 22 - 25

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editorial

The IACM President contemplates the millennium

This is my first opportunity since being elected IACM President at the World Congress last year to communicate some thoughts about IACM and the field of Computational Mechanics in general. Firstly, I am very honoured and pleased to hold this office and intend to work diligently over the next four years to achieve the goals of the organization.

The new millennium is imminent and with it comes the opportunity to take stock of where we have been and where we are going. The development of the field of Computational Mechanics was clearly one of the great scientific and engineering achievements of the second half of the twentieth century and we can all take great pride in having been active participants in this epoch-making movement.

But what of the future? I believe we are on the threshold of a period of even greater potential in which new areas of application will open up and and new technologies will be developed reconstituting and revitalizing the field. The Internet is revolutionizing many aspects of life and it is only a matter of time before it significantly impacts Computational Mechanics. We can also look to other recently developed software and hardware technologies, such as web-based computing languages (e.g., Java and VRML) and ever more powerful commodity microchips, as platforms for new advances in our field. We are also seeing the integration of many previously disparate technologies, such as medical imaging and geometric modelling, opening the way to exploiting Computational Mechanics in entirely new areas. The list of intriguing, new opportunities abounds.

The coming years should be a truly exciting time for all involved in Computational Mechanics. We are embarking on a journey of continual growth and discovery and one in which IACM promises to be at the forefront of international activities in the field.

Thomas J. R. Hughes
IACM President

The Study of Crystalline Morphology Effects on Sheet Metal Forming

(by using Elastic/Crystalline Viscoplastic FEA)

by
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Japan

In this paper we focus to investigate the effects of the hardening-softening evolution, the crystal grain size and orientation distribution on the strain localisation of the rectangular sheet under the uniaxial tension by using the Dynamic-Explicit finite element code based on the crystalline plasticity theory. Recently, great progress in the measurement technique of crystalline microstructure has been achieved. It offers the possibility to develop the meso-scale crystalline model. This crystalline modelling consists of two main factors, (1) morphology - the lattice structure, orientation, and grain (shape, size and boundary), (2) hardening - softening evolution equation - the self evolution and the interaction one between the slip system. The investigation is conducted by adopting aluminum alloy and multi slip hardening evolution equation determined by experiments. We focus on the texture effects on the plastic instability.

The effects of the grain size on the strain localisation and the selected crystal orientation on the earing of the cylindrical cup are studied.

"... focus on the textured effects on the plastic instability."

Elastic/Crystalline Viscoplastic Material Model

Constitutive equation

The crystalline plasticity theory, which is based on the hardening and softening evolution equations defined on the slop system of a crystal lattice cell, is employed to describe the anisotropy and heterogeneity of meso-scale characterisation of plasticity of sheet metal (Beaudoin et. al 1994), (Becker 1995), (Skalli 1985). Plastic anisotropy of sheet metal is mainly caused by the texture - selected orientation. The texture of the polycrystal metal is modelled by assigning the Euler angle set to the integration point of the finite element. It means that the crystal grain corresponds to the finite element integration point. The orientation is randomly selected from the corresponding sample set of typical texture of the cold rolled FCC sheet metal, such as Brass, Copper R and Cube textures.

The derivation procedure of a elastic/crystalline viscoplastic constitutive equation is detailed in references (Pierce et al 1982, 1983), (Needlemann and Asaro 1985), (Nakamachi 1996, 1997).

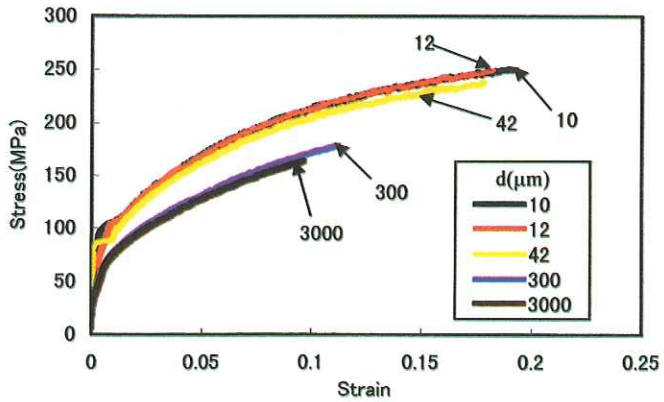


Figure 1
Stress-strain relationships of A5052 uni-axial tension experimented (d - 10, 12, 42, 300, 3000μm)

Voronoi polygon modelling

The rectangular sheet 0.1 mm x 0.3 mm with the thickness 0.005 mm is divided into 10, 30, 50, 100 crystal grains. These correspond to the polycrystal sheet with the average grain size 55, 32, 25, 18μm, named model-55, model-32, model 25, model-18. The Voronoi polygon division process is briefly explained below. The centre points of grains are located in the rectangular domain. Using the midperpendicular between the selected neighbouring points, the outlines of crystal grain can be drawn. The Voronoi polygon surrounded by the midperpendicular can be obtained. By repeating this process, finally the Voronoi modelling to predict the polycrystal sheet metal is completed.

The orientation of the crystal lattice, which represents the typical texture, such as Brass, Cube, Copper and R, is assigned to Voronoi polygons. Actually, the finite element integration point, which locate in Voronoi polygon, has the assigned orientation. Each texture - selected orientation - has the deviation of 0, +-1, +-2, +-5 degrees. The more deviation, the more the grain number. The percentage of the assigned texture is selected as 40% for Brass, 10% for Copper, 30% for Cube, 20% for R. Those orientations are assigned randomly to the finite element integration.

Finite Element Analysis

The parameters adopted in FE analyses were determined by A5052 uniaxial tension. The critical resolve sheer stress υ_0 for the polycrystal sheet as shown in Figure 1 were given as 9.72, 11.07, 11.53 and 12.o Mpa, respectively at first. The influence of the grain size on the strain localisation was studied by this dynamic explicit elastic/crystalline viscoplastic finite element analysis.

Material Properties

Young's modulus	E069GPa
Poisson's ratio	$\upsilon=0.33$
Ref. Strain rate	$\alpha=0.5/s$
Strain rate sensitivity exponent	m=0.03
Specific heat	$c=9.6x10^5(mm)^2/(s^{2o}C^{-1})$
Density	$\rho=2.7x10^{-6}MP_a/(mm/_s)^2$
Hardening coeff.	C=0.610
Hardening expo.	N=0.30
Init. Sheer strain	$\gamma_0=0.003$
Number of FE	1200

The nominal tensile strain rate 1000/sec was adopted, because the dynamic effect on the strain localisation can be neglected. The material viscosity - rate sensitivity - is also small enough to be ignored. *Figure 2 and 3* show the stress-strain and tensile strain- maximum thickness strain relationships, respectively. It confirms that the larger the crystal grain the quicker the strain localisation occurs. The failure occurs earlier in case of the large grain size. *Figures 4 (a)-(d)* show the thickness strain distributions at described tensile strains. As the total nominal elongation of the rectangular sheet ε_0 increases, the strain localisation becomes obvious, as shown in *Figure 4*. Finally the extreme strain localisation appears. It also shows that the larger the grain size, the more the strain localised at the specified crystal strain. Further, it is observed that the strain distributes even in the same grain. In case of the smallest grain 18μm, rather uniform strain distribution is obtained. The strain localisation is prevented by the constraint from the larger number of the adjacent crystal grains. *Figure 5 (a)-(d)* shows how the crystal rotates according to the tensile deformation using the {111} pole figures of four models. The tension direction coincides with the rolling direction (RD).

The largest grain size sheet shows more tendency to rotate toward the tension direction and "Cube" texture direction.

Figure 6 shows the results of the cylindrical cup deep drawing in cases of the single crystal having the selected crystalline orientations as described in the figures. The earing in the direction of 0 degree in cases of "brass type" and "copper type" textures, those {111} pole figures are shown in the figures. 45 degree earing was observed in the case of "cube type" texture single crystal.

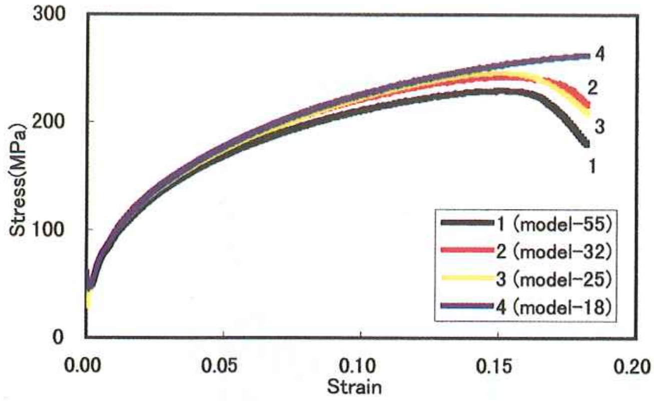


Figure 2
True stress - true strain relationships. (grain size 55, 32, 25, and 18 μm)

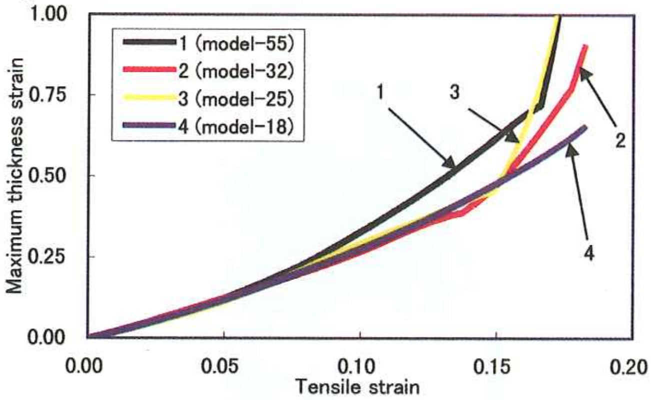


Figure 3
True tensile strain - maximum thickness strain relationships.

Conclusion

The elastic / crystal viscoplastic finite element method based on a newly proposed hardening - softening evolution equation was formulated and applied to the plastic instability of uni-axial tension of the rectangular sheet. The crystal orientation distribution and the crystal grain were modelled by using Voronoi polygon and the combination of the typical textures. It is demonstrated that how the grain

"... the crystal rotates according to the tensile deformation."

Figure 4
Thickness strain distribution in case of four models (grain size 55, 32, 25, & 18 μm)

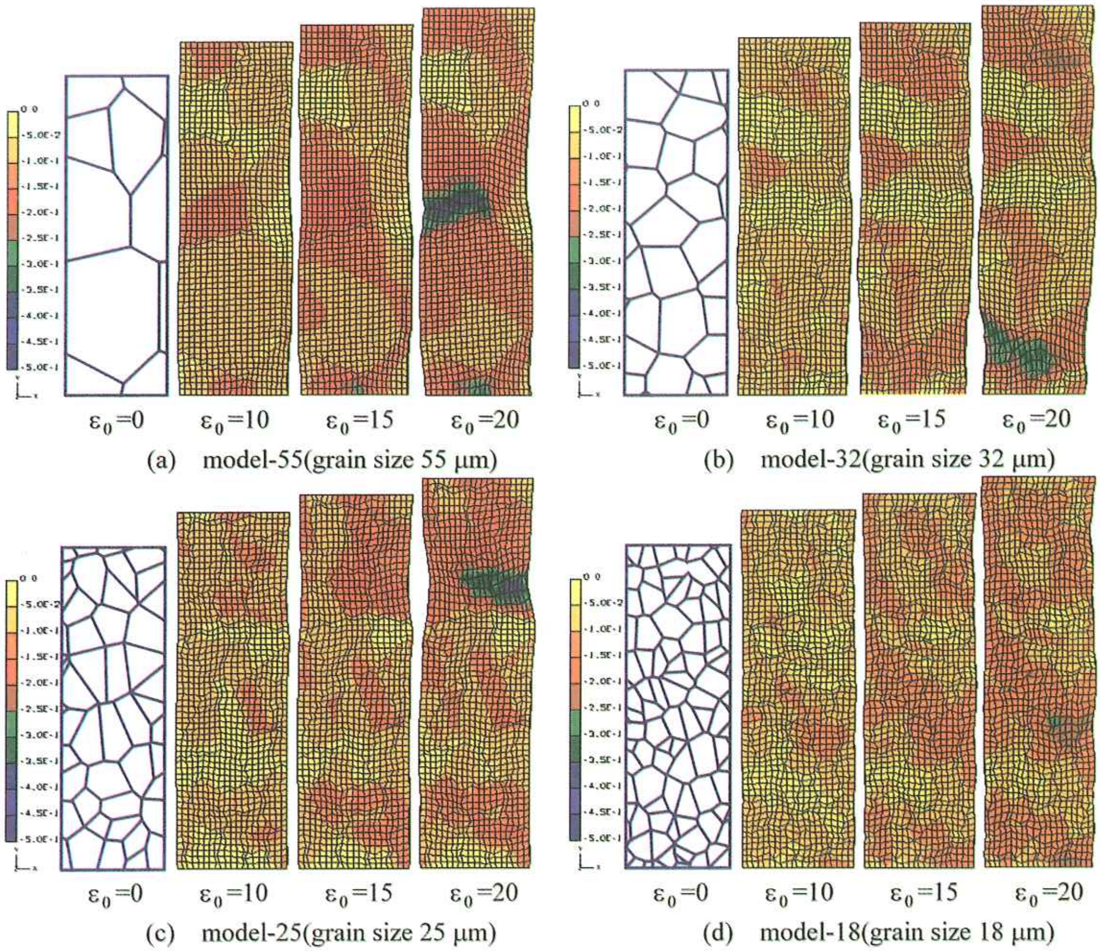
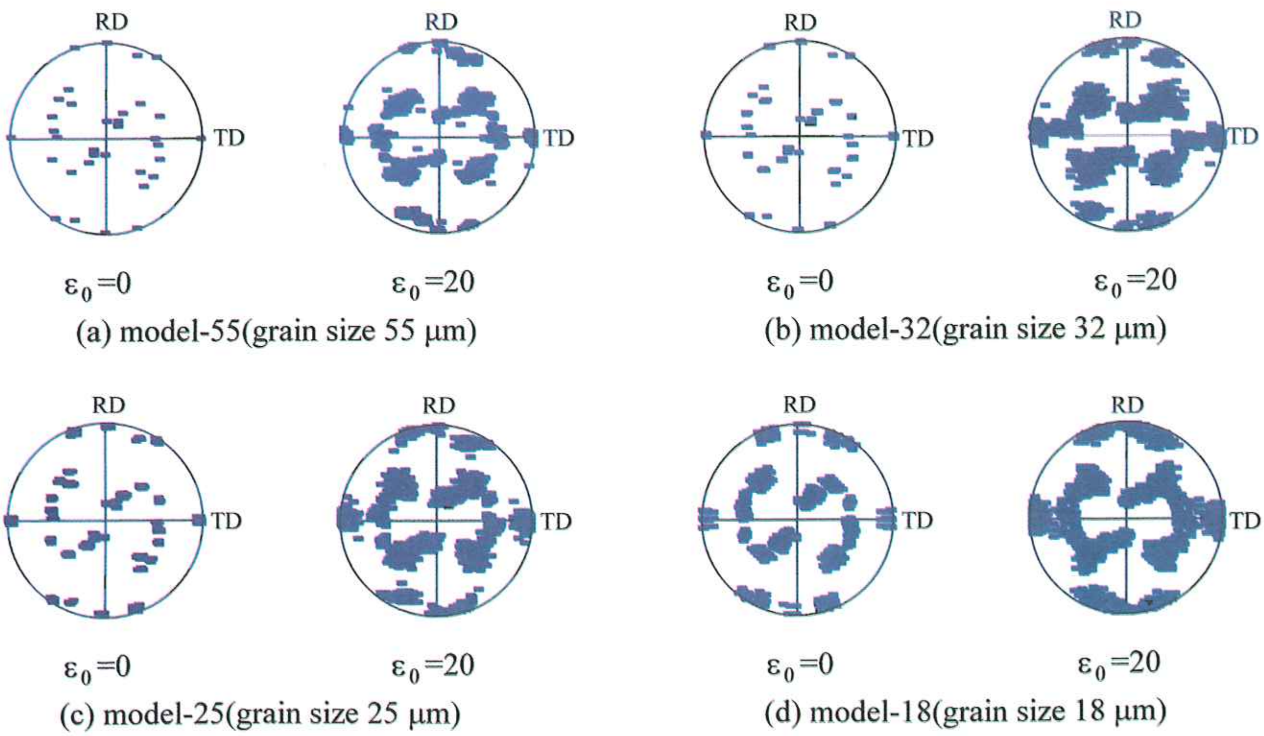


Figure 5
{111} pole figure of four models



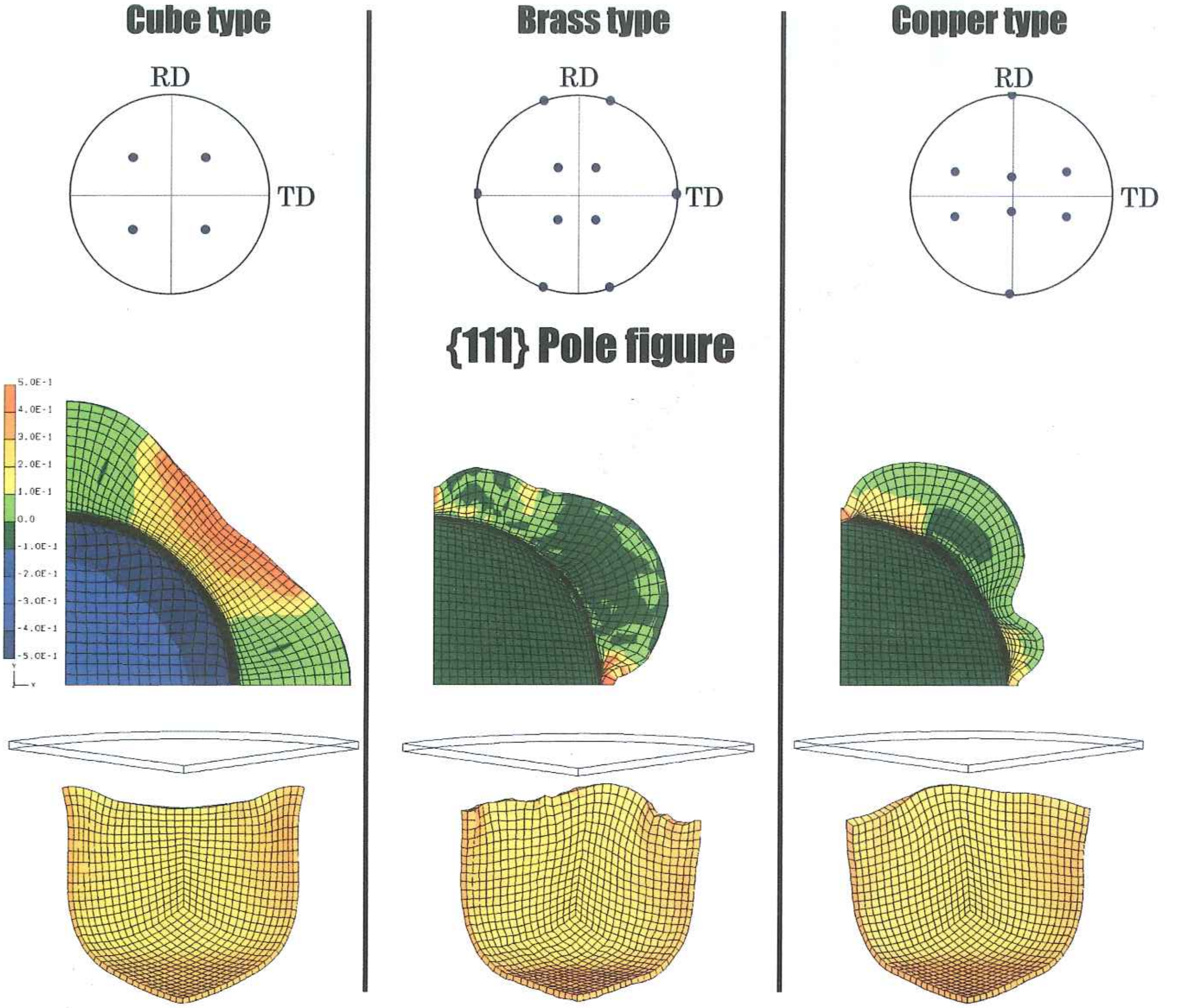


Figure 6
Cyndrical cup deep drawing of single crystal disks having the selected crystalline orientations.

size of the crystal and the effective distance between the slip system affects the strain localisation. Furthermore, the influence of the texture - the selected crystalline orientation - on the occurrence of earing of cylindrical cup deep drawing, was also shown. Finally, the availability of this crystalline plasticity FE code was confirmed. ●

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"... elastic / crystal viscoplastic finite element method ..... was formulated and applied to the plastic instability ..."

The Aura of Numbers

by
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CIMNE
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Looking back towards the origins of mankind it is surprising how humans have evolved in parallel with their wish to quantify the phenomena of nature. Indeed, it is now clear that the progress of civilization has been lead by the capacity of men to express numerically a solution to their everyday problems.

The relationship between man and numbers is intertwined with the development of all sciences, and mainly with mathematics and philosophy. Engineers can perhaps realise clearer than others that numbers form an intrinsic part of our professional life. In our daily tasks we look for quantitative answers to questions such as which dimensions must have a mechanical part or a reinforced concrete structure, when will fracture occur in a brittle material or what the manufacturing cost of a new product will be. As years go by I have gradually and imperceptibly noticed that, without reaching the Pithagorean creed that "numbers are everything", it is true that numbers irradiate their own light which lights up our lives, and that the success of man in the fight for improving his existence lies in knowing first and influencing next, the circumstances which surround him which, in addition to any other subjective aspect, have a distinct numerical value.

Figure 1
'Numbers in Colour' by Jasper Johns

The joint path followed by man and numbers through history has distinct features. The numerological conception of the universe initiated by the school of Pithagoras, evolved for over twenty three centuries up to the discovery of infinitesimal calculus by Newton and Leibniz. Nowadays, once the exact (analytical) solution of these equations has proven to be impossible in most cases, numbers return as the protagonists of the story. The come back of numbers has happened throughout the numerical solution of the differential equations, that is by providing quantitative values to the parameters which govern the mathematical equations of a problem in science or engineering.

There is nothing new in above ideas. The role of numbers made the great Bertran Russell say that "what is more astonishing in modern science is its return to Pithagorism". These words, spoken more than fifty years ago, are even truer today. The recent spectacular progresses in science and technology have been driven by the advances in the so-called numerical or computational methods, aiming to extract quantitative answers from the differential equations deduced by mathematicians in the past two centuries.

The triad numbers - differential equation numbers - has many examples of its admirable symmetry. The initial conception of numbers since several millennia before our era reaches its peak with Pithagoras when numbers took up the centre role in the universe. The subsequent numberization of sciences allowed the development of the philosophy of Plato and Aristotle, the geometry and algebra of Euclid and the physics and quantitative methods or Archimedes which have, for centuries, influenced (even nowadays) the development of mathematics, science and technology. From those inspiring times to the formulation of everything in nature, in terms of differential equations, took almost twenty centuries.

After the discovery of infinitesimal calculus, the inconditionals of Newton and Leibniz probably thought that "differential equations are everything". Nowadays the loop has been closed and any computational method is good only in terms of its capacity to provide "acceptable" numerical results. Numbers are back, two thousand five hundred years after they were taken to the zenith by the Pithagoreans.

The following lines try to present an overview on some of the fundamental steps in the magical braid of numbers. I will refer to the initial conception of numbers, centered around the golden era of ancient Greece, the evolution of "quantitative methods" up to the discovery of infinitesimal calculus in the XVII century and, finally, the resurrection of numbers with the help of numerical methods and computers.

This written journey is obviously equivalent to describing a great part of the history of science and technology and obviously it can not be undertaken in a few pages. Many important achievements and facts will therefore be omitted with the hope that the main argument of the story remains. That is, to show the invisible line which links the first perceptions of numbers some three thousand years ago with the generalized applications of numerical methods nowadays, which even allow to translate into feelings, through virtual reality machines, the output of lengthy computations.

The Perception of Numbers

The idea that the concept of numbers is innate to man has many supporters. The natural perception of numbers reveals itself in human beings, and even in some animals, by the fact that they can detect the presence of small quantities.

Does this necessarily mean that animals can count? The answer is no. For that purpose they should be able to enumerate any series of numbers. Up to now, there is no creature known to be capable of such an achievement. Therefore, men are still the only living species who can argue: "I count, therefore I am".

There are no well defined references of when and by whom numbers were invented. It is however accepted that their origins precede in some thousand years to the Egyptian warriors who counted their captures. Not even the inquisitive Greeks asked themselves explicitly what the numbers were, even though Pithagoras and his followers spoke of numbers constantly as if they were alive.

The question of who invented numbers is probably ill posed. It is possible that numbers were never deliberately invented by a single man or a group of men. Most probably the concept of numbers evolved almost imperceptibly through the centuries. Somewhere, some time, humans started to get used to using numbers without precisely realizing what they were doing. However, numbers 1,2,3 exhibit the trademark of a conscious inspiration and invention. Although it may be a mere speculation, we can imagine an unknown genius suddenly perceiving that a man and a woman, a dog and a cat, a dawn and a sun-set and, in fact, every pair of things have something in common, they are two. From that instant to the conception of the number two it many have been a big step forward, but, surely, someone took it well before the Egyptian soldiers counted their captures.

By admitting that numbers were invented one takes a position in front of many eminent philosophers, Plato amongst others, and relevant mathematicians from the XIX and XX centuries who defend other option. If numbers were not invented by humans they could -not necessarily must- have been "discovered". This is the crossroad where knowledge ends and opinion starts. It is the old divergence between those who believe that mathematics originated from within our minds and those who defend that they came from outside us. The former are convinced that we invent mathematics as a useful tool for describing the surrounding world. The latter maintain that we discover mathematics, that they are "out there" and they would still be there even if there were not mathematicians.

I do not intend to take part in this old controversy. My only concern here is to point out the analogy between the influence that the first perception of numbers had in the origins of our civilization and the impact of numbers nowadays. If the question on the origin of numbers falls within the class of the "non decideables" is of little relevance in front of the indisputable fact that numbers have influenced, as any other concept, the development of man's life. Moreover, it all indicates that the presence and company of numbers among us will increase to help us in the design of our future.

" ... the process of civilization has been lead by the capacity of men to express numerically the solution to their every-day problems."

The Daybreak of Numbers

It is well known that the Greek scholars had renowned predecessors who were also interested in arithmetic and algebra. The oldest archeological evidences show that towards the end of the Neolithic times (3300-3100 B.C.) when the Greeks were little more than a group of nomadic tribes moving around Minor Asia, wise men in Mesopotamia and Egypt had already independently elaborated a numbering system. Babylonians, differently from Egyptians, were not only good mathematicians and algebrists. The erudites of Babylon developed the sexagesimal numbering system. Moreover, they are also credited for having discovered the positional principle, which is the basis of the current representation of numbers.

However, if ever the Egyptian and Babylonian scholars made a mistake, that was the inability to transmit their achievements by creating schools of thought aiming to ensure the survival of their ideas. Overcoming this shortage was, undoubtedly, one the greatest merits of Greek civilization whose benefits have been collected throughout the subsequent centuries up to nowadays.

The Decisive Century

If we believe in points of inflexion in history, the VI century B.C. was a clear example. In that century two Greeks, Thales and Pithagoras, probably the first immortals of exact sciences, produced so decisive advances in mathematics, and in science in general, that made the work of Galileo and Newton possible many centuries later. In all aspects, either scientific, mathematic or religious, the VI century B.C. was a memorable time for western civilization. In this respect, I can only agree with the american mathematician Eric. T. Bell [1] that in that critical period our civilization shifted its evolution from East to West. It is difficult to imagine what the state of the world nowdays would be should this shift never have occurred.

Of Thales of Mileto there are so many stories, as evidences of its deep interest and knowledge of geometry and calculus. The most famous anecdote is perhaps the prediction of a sun eclipse during one the Medic wars. Coetaneous of Creso, the king famous for this addiction to gold and wealth, Thales used to answer to his thankful citizens when they asked him the prize for his services that he just wished "recognition for his discoveries". In this way, Thales probably became the first man who clearly noticed that the intangibles of fame are far superior to material riches.

The Revelation of Pithagoras

The definitive turn towards civilization was, however, given a few years later by Pithagoras.

Two important consequences for the future of science and philosophy emerged from the fascinating contributions from Pithagoras. The first was the belief that the physical universe can consistently be described in terms of numbers. The second was his deep conviction that conclusions reached by means of mathematical reasoning are of greater certitude than those obtained by any other mean. Both opinions have been frequently questioned. Both have been modified once and again to accommodate the advances of knowledge. However, the essence of these two asseverations remains basically unchanged and, nowadays, they can be considered complementary postulates of a single thesis not yet verified: the rational comprehension of the world is possible and, once this occurs, it will agree with the experiences of the senses and will allow man to predict the course of nature.

This is the dream that nowadays, despite of every new discovery, seems a little more distant, although still reachable for many. Pithagoras believed he had found the magical formula in his idea that "everything is number". In the most primitive version, the numerology of Pithagoras covered literally "everything", from heaven to the musical armonies and the intimate human emotions. As the knowledge of universe increased, the "everything" was progressively reduced to more modest proportions. Thus, towards the first half of the XIX century, "everything" covered just the astronomical and physical sciences. The recent evidence that practically all phenomena in nature are expressable by mathematical equations which solutions can be found in terms of numbers, brings back the possibility that "everything" can be explained by numbers. The Pithagorean creed remains thus unchanged, supporting those who believe that man and number form an undissociable binomial from the origin of times.

Before going any further, it is necessary to analyze a doubt which worried Pithagoras during his last days of existence. Indeed the same doubt has returned twenty-five centuries later to disturb modern Pithagoreans. The basic assumption supporting all applications of numbers into science is that nature laws are rational, that is, they are accessible by a healthy mind. This might however not be true.

Concepts such as that of infinity, the evidence that it was impossible to measure the diagonal of a square which sides were rational numbers, or the fact that the length of a circumference which diameter was a rational number was not computable, brought a serious shade of doubt into Pithagoras assumption that the universe could be expressed in terms of known numbers. Something seemed to indicate that a part of the universe is beyond the understanding and control of man. In the more general sense, the universe suddenly appeared to Pithagoras as numerically "irrational". From our own perspective 25 centuries later we see clearly that the word irrational should not be interpreted here as "contrary to reason", but rather contrary to the axioms on numbers accepted in those times.

The evidence that the mathematical truth is beyond all axioms and rules has been defended by many scientists in all ages. In Pithagoras times, Zeno of Enea invented his famous and controversial paradoxes on movement which helped to demolish the classical concepts of space and time and which have influenced many later developments in science and philosophy.

Many centuries after Zeno, in 1931, the Viennese mathematician Kurt Gödel explained in his own way that in order to fully understand nature through mathematics one should go out from mathematics. Gödel's proof on the unavoidness of undecideability has been the incentive for many applications to other areas of knowledge. In particular, much has been discussed on its consequences for any comprehensive understanding of the universe by means of mathematical methods. It has been said that as we can "see" the evidence of Gödel's statement, this necessarily means that the human mind can not be a formal system and, therefore, the sophisticated attempts of the so called artificial intelligence methods, based on reducing the behaviour of the mind to a finite set of algorithms, can never be successful.

Accepting the conclusions of Gödel's theorem, we have to admit humbly that our knowledge of nature is only possible in an "irrational" sense. Thus, regardless of the sophistication of any new theory contributed to the existing ones, new problems will always appear where solutions will be undecideable using the known methods. Once more, the persevering man will advance in his discoveries until he reaches a new crossroads in science and so on. This process is analogous to the search for all figures of some irrational numbers (such as the number π which in thirty centuries has passed from the knowledge of 15 figures to some millions) remaining still the whole infinity of figures to be found.

Three Glorious Centuries

One of the most faithful inheritants of the Pithagorean culture was Plato. Accepting the philosophy of numbers, Plato codified and amplified it by providing a rational basis for the "everything is numbers" of his mystical predecessor.

In his Republic, Plato ordered an intensive education in mathematics for the guardians of his ideal city, since, as he used to say, "all arts and sciences involve numbers and computations". Plato took this obsession into practice in the every day life of his Academy where over the entrance he posted the ban: "Let no-one ignorant of geometry enter my doors".

Plato, differently from his disciple and ideological rival Aristotle, was perhaps the clearest example after Pithagoras of a life devoted to the interpretation of the world through mathematics and also, in a lesser sense, to trying to capture the essence of the Ideas, the mathematical truths, through the experiences of senses. His conclusion, that "mathematical reality lies outside us" was shared by many subsequent philosophers and it links with the belief in a mathematical universe that man can progressively discover and explore.

Euclides of Alexandria

During his expedition to Egypt in 332 B.C. Alexander the Great founded the city of Alexandria where it flourished a cosmopolitan community of mathematicians. Among the wise men who came to Alexandria from Greece was Euclid.

Despite his many contributions, Euclid fame has reached us mainly for being the author of the famous book *The Elements*, probably the most re-published book in history.

The influence of *The Elements* in the development of all branches of geometry was enormous. From a computational point of view geometrical methods were the basis for the evaluation of areas and volumes, which helped to conceive the principles of infinitesimal calculus. Nowadays, geometry plays an essential role in the development of numerical methods for the solution of differential equations over a domain using discretization techniques. These techniques are based on the division of the domain shape into simple geometrical elements, such as triangles and quadrilaterals in the plane, or tetrahedral and hexaedra in space. Indeed geometry is also essential for developing graphic representation methods for visualizing the results of computations.

Archimedes of Siracusa

Archimedes was the best disciple of Euclid and probably the last representative of the school of thought in ancient Greece. He is seen by many as the father of physics as a science and also as the first engineer scientist: the man in search of general principles for application into specific problems. In this respect Archimedes can be considered as the clear predecessor of modern computational methods.

Most developments of Archimedes were motivated by the need of finding the solution to practical problems, generally of military nature. It is remarkable how he managed to combine and extend concepts in mathematics and physics, reaching, in many occasions, to general conclusions such as mathematical formulae of universal validity and, in others, to the numerical solution of everyday's problems. As such, Archimedes can be considered the father of modern applied mathematics and, more specifically, of numerical methods.

Figure 2
'Abacist vs. Algorismist' by Gregor Reisch, Margarita Philosophica, Strassbourg 1504

Archimedes was also the first in proposing a method for computing the number π with any precision. The technique, a predecessor of discretization methods, is based on the fact that the perimeter of a polygon inscribed or circumscribed in a circle approximates the length of the circumference.

The approximate value of π is computed by evaluating the perimeter of the polygon and dividing this by the diameter of the circle. Obviously, as the number of sides increases, so it does the approximation of π. It is indeed fascinating the analogy of this discretization technique with the approach followed by many numerical methods used nowadays to solve more complex problems with the help of computers.

The Long Dark Journey

A number of prestigious Greek mathematicians remained in Alexandria during the Roman Empire. Important names were Apollonius, Erastosthenes (who estimated quite accurately the length of the earth´s meridian), and astronomers Ptoloemy, Heron, Pappus, Diophantus and others.

Despite the efforts of these eminent scientists, Greek mathematics, as many other sciences, elapsed slowly under the power of Rome. It was the prelude of a long period of darkness in Europe, which lasted for many subsequent centuries.

The Shinning from other Cultures of Numbers

From the fall of the Roman Empire up to the end of the IX century Western Europe, devastated by epidemies, hunger and wars, sank in the deepest political chaos, the economy of the mere subsistence and the complete medieval darkness. As an example, arithmetic in those times was simply based on the old Roman numbering system and the use of pebbles or chips on the abacus inherited from the Romans, including the method of counting with fingers taught by Saint Isidorus of Seville.

Fortunately for Europe, other men in far away countries like China and India, continued the inexorable progress in mathematics and physics. Indeed Europe was saved by these remote cultures and, paradoxically enough, through the biggest enemy of Christianity in the Middle Ages.

The Hindu civilization deserves an special remark as it produced the master piece of our actual numbering system based on the three following great ideas:

- The description of figures by graphic signs which do not evoke the number of units they represent.
- The use of a decimal positional system.
- And, last, but not least, the invention of number zero.

These fundamental contributions completely modified the existence of human beings. From that point in history onwards, any arithmetic operation was possible without difficulty and this opened the door to the development of mathematics, science and technology.

" ... numbers are back, two thousand five hundred years after they were taken to the zenith by the Pithagoreans."

Unfortunately, the revolutionary contributions of the Hindu mathematical culture, already developed by the mid V century A.D., took almost eight centuries to be fully accepted by the western world. In fact, the influence of Hindu civilization did not reach Europe directly. This task was the credit of the Arab scholars, who transmitted the science from the Hindus, playing, among many other roles, that of intermediaries between the East and the West worlds.

Among the many Arab scientists who contributed to the dissemination of the Hindu numbers and arithmetic, the mathematician Al-Khuwarizmi stands out. The scientific contributions of Al-Khuwarizmi are collected in two fundamental books. The first, entitled *Al jabr wa'l muqabala* gained so much popularity in his days that the name of the book was the origin of the word *algebra*. The second book of Al-Khuwarizmi was *the Book of Addition and Sustraction following the Arithmetic of Hindus.* This book, as the former, became so popular and prestigious that the name of his author was used as generic reference to the new arithmetic system. In this way, the name Al-Khuwarizmi, once latinized, become *Algorithm*, which initially denoted the system formed by the number zero, the nine significant figures and the calculation methods originated in India. As years went by the name algorithm progressively took the more general and abstract meaning given nowadays.

Thanks to the scientific and technical contributions of the Islam scholars, generally unknown for the majority of western world, Europe was able to initiate, around the XI century, its intellectual renovation. One of the predecessors of the introduction of Arabic science in Western Europe was the French monk Gerbert d'Aurillac who in 999 became Pope under the name of Silvester II.

Figure 3
The Figure 2 by Jasper Johns

During his many travels through Muslim Spain, Gerbert d'Aurillac became acquainted with Arab numbers which he then introduced in other European countries. Unfortunately his contribution was limited to the first nine numbers, excluding number zero and the calculation methods from the Hindus. The explanation of this odd circumstance which considerably delayed the progress of European science was the resistance and conservatism of some officers of the Christian community, hooked to the culture of the Roman numbering system. Gerbert d'Aurillac could not escape to the retrograde spirit of those times. Some said that he practiced alchemy and witchcraft and many thought that having tasted the science of the infidel Sarracens, he surely must have sold his soul to Lucifer.

However, the efforts of the Pope Silvester were not in vain. The first lights of dawn in the medieval night brought up by his work lit the path for many in the slow come back of Europe to scientific activity. This rising of the western spirit, in times of Richard Lion Heart, occurred, paradoxically enough, under the sign of the Cross, precisely the same which indirectly had kept Europe in the darkness.

Thus, through the many trips of the crusaders, from the XII century onwards, Europe started to be acquainted with the work of the Arabs and also with that of Greeks and Hindus from books translated into Arabic language. The cultural contacts between both worlds increased and so was the number of Europeans wishing to get instruction in arithmetic, mathematics, astronomy, natural sciences and philosophy.

In summary, the Crusades allowed the big step forward which neither the science or the willingness of the Pope Silvester had achieved: to impose the number zero and the new calculation methods to western Europeans.

The subsequent invention of printing and the necessity of greater technical knowledge derived from the time of many geographical expeditions, contributed to the dissemination of Arab numbers and the written calculation techniques. These, as a new religion, were finally accepted by the majority of people, therefore contributing to the democratization of calculation methods in Europe[2].

Unfortunately the guards of medieval orthodoxy harshly resisted accepting the new winds which blew in all directions with progressive strength. The transition from the Middle Ages to the Renaissance in the scientific- mathematic world was long and painful and indeed had its victims. As far from the official end of Middle Ages, in 1600, Giordano Bruno was sent to the fire in Rome for defending Copernicus astronomy. A few years later, in 1633, Galileo at the age of 70, had to retract his ideas on the earth moving around the sun.

The effort of these distinguished scientists were not however in vain. Soon before the end of the year in which Galileo died a child was born. This boy was later to take and extend Galileo's legacy to such high levels that both their names would remain as a necessary reference in the history of progress of men. The name of the boy was Isaac Newton.

Numbers Light Up Everything

It can be said that the consequences of the discovery of infinitesimal calculus by Newton and Leibniz for science and technology are comparable to those of the finding of fire for primitive men, or electricity for the industrial revolution.

This statement is, by no means, exaggerated. Before the days of Newton and Leibniz, there was no general procedure for describing (in terms of mathematic equations) the behaviour of a specific problem in physics, such as the transmition of heat in a body, the flow of a fluid or the deformation of an elastic solid. Obviously, as the problem could not be posed in mathematical form, its solution was impossible. After the contributions of Newton and Leibniz it was then possible to describe the behaviour of any physical system of either solid, liquid or gas form by differential and integral equations. Moreover, new techniques were made available to solve these equations in many cases which, despite being simplifications of the general problem, allowed important advances in scientific and technical knowledge. The disciples of Newton and Leibniz were able to say with full conviction that "mathematics are everything", meaning that from the end of the XVII century onwards any problem could be expressed in mathematical form, using the tools provided by the new calculus.

The optimism injected into the scientific community by the first successes of infinitesimal calculus was soon shaded by unpleasant evidence. It was indeed true that any problem in nature could be posed in mathematical form by means of differential equations. However, the "exact" solution of these equations was only possible in a few particular cases, which frequently represented coarse simplifications of reality. The difficulties in finding the universal mathematical formula dreamt by Pithagoras (which would solve all practical problems in science and technology) forced the need for deriving alternative methods for solving the new differential equations.

In this way, at the turn of the XX century, a number of scientists and engineers observed that approximate numerical values of the unknown parameters of a problem could be obtained by "discretizing" the governing differential equations using techniques similar to those used by Archimedes to estimate the value of number π. Numerical methods were then born.

The strategy followed by most numerical methods is to transform the differential equations governing a problem into a set of algebraic equations which depend on a finite number of unknown parameters. This number is in most practical cases of many thousands (and even millions) unknowns and therefore the final system of equations can only be solved with the help of computers.

This explains why even though many numerical methods were known since the XVIII and XIX centuries, their development and popularity has occurred parallel to the progress of modern computers in the XX century.

Numerical methods represent, in fact, the return of numbers as the true protagonists in the solution of a problem. The loop initiated by Pithagoras 25 centuries ago has been closed in last few decades with the evidence that, with the help of numerical methods, we can find precise answers to the problems of universe.

Perspectives of Numerical Methods

History tell us clearly that progress in science and technology has run in parallel with the increasing knowledge by men of the phenomena of nature and the impact of human interventions in these. The unavoidable need for "quantifying" the solution of a problem, such as the design and construction of a building, the prediction of life in a cell or the economic production of food cans, has even increased nowadays. The aura of numbers which has fascinated man since the origins of times, finds out its raison d'être through the extended use of numerical methods fostering development in all branches of science and engineering [3].

We should not forget that numerical methods are inseparable from mathematics, material modelling and computer science. Nowadays it is unthinkable to attempt the development of a new numerical method for solution of a problem in science or engineering without referring to those disciplines. As an example, any new numerical method for solving large scale problems has to take into account the future hardware environment (most probably using parallel computing facilities). Also a modern computer program should be able to easily incorporate the continuous advances in the modelling of new materials.

The word which perhaps best synthesizes the immediate future of numerical methods is "computational multiphysics". The solution of problems will not be attempted from the perspective of a single physical medium and it will incorporate all the couplings which characterize the complexity of reality. For instance, the design of a structural component for a vehicle (an automotive, an airplane, etc.) will take into account the manufacturing process and the function which the component will play through its practical life time. Structures in civil engineering will be studied taking into account the surrounding environment (soil ground, water, air). Similar examples can be found in mechanical, naval and aeronautic engineering, among others, as well as in bio-engineering and indeed in practically all branches of science. Accounting for the non deterministic character of data will be essential for estimating the probability that the new products and processes conceived by men behave as planned. The huge computational needs resulting from a "stochastic multiphisic" perspective will, in the next century, demand better numerical methods, new material models and, indeed, faster computers.

It is only from the perspective of a narrow cooperation between all sides of the triangle formed by a deep knowledge of the physical and mathematical basis of a problem, numerical methods and informaics, that effective solutions will be found for the mega-problems of next century. This cooperation should also be reflected in a greater emphasis for optimizing the human and material resources required for confronting, with enough confidence, the change of scale in the solution of future problems. Last but not least, innovative training schemes will be needed to accordingly educate the new generations who, with the help of numbers, will solve multi-disciplinary problems for the benefit of mankind. •

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Practice What you Teach ...

an interview with
Thomas J.R. Hughes

First of all, may we congratulate you on receiving both the highest IACM and highest USACM awards the last two years?
Thank you. It was a great honor to receive the IACM Congress Medal and before that USACM's von Neumann Medal. Academically speaking, the last two years have been extremely rewarding. It is truly satisfying and humbling when one is recognized by one's peers.

You have also reached other important landmarks this year. I believe the last of your children has flown the nest. What plans do you and your wife have with your renewed freedom?
Yes, our youngest child entered university this past fall. My wife and I have not travelled together significantly since the birth of our first child. We often murmured that "when the children leave" we'll do this and that. Well the time has come! I am taking sabbatical leave in the Spring and plan some time in Italy. I have been offered a visiting position in Pisa, the Galileo Chair, and my wife plans to join me after I fulfill my professional obligations.

Before the children were born we took several trips to Italy together and always enjoyed ourselves immensely. We love the culture, the food, the wine, everything.

This is a long way from Berkeley in the 60's. Some were there with you, others remember those times. What was it really like?
Berkeley is an exciting place and it was especially exciting during the late 1960's and early 1970's. At the time, Berkeley was the capital of finite element research in the U.S. I had become involved in research in the finite element method while working at the Electric Boat Division of General Dynamics in Groton, Connecticut. This was prior to pursuing the Ph.D. I wanted to continue to study finite elements, but I wanted to first prepare myself for advanced research by studying continuum mechanics and mathematics. Berkeley was a spectacular place for all these endeavors and it was my first choice for Ph.D. studies.

I was also very aware that Berkeley was one of the liveliest and most interesting cultural environments in the world. The era was one in which there were student demonstrations and upheaval at universities throughout the U.S., and Berkeley was certainly at the forefront of this activity.

Despite extravagant expectations on my part, Berkeley did not disappoint in any way. In fact, it exceeded my wildest dreams. I had never experienced an environment like it in my life. Graduate study was like visiting an intellectual candy store. The breadth of offerings,the numerous world famous teachers and researchers, and the Northern California life style all had a tremendous impact on me. It was a great time in my life and I benefitted from it immeasurably. Many of my student colleagues at the time are now famous engineers, researchers and teachers. I see many at conferences and meetings throughout the world, and they all share my enthusiasm for the graduate education and experience at Berkeley during that time.

Your work takes you into many various and diverse areas of science but which particular one would you describe as your passion?
I have a number of scientific and engineering interests that excite me. One area though I find particularly intriguing at this time, namely modelling blood flow and surgical planning. Actually, I have had a long history with this subject as I did my thesis research in arterial pulse propagation.

However, I realized at that time (25 years ago) that the software and hardware tools available, and the lack of a scientific mindset amongst surgeons, precluded computational mechanics from having a great impact on the field. Consequently, I did not pursue the area again until about five years ago when a confluence of circumstances created new possibilities. Since then a significant activity at Stanford has been developed and I am very excited by the opportunities. Presently we are developing a surgical planning system in which we use computational mechanics to analyze and compare surgical interventions. This system provides a predictive tool for surgeons who, heretofore, have had to rely exclusively on a diagnostic approach. We have an excellent team in this area at Stanford which spans the engineering and medical schools. It consists of Dr. Christopher Zarins, the Chief of Vascular Surgery, Dr. Charles Taylor, an Assistant Professor of Vascular Surgery and Mechanical Engineering, a number of other faculty, research associates, graduate students, and me.

Is it being so involved with health issues at a scientific level that makes you so conscious of diet and fitness in daily routines?
Yes, it certainly does. Diet and fitness are important considerations when it comes to health issues. For example, a high fat diet and sedentary life style are risk factors in vascular disease. Dr. Zarins emphasizes the importance of exercise in preventing vascular disease. Atherosclerosis typically appears in areas of adverse flow conditions in arteries. Exercise improves flow features which is viewed as a direct benefit. Whenever I think about vascular problems I feel the urge to exercise! Unfortunately, there are other risk factors, some of which we have no control of, for example, genetic factors.

But professionally you see engineers and surgeons drawing together to achieve a mutual goal, is that right?
Engineers and surgeons have much to gain by collaborating. It is manifest that technology has changed, and will continue to change, medicine. Devices, such as grafts, catheters, artificial heart valves, pacemakers, etc., are examples of technologies used in cardiovascular medicine. The engineer and physician are thus natural collaborators. However, historically they have worked to different paradigms. In engineering the paradigm is based on prediction, in medicine it has been based on diagnosis.

I believe, along with my colleagues, that medicine has much to gain by adopting the predictive paradigm.

I understand your oldest daughter was an art major and you too are artistic. Do you think an engineer who is creative is advantaged or even necessary these days?
Yes, early on I felt drawn to both science and art. For a while I thought architecture might strike the right balance, but a series of events caused me to pursue engineering. I believe engineering is a very creative discipline. Only at its lowest levels, does engineering cease to be creative. Of course, the lowest levels of any discipline are uninteresting by definition. The engineering sciences are replete with beautiful theories that evoke strong visual images. I may mention the theory of shells and fluid dynamics as examples. Engineers have always prized excellent visualm depictions of quantitative information. In years gone by, engineering drawings were an art form. Now we rely on computers to convey information visually. This area has had enormous recent impact. Interactive, real-time, three-dimensional visualization tools are now widely available, facilitating animation and multimedia presentation of results. It takes creativity to develop and use these tools to their full potential. Much is gained in the process in teaching and professional practice.

Design is fundamental to engineering and it too represents an essentially creative activity.

What do you think is the reason for the shift in engineering students in America from native American towards foreigners nowadays?
I think there are two reasons for this phenomenon. One is American popular culture. It glorifies athletes, entertainers and even certain professions such as law, medicine and finance, but it misrepresents engineers and scientists who are usually characterized as strange people, often mad, who wear white coats and sit in the corner of laboratories, not communicating with other humans, and dream of blowing up the world or some other dastardly act.

Young people make disparaging remarks about students who are very strong in sciences, even if they excel at other things as well. This seems to turn a lot of young people away from engineering and science.

This is in complete contrast with the time of my youth. Then, if you were good at mathematics you were considered smart and this indicated you would be successful. Everyone wanted to get good grades.

The nation needed a generation of great engineers who could win the space race. The high school I went to was a magnet school that was a training ground for future engineers. It was considered a big honor to gain admittance to it. Times have changed!

The other reason is that salaries can be kept lower if engineers immigrate in large numbers. Recently, a very high-profile effort of CEO's of high tech companies was undertaken to remove immigration quotas on engineers. The argument was that there were not enough engineers to feed the high-tech boom in the U.S. and droves of additional engineers were needed for U.S. companies to remain competitive in the world economy. These arguments have been successfully made before and they were this time.

However, it has become increasingly apparent that the end effort is to motivate American youth to pursue careers in other, more lucrative professions. We seem to have no shortage of physicians and lawyers in the U.S. •

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Computational Mechanics in Norway

by
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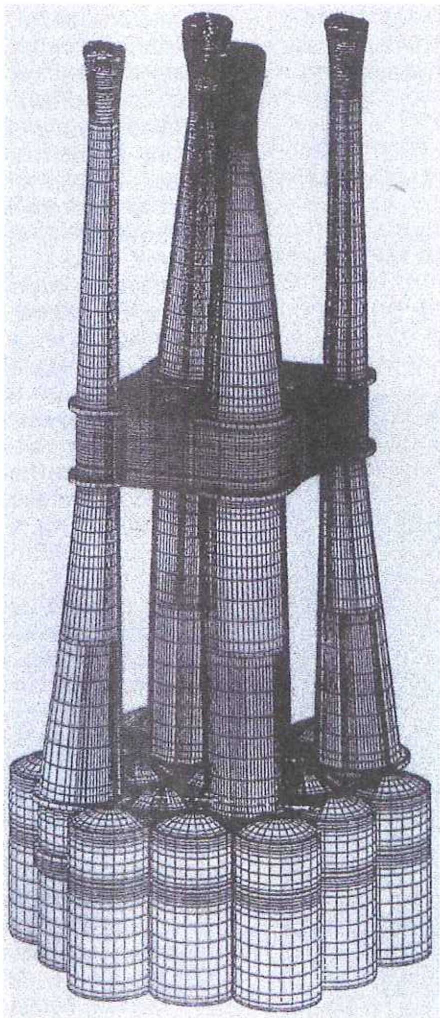
The story of how computational mechanics evolved in Norway is interesting and may at some time be worth an in-depth study by a technology historian. The Norwegian computational mechanics story may be referred to in three main axes. The first is the international dimension, which describes how technology is transferred from one country to another through international networks between universities and between individuals. The second axis shows how strong science and technology groups can develop within a university through inspiration and leadership by strong individuals.

Figure 1
Finite Element Model of the Troll Platform



The third axis, which in fact is particularly important in the Norwegian case, delineates the powerful driving force and interaction that sometimes develop between university on the one side and important industrial developments and needs on the other.

It is widely accepted that the first "finite element paper" was publishes by Turner, Martin, Clough and Topp [1] in 1955, and that University of California, Berkeley Professor Ray W. Clough, coined the label "finite elements" for the computational method some time later. It so happened that Professor Clough chose the Norwegian Ship Research Centre in Trondheim, Norway for his first sabbatical in 1956, a decision believed influenced by a distinct content of Norwegian blood in the veins of his wife and in himself. This visit initiated a lasting link between the Norwegian University of Technology and Science (then called NTH) and the University of California, Berkeley. In the following years this link resulted in a series of lectures, exchange visits and studies, in particular Norwegian research students going to study at Berkeley.

During the early sixties Ivar Holand became Professor of Structural Mechanics at NTH. Although he had a research background mainly from classical shell theory he saw that the finite element method would be the way of the future for analysing structures. He introduced matrix theory of structures and finite element theory into the curriculum of Civil Engineering at NTH long before these topics were commonly accepted [2]. He brought a series of prominent researchers to Trondheim and systematically built a strong research team around him. The visitors included Professor John H. Argyris from Stuttgart who gave his well-known "Trondheim lectures" on the topic of computational mechanics in 1963. The same year Professor J.R. Paulling from Berkeley came to Det Norske Veritas (DNV) in Oslo and introduced new finite element based methods for analysing ships. The Norwegian network later expanded to include many other outstanding institutions such as Chalmers in Sweden, Swansea in the UK, University of Bochum in Germany, MIT, Northwestern and Stanford University in the US and many more.

An important milestone in the computational mechanics history in Norway was the international seminar on Finite Element Methods arranged in Trondheim during the January of 1969. The contributions at the meeting were published in the book "Finite Element Methods", edited by Ivar Holand and Kolbein Bell [3]. The book included a series of important contributions, most notably by Professor O.C. Zienkiewicz and his co-workers. The book soon became a much-used international text and it was even translated into Japanese.

By luck, I was in the first class of 1966 that followed Professor Holand's new computational mechanics course program; indeed, it was a much inspiring and quite demanding experience. As a fresh research assistant I asked him to be allowed to develop a general-purpose finite element program. This program would facilitate general large-scale computations, combination of different types of elements, and would permit a wide span of practical applications through flexible input and output. After one year's work, the first version of this program, named SESAM [4], was sold to DNV in Oslo. DNV primarily intended to use the program for analysing large ship structures. However, in 1970 the offshore oil era started in Norway, and DNV focused much of the further development of the program on analysing offshore structures. Through the years, SESAM [5] has become an "industrial standard" for analysing offshore structures; in fact, nearly all of the 30 concrete platforms in the North Sea have been analysed by using this program. New versions of the program have been developed through the years, and the next version of the program is due in a few months.

There can be no doubt that the advancements in Norwegian offshore technology, starting from scratch thirty years ago, to being a world leader in development of large offshore installations today, is, to a large extent, closely linked to the "finite element story" just described. For instance, the Norwegian CONDEEP type reinforced concrete offshore platform is a direct result of being able to analyse complex shell structures exposed to extreme load environment. An example of a finite element model for such a structure, the Troll Platform, is shown in *Fig. 1.* The complexity of this structure is evident, and building the element model using multilevel super-elements (sub-structuring) and defining the total input data is a very extensive and demanding process. Typically, some of the largest finite element models may involve more than 2 million degrees of freedom and more than 200 different load cases.

Figure 2
An Example of "Pushover" Analysis by USFOS

Unfortunately, the Norwegian offshore history also shows that things can go wrong, very wrong. In 1980 the Norwegian floating housing unit Alexander Kielland failed and turned over in a storm and 123 lives were lost. The accident was caused by a sequence of circumstances starting with cracking in one of the pontoon legs of the steel platform. Failure and overturning developed step by step as bracing members were torn off and water penetrated into the structure. The disaster, which has been extensively described in [7], may be seen as a prime example of the importance of structural redundancy and system reliability. It also led to new requirements to carry out failure analysis and analysis of the progressive, ultimate limit state. Considering the complexity of the structures, such analyses can be rather demanding. Two main Norwegian computer programs have been developed for such purposes: FENRIS [8] and USFOS [9]. An example of a "pushover" analysis by USFOS is shown in *Fig. 2.*

"... may be seen as a prime example of the importance of structural redundancy and system reliability ..."

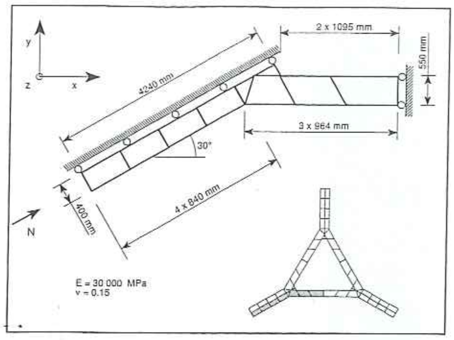


Figure 3
Sleipner A Platform that sank near the city of Stabanger during August of 1991

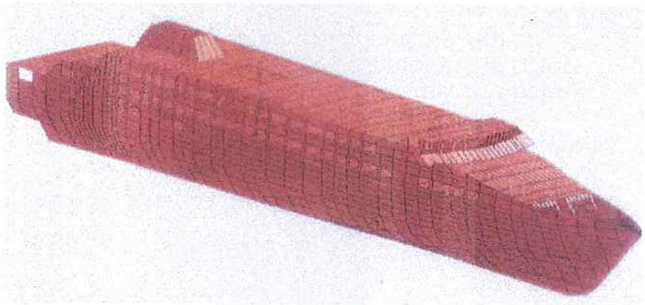


Figure 4
An example of a ship model

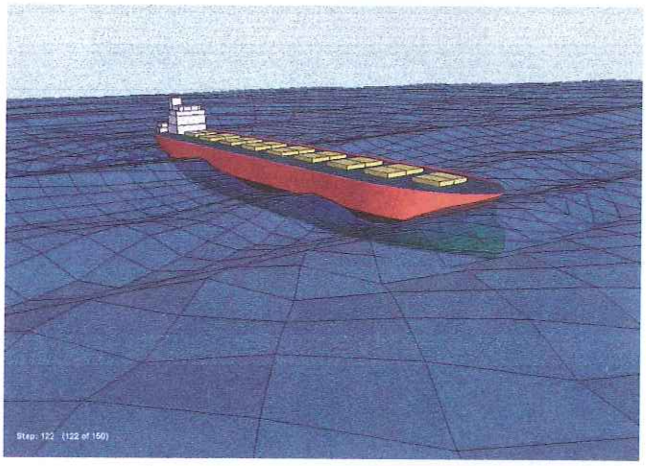


Figure 5
Computed wave pattern and pressure contours generated on the surface of a ships hull

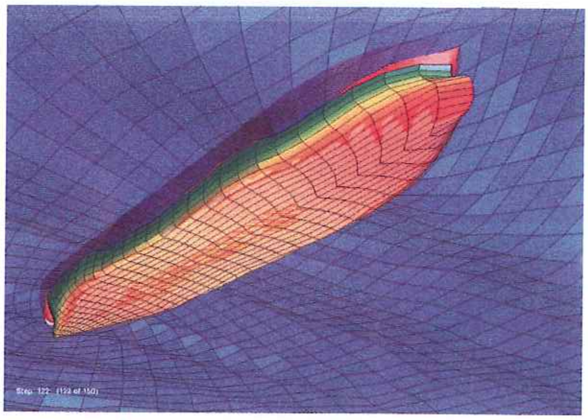


Figure 6
Computed wave pattern and pressure contours generated on the surface of a ships hull

Another example of a serious accident is the "Sleipner A" platform that sank near the city of Stavanger during August of 1991. Fortunately, no lives were lost, but the total cost of the accident has been estimated to about 500 MUSD. The accident report [10] showed that the insufficient design strength was largely due to inadequate finite element analysis with use of too coarse and distorted element meshes and to erroneous stress interpretation, see *Fig. 3*. This case is a textbook example of how important it is to understand the limitations of the analysis method and to carry out quality checks of every phase of the analysis.

Traditionally, analysis of ships has been based on simple beam models and quasi-empirical formulas. However, today ship structures are increasingly being designed by use of extensive computer program packages such as the Norwegian SESAM program. This program comprises extensive modules for interactive modelling of the structure, wave load analysis, local and global strength and fatigue analysis, rule checking etc. An example of a ship model is shown in *Fig 4*. SESAM is today being integrated into a much more extensive information processing and production environment called "Nauticus" [11]. This program deals with the overall analysis processes and information management tasks that are involved in design, approval, building and operation of ships.

The research and development within computational fluid dynamics in Norway started several years later than the structural mechanics efforts. The fluids groups in the Marine Technology Department of NTH and in the Mechanics Department of the University of Oslo have been particularly occupied with free surface flow and wave loads, as these problems relate to the marine industry in Norway. Initially, the research concentrated on potential flow and "strip methods", however, recent work has included panel formulations and inclusion of various non-linear effects. There has been a close co-operation with MIT in this area. Adaptations for practical use have mainly been carried out by DNV and some of the oil companies operating in the North Sea. *Fig. 5 and 6* show the computed wave pattern and pressure contours generated on the surface of a ship hull and have been calculated by means of the program SWAN [12].

Another major Norwegian computational mechanics application area is fluid-structure interaction as it relates to fixed and floating offshore installations, as well as to ships in sea conditions. A particular challenge is that these problems in reality are extremely large and complex; hence, large scale "sledge hammer", three-dimensional techniques are virtually impossible because of the computational cost involved. *Fig. 7* shows wave pattern around a vertical cylinder as a part of investigating a higher order fluid-structure interaction phenomenon called "ringing". *Fig. 8* shows interactive vortex shedding around two adjacent vertical pipelines (risers) using a "layer by layer" simulation by means of the program VISFLO [13].

Although many areas within computational mechanics seem to have matured considerably, there are many important challenges and problems remaining, such as performing large-scale failure analysis of structures, and solving fluid and fluid-structure interaction problems. Moreover, the overall information management challenge, and the integration of the computations within the framework of engineering and manufacturing, must be addressed to an increasing degree. The present conceptual key word is "system", where the sphere of what is meant by "the system" keeps expanding far beyond the computational mechanics It includes aspects like work processes, safety and acceptance criteria, economy and environmental considerations. It is good news for the researcher that, as an increasing number of problems are being solved, even more seem to be appearing. •

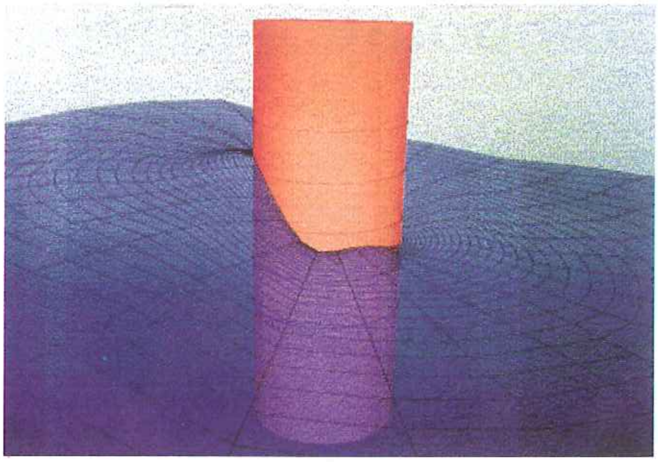


Figure 7
Wave pattern around a vertical cylinder

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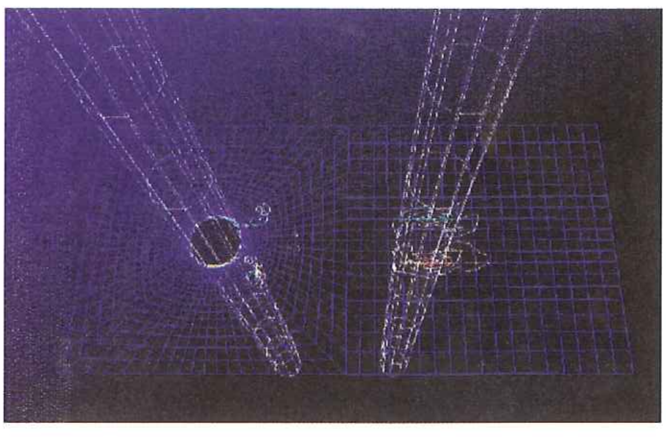
"... the strong driving force and interaction ... between university and industrial developments and needs ..."

Figure 8
Interactive vortex shedding around two adjacent vertical pipelines



Some Examples of the Computational Mechanics Research in Turkey

by
M. Hasan Boduroglu
Istanbul Technical University
and
C. Ruhi Kaykayoglu
Istanbul University

The Turkish Group on Computational Mechanics was formed in 1994 by a group of scientists from various universities of Turkey. Begun in 1993 as a response to the high demands of researchers from university and industry, the members of the acting executive group began to initiate the contacts among academician. The members of the present Acting Executive Council of the Turkish Group are:

Prof. Dr. M.Hasan Boduroglu, *Istanbul Technical Univ.*
Prof. Dr. Mehmet Bakioglu, *Istanbul Technical Univ.*
Prof. Dr. Ertac ErgÅven, *Istanbul Technical Univ.*
Prof. Dr. C. Ruhi Kaykayoglu, *Istanbul Univ.*
Prof. Dr. Nuri Akkas, *Middle East Technical Univ.*
Prof. Dr. Aydin Dumanoglu, *Karadeniz Teknik öni.*
Prof. Dr. Semih S.Tezcan, *Bogaziái Univ.*

Development of computational mechanics in Turkey has followed similar trends in many developing countries. It has started with the matrix methods of analysis of structures using computers. First applications were in the area of structural engineering. During late sixties and early seventies there were several workshops and seminars organised on computational methods. Later on, with the development of personal computers the inevitable use of finite elements in almost any solid and fluid mechanics problems has become very popular.

Symposiums on Computer Applications in Civil Engineering

In June 1988 First Symposium on Computer Applications in Civil Engineering was organised by Prof. Dr. M. Hasan Boduroglu, Dean of the Faculty of Civil Engineering of Istanbul Technical University. In this symposium 39 papers were presented and 9 of which were invited papers. There were also 13 poster presentations. The topics covered in the symposium had diverse areas such as structural analysis, mechanics, hydraulics, geotechnical engineering, transportation, geodesy and photogrametry, and environmental engineering. Half of the invited lectures were from the U.S.A. and Canada. Some of the topics of the invited papers were: Parallel Processing in Structural Engineering, Asynchronous Dynamic Analysis, An Improvement of the VHS Algorithm for Three Dimensional Tidal and Storm-Surge Computations, Reliability Analysis of Wood Trusses and the Use of Computers in Engineering Analysis and Design. The proceedings were then published in two volume set of total 618 pages.
The Second Symposium was held in September 1990 in which 34 papers were presented. The proceedings, totalling 561 pages, were published in two volumes. The Third Symposium was held in June 1992.

62 papers were presented at the symposium. The proceedings of total of 532 pages was published in two volumes. The Fourth Symposium was held in June 1994. 41 papers were presented and the proceedings of total of 417 pages were published in one volume. The Fifth Symposium was held in June 1996 and 47 papers were presented and the proceedings of total of 498 pages was published in one volume. In order to organise symposiums in every two odd years, the next symposium will be held in 1999.

National Computational Mechanics Conference Series

In 1993, the First National Computational Mechanics Conference (UHMK'93) organised by Turkish Group took place on 8th - 11th June 1993 at Istanbul Technical University. The Conference was sponsored by various institutions and private industries, such as; Civil Engineering Department of Istanbul Technical University, ATA Construction and Industry Inc., ESCORT Computer and TEKFEN Engineering Inc.. 60 delegates, mainly academics, attended the Conference along with a number of industrialists. 30 papers were presented over the four day span. 4 invited lectures also presented. The papers reflected the broad range of computational and numerical methods and their applications in industrial processes. The distribution of the papers from various themes were as follows: Fluid Mechanics and Dynamics, 8; Heat Transfer, 2; Industrial Forming Processes, 2; Numerical Methods, 5; Fluid Structure-Interaction, 2; Vibration and Control, 1; Geotechnical

Problems, 2; Solid Mechanics, 7 and Orbital Mechanics, 1. The Proceedings of the Conference was published by Istanbul Technical University the Civil Engineering Department's Press Office. The extended abstracts of the papers were also included in the proceedings in English. The second series of the national computational conferences (UHMK'96) was held at the Karadeniz Technical University on 4th - 6th September 1996 in Trabzon with the supports of TUBITAK (Turkish Scientific and Technical Research Council) and Yavuz Findik Inc., a local Hazelnut company near the University (Trabzon region is well known for hazelnut industry). There were 52 papers in the Conference program. Professors Basar and Ding, invited lectures from Bochum University, Germany presented a lecture titled "Large Strain Shell Analysis with a Shear-Deformation Model". The conference papers spanned a broad theme of computational and numerical methods. Particularly, the papers that reflected the industrial applications were noteworthy. The distribution of the papers are as follows, Solid Mechanics, 17; Biomechanics, 3; Automotive, 7; Numerical Methods, 6; Materials, 4; Fluid Mechanics and Dynamics, 11; Heat Transfer, 3 and Control, 1. The third series of the Conference (UHMK'98) will be held at Istanbul Technical University on 16 - 18th November 1998. There are 84 papers planned to be presented in three parallel sessions. The announcement of the Third conference can be found in web page: http://www.ins.itu.edu.tr/uhmk98.

Towards the future, The Group has plans to establish the "Computational Mechanics and Engineering Research Foundation of Turkey". At the moment, formalities of the foundation are being taken care of by the Group.

A Case Study: CFD Research at Arcelik Inc.

(Communicated with Cezmi Aydin, Murat Dal & Engin Dirik, Resear-chers at Arcelik R&D Centre)

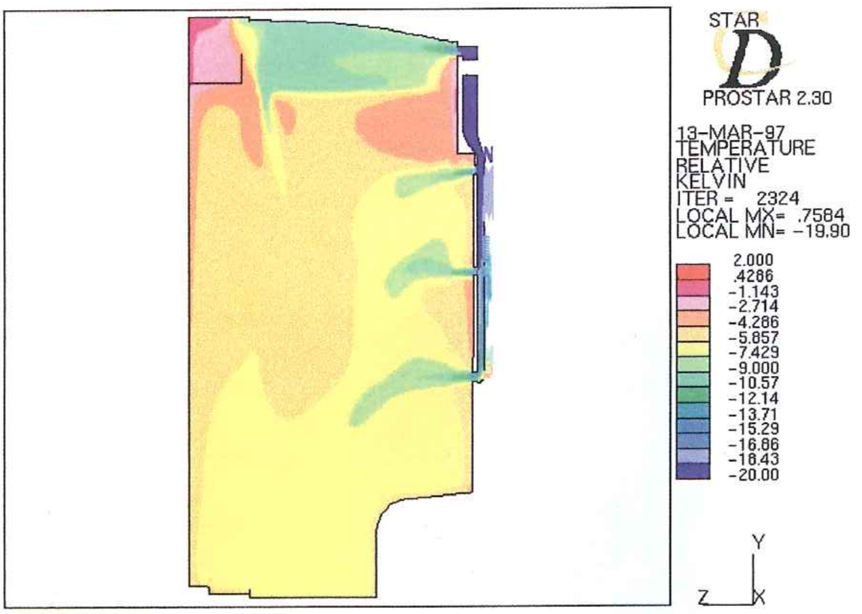
There are large number of companies doing research in the computational mechanics area towards product development. Arcelik Inc. is one of them. Arcelik Inc. is the biggest white household good company in Turkey. Arceliks' trademark (BEKO) is also well known outside the country. Arcelik, Research and Development Centre has been using CFD tools since 1992 and in- house simulation tools were developed. Also many commercial software were bought and applied during the product development cycle. Within the concept of Concurrent Engineering, various projects have been carried out by Arcelik. At the moment, commercial software, namely, STAR CD, CFD2000 and FLUENT are used with HP J280 and HP 735 type workstations. A main computer platform SGI ORIGIN 2000, a super computer, is used for the detailed computations. Some of the CFD related projects carried out by the Arcelik R&D Centre are listed below;

- Flow and Temperature Distributions inside the No-Frost Refrigerators
- Simulation of Drying Process in Dish Washing Machines
- Air Distribution System in Air-Conditioners
- Fan Fluid Dynamics

A sample case study showing the temperature distribution inside a No-Frost Refrigerator is shown in Figure 1. The complex 3-D nature of the refrigerator including the walls was modelled by the STAR CD grid generator module. Turbulent flow computations using k-e type turbulence model were used. This sample result was obtained at the HP J280 workstation that took 5 days of computation time. Arcelik Inc. is also using other tools of computational mechanics so as to design her goods to fulfil the quality agenda of her customers. •

"...to design her goods to fulfil the quality agenda of her customers."

Figure 1
Temperature Sidtribution inside a No-Frost Refrigerator



Computational Mechanics,

an area of blossom, in Brazil

by

Philippe R.B. Devloo
Faculdade de Engenharia Civil UNICAMP

and

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COPPE / Civil - UFRJ

and

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Dept Estruturas - UFMG

The request to write a survey article on finite element research in Brazil, made us very happy. Even though the research community in Brazil is rather small, the particular area of computational mechanics is blessed by a relatively large community of excellent researchers. On the other hand, we were rather concerned with the impact that such an article can have on the Brazilian community. This article will focus on the main research areas being developed at different computational mechanics centres in Brazil and on large research projects. Obviously, not all research projects or research centres will be mentioned, nor was there a strict criteria by which the most relevant research projects were selected. The intention is just to show that good computational mechanics research is being undertaken in Brazil and to show some examples which illustrate this.

The structure of research in Brazil

Computational mechanics research in Brazil is developed in different centres. There are federal universities, state universities, private universities, state funded research laboratories and privately funded research laboratories. Federal universities are funded by the state government of Brazil. Each of the 26 States of Brazil has at least one federal university. The federal and state universities provide free schooling to their students. Most States also sustain a State university system, similar to the system found in the United States : depending on the revenues of the individual States, these universities receive larger or lesser funding.

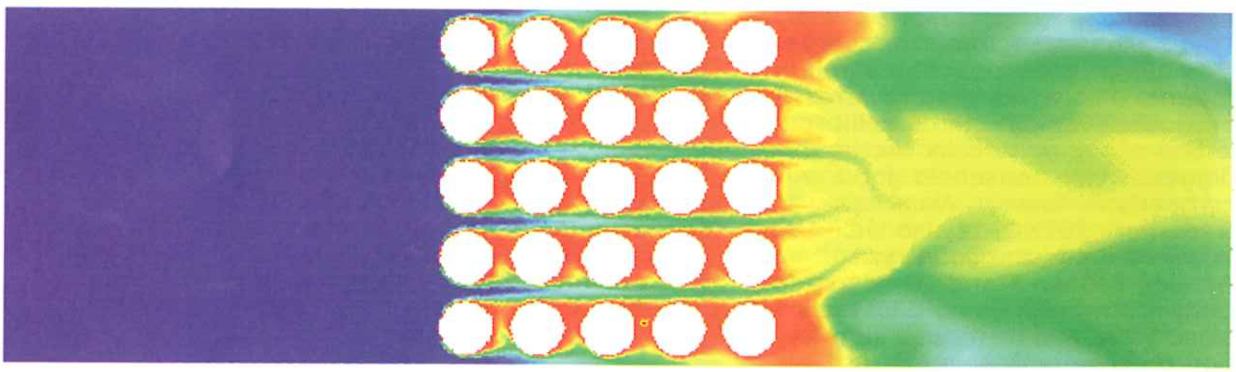
In September 1997 the long due formal Brazilian Association of Computational Mechanics Society (ABMEC) was founded in Rio de Janeiro. ABMEC is congregating close to 200 researchers, and bringing a more organic Brazilian participation in IACM, in an effort to foster cooperation with colleagues from other countries. ABMEC was made possible thanks to more than 30 years of work in computer applications by pioneers like Pros. Venancio, Sousa Lima and Lobo Carneiro.

Main research groups

All areas of computational mechanics research are covered by the Brazilian research institutions. The main research groups in computational mechanics are :

- LNCC (http://www.lncc.br) : the only research centre of the country dedicated to scientific computation, including computational mechanics. Host a large and very qualified group of researchers dedicated to computational mechanics.

Figure 1
Flow-Line Hub



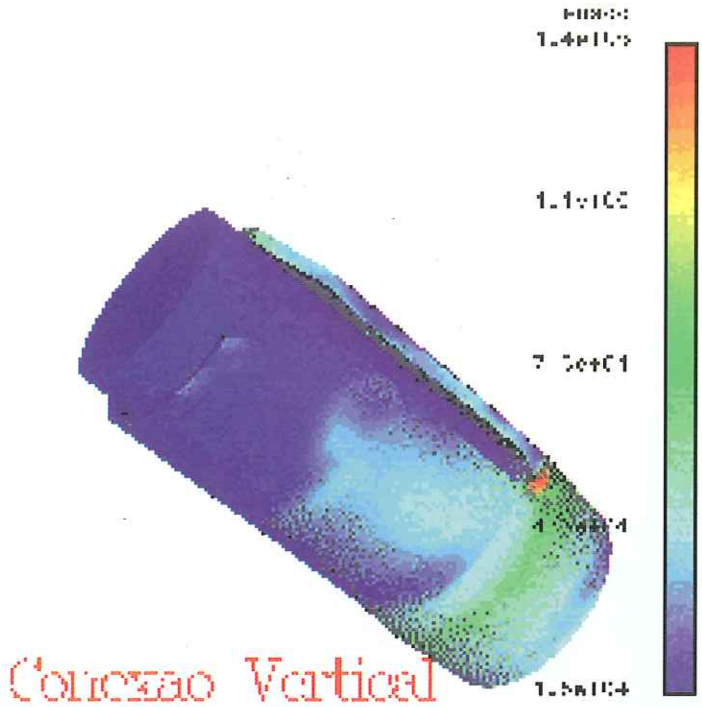


Figure 2
Elasto-plastic analysis of a offshore pile group showing plastic fringes

• COPPE (http://www.coppe.ufrj.br): Has developed important research in cooperation with the petroleum industry. Has a strong tradition in the development of engineering software and has an active participation in major national research projects. Computational Mechanics research is present in many of COPPE's departments, but the Department of Civil Engineering (http://www.coc.ufrj.br) and the Department of Mechanical Engineering (http://www.pem.ufrj.br) concentrate most of the developments. Recently the Inter-disciplinary Area of High Performance Computing (http://www.nacad.ufrj.br) and the Laboratory of Computer Methods in Eng.(http://www.coc.ufrj.br/lamce/lamce.html) have strengthened research in several computational mechanics areas.

• USP (http://www.usp.br): The largest university of the country, includes a very important polytechnical institute. Traditionally very active in interacting with the industry, promoting technology transfer.

• PUC/RJ (http://www.tecgraf.puc-rio.br): The Catholic university of Rio is the most important private university developing research in computational mechanics. It has a distinguished centre on computer graphics and man machine interface applied to engineering.

• Mechanical Engineering/UFSC (http:///www.ufsc.br) : Located on one of the most beautiful settings, is the country's leading research centre in heat transfer and fluid mechanics.

This group, in no way comprehensive, illustrates a very representative sample of the more consolidated research centres in Brazil. Most universities and research centres have researchers which work in the area of computational mechanics. There is no doubt that the tendency is to recognize more research groups dedicated to computational mechanics in the near future.

Main research centres in Brazil

• CENPES (http://www.petrobras.com.br) CENPES is the largest reserch facility of Latin America. It the main research laboratory of Petrobras, the Brazilian petrol company. CENPES deserves a special mention for the amount of applied computational mechanics research it has funded over the past decades.

• LNCC (http://www.lncc.br) : is a research laboratory dedicated to scientific computing. It has fulfiled a role as a reference centre for computational mechanics by organizing short courses, seminars and receiving distinguished researchers.

• INPE (http://www.inpe.br) : is the national aerospace research laboratory and is dedicated to aerospace research in general : satellite development, orbital guidance and control, remote sensing and meteorology. The researchers at INPE apply numerical analysis techniques to most of their research projects.

• CNEN (http://www.cnen.gov.br): is the national laboratory on nuclear power research and coordinates the Brazilian effort to dominate nuclear technology applied to power generation. Brazil did sign the nuclear non proliferation act of the United Nations. Many researchers of CNEN develop computational mechanics research.

"...the roots for a productive scientific community are well set."

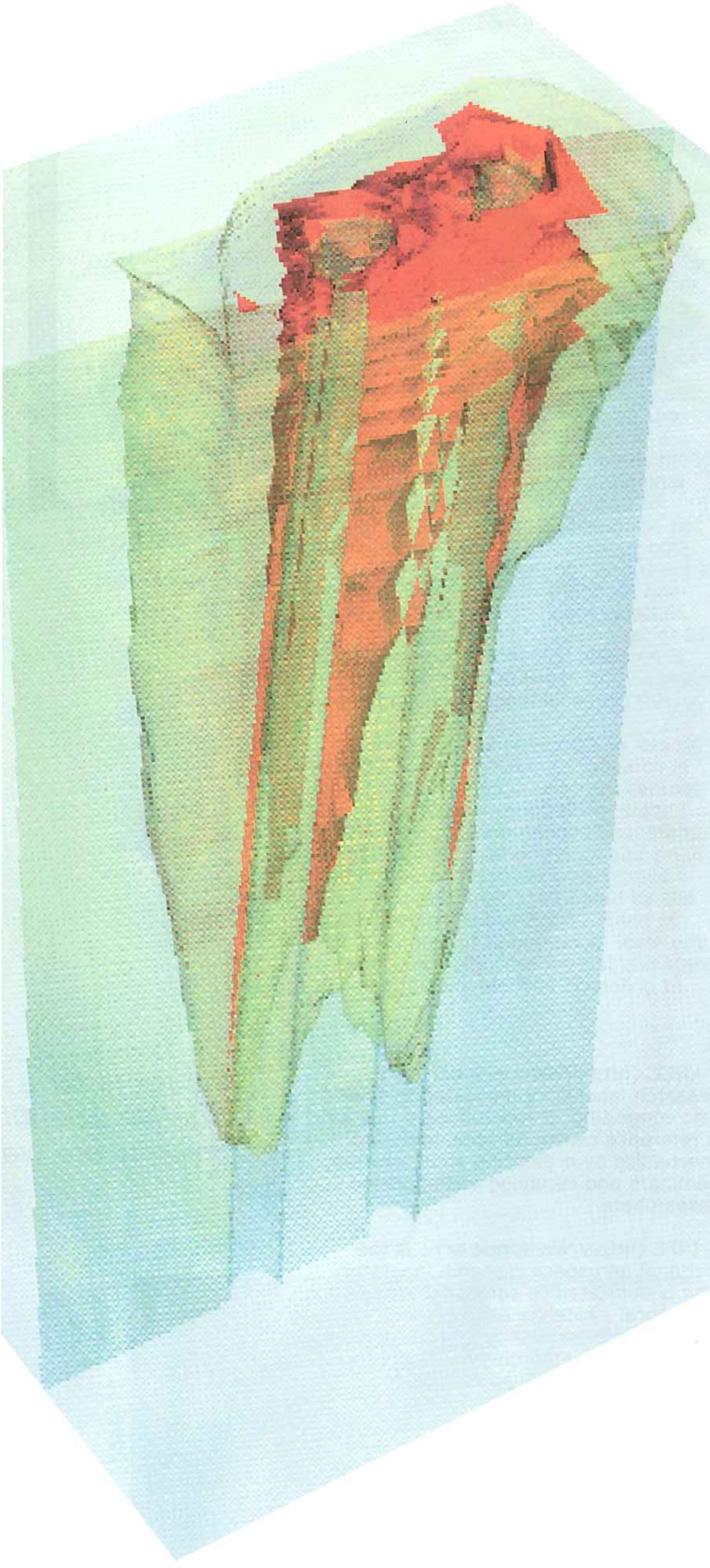


Figure 3
Parallel adaptive simulation of incompressible Navier-Stokes equations with temperature

Computational infrastructure

Brazil fosters both a publicly owned and a privately owned network. There is no dedicated network to scientific computing. In order to promote large numerical research projects, six national super computer centres were developed, geographically spread over the country. These supercomputer centres provide the computer power needed to make large scale simulations possible. Obviously, the dramatic increase in performance/price ratio is a major factor which influences the spread and interest in computational mechanics.

Financial resource for computational mechanics research

With the exception of the support of Petrobras, most basic research is funded by government institutions. At the federal level, all Brazilian researchers have access to these three federal funding agencies :

CNPq, CAPES, FINEP.

- CNPq (http://www.cnpq.br) : funds general research projects and grants a large amount of scholarships for faculty, graduate and undergraduate students. CNPq also grants travel money on a project basis

- CAPES (http://www.capes.gov.br) : its main mission is to finance and evaluate graduate schools. As such, CAPES grants scholarships to graduate students and provides operation funds to graduate school administrations. To a lesser extent, CAPES funds international cooperation projects and finances participation of researchers in conferences.

- FINEP (http://www.finep.gov.br) : is a research financing institution. Contrary to CNPq, which evaluates research topics proposed by the academic community, FINEP traditionally calls for research proposals in strategic areas. The projects which have gained most visibility are :

  PADCT : calls for research projects in strategic areas. These areas cover all fields of science. There hasn't been a PADCT dedicated to computational mechanics specifically, but many projects require an association with a researcher of the field of computational mechanics.

  SINAPAD : National system of supercomputing. This project finances six supercomputer centres in Brazil.

  RECOPE : Finances cooperative projects between academic institutions and industry. RECOPE has turned an important instrument of inter institutional cooperation.

It is written in the Brazilian constitution, each state must create a research foundation which is entitled to 1.5\% of the state income tax. Of the 26 Brazilian states, the states of Sao Paulo, Rio de Janeiro, Minas Gerais and Pernanmbuco have created a funding agency dedicated to the funding of research projects. The funding agency of the state of Sao Paulo, the largest one, FAPESP (http://www.fapesp.br) has been instrumental in supporting research projects within the state of Sao Paulo and has given an edge to the research community of Sao Paulo. FAPESP is very innovative in the modalities of the research projects it proposes and has received international awards for its efficient administration.

Human resources

In the last decades, the Brazilian policy to increase the level of academic excellence has been to grant scholarships to Brazilians pursuing their higher education abroad. There are hardly any major research centres that haven't worked with Brazilian students. Currently the number of foreign scholarships granted has diminished, due to the belief that the main Brazilian institutions have enough qualified researchers to form master's and PhD students.

Today one can say that the roots for a productive scientific community in Brazil are well set. Promising groups are active all over the country, from the drylands of the Northeast to the Gaucho Pampas. The National conference in Computational Mechanics is a forum that gathers more than 200 researchers annually.

In order to foster cooperation between Brazilian and foreign institutions the government prioritizes (sandwich) PhD projects. In this modality, the student develops his course work in Brazil, executes a one year research project abroad and concludes his thesis in Brazil. This model presumes a close cooperation between the Brazilian and foreign supervisors.

Some research projects developed at COPPE/UFRJ

The research group at COPPE/UFRJ is known for their large scale simulations. They are the research group by excellence for developing highly efficient vectorized code. In this section, some research results are presented which envolved large scale computing :

Figure 1 shows results of simulation where one cylinder is driven into a second cylinder by impact. The plastic deformation of the second cylinder is clearly visible. This computation was developed by J. L. D. Alves http://www.coc.ufrj.br

Figure 2 is the result of Elasto-plastic analysis of a offshore pile group showing plastic fringes. This computation was performed by A.L.G. Coutinho http://www.coc.ufrj.br

Figure 3 shows the result of a parallel adaptive simulation of incompressible Navier-Stokes equations with temperature and was developed by Alvaro L.G.A. Coutinho e Paulo A.B. de Sampaio - sampaio@cnen.gov.br

Figure 4 shows the result of a stabilized space-time finite element simulation of shallow water equations applied to the Guanabara Bay, Rio de janeiro, Brazil, and was developed by Fernando L.B. Ribeiro http://www.coc.ufrj.br

Evolution of the Brazilian state model

The evolution of the Brazilian state in the last decade has been significant, partly due to the globalization of the world economy and also due to the opening of the Brazilian market to foreign investors. This has an impact on the current structure of research funding. It is foreseen that private institutions will play an increasing role in academic excellence, and research centres will have to reorient themselves towards increasing cooperation with private companies. Nevertheless, the role of the state in the definition of national policies (and corresponding funding) will continue to be fundamental. •

"...research centres will have to reorient themselves towards increasing cooperation with private companies."

Figure 4
Stabilized space-time finite element simulation of shallow water equations on Guanabara Bay, Rio de Janiero, Brazil

Listen, Mirror and Win

extracts from
The Art and Skill of Dealing with People
Brandon Toropov

Every day we are asked to do more with less. Those who stand out from the pack seem to possess a special knack for getting results, with relative ease. Many others struggle constantly with peers, superiors and subordinates, pleading, cajoling, and haggling, even taking on a good deal of work that wasn't meant for them. Typically, their jobs expose them to excessive stress, and their departments have trouble meeting their goals. How-ever effortless or in born the ability to deal with others may seem on the surface, it is a talent you can master.

One part of this larger jigsaw is how to improve your listening skills - and how to deal with the four distinct initial mindsets from which people on the job tend to operate. These are four basic styles of working that, taken together, describe the first instincts of the vast majority of people we come in contact with every day. The various followers of these four styles take radically different approaches to the task of getting things done.

"Each person you meet knows something you do not."

The four frames of reference are based on two priority scales. Most of us don't fall exactly in the middle of these two scales, we have a preference (and sometimes a strong one!) about the way we should approach a task. When it comes to first instincts, most of us prefer, to some degree, either to:

- **do things ourselves**

  or

- **get things done through others**

THE "WHO-DOES-IT" PRIORITY SCALE
Doing it myself vs. doing it through others.

First Priority Doing it Myself ⟷ ***First Priority*** Doing it Through Others

When it comes to first instances, most of us prefer, to some degree, to:

- Forget about the clock if we possible can and check for every likely error or potential problem in the project

  or

- Accomplish as much as we can within the time constraints imposed by a preassigned deadline - whether it's this afternoon or six months from now.

Questions you are most likely to ask yourself:

- ⇨ What will happen if I miss something?
- ⇨ Suppose one of my key assumptions is incorrect?
- ⇨ Suppose one of my colleagues has some experience in this area that I should be taking advantage of?

or

- ⇨ Why can't people understand things the first time around?
- ⇨ Why do we have to spend so much time in meetings?
- ⇨ What's wrong with acting on a hunch every once in a while?

THE "HOW-DO-WE-DO-IT" PRIORITY SCALE
Getting It Out the Door vs. Getting It Error Free.

First Priority - Get it out the Door
↕
First Priority - Get it Error Free

Questions you are most likely to ask yourself:

- ⇨ What good will a technically prefect product be if the competition brings out a rival release ahead of time and steel away customers?

- Is there a strategic cost associ ated with spending so much time developing a piece of software that the generation of computers is no longer state of the art? Do you then return to the drawing board and start again and where does this cycle ever end?
- Are all errors really of the same potential magnitude? Is it worth holding up a multi-million dollar release for any error?

  or
- How meaningful will keeping retailers happy seem when the company is swamped by calls from angry customers demanding to know why their software refuses to function properly?
- Why does talk about quality and product excellence fade into the back ground when it's most essential - during the time when errors can still be addresses?

Frames of Reference

It 's a good bet that the people we find most frustrating on a day-to-day basis are those who make little or no effort to view matters from any vantage point other than the easiest one (from their point of view,at any rate). By the same token, if we show little or no flexibility and make a habit of clinging tenaciously to the far end of one of the two poles described for virtually every discussions of strategy or resources allocation, we are likely to find a good many discussion sending in deadlock and disappointment.

When people insist on tackling massive projects entirely on their own, even though assistance is available, or insist on "delegating" even the most inconsequential tasks to others or recklessly cut corners to meet a deadline or take a mandate to "improve quality" as an invitation to painstakingly review every comma, regardless of schedule or resources - then there are problems. Balance is everything when it comes to working effectively with others.

Two Scales, Four Squares

All four points on the two priority scales can be incorporated with a "four-square" model. These four sets match the first instinct tendencies of the vast majority of people who are trying to get something accomplished on the job or in virtually any other setting.

The Four Mindsets in Depth

Lone Rangers are self-directed, goal-orientated and generally quite persistent. They take deadlines very seriously indeed. They occasionally overcommit, but only because they have great faith in their own abilities. The Lone Ranger lives to work miracles ... and craves individual credit for having done so.
Pro: Has been known to move mountains.
Con: Often overcommits or makes unrealistic predictions.

Get it Out the Door

Get it Done Myself			Get it Done Through Others
	Lone Ranger	Cheerleader	
	Sharpshooter	Professor	

Get it Error Free

Sharpshooters are just as self-directed and persistent as Lone Rangers; their primary focus, however, is on bringing their technical knowledge (which can be staggering) to bear to a particular assignment, and finding the "holes" in a particular system. The Sharpshooter lives to track down mistakes ...
Pro: Will often catch potentially catastrophic errors.
Con: May drive people crazy with "nit-picking".

Professors share with Sharpshooters a penchant for technical detail. In their world, however, the focus is on developing policies, procedures, and systems that keep everyone focused on high-quality activity. The Professor lives to anticipate and overcome problems ... and keep the operation running smoothly.
Pro: Has a way of turning chaotic groups into well-oiled machines.
Con: May get distracted with endless minutia.

Cheerleaders share with Professors a reluctance to alienate others. They are generally optimistic and gregarious; they operate with a time-sensitive, goal-orientates focus. The Cheerleader lives to interact with others ... and often excels at getting others engaged in the latest adventure.
Pro: Makes people feel great.
Con: May be perceived as someone who "talks a good game".

Where do you fit in?

Listening at all levels.

"Taking notes is one of the most powerful ways to assume a quiet position of understated control."

Listening well to anyone you come in contact with is your secret weapon in dealing with others. So few people truly listen - or pretend to listen - that you can instantly set yourself apart from most of the other individuals by merely paying attention to what they have to say.

Open, attentive listening is not something that should be reserved for meetings with a superior. It's tempting to fall into the trap of thinking that some people are inherently dull. But operating with that working assumption is dangerous. The better assumption is that everyone, regardless of their position in the organisation, has an interesting story of some kind to tell. Each person you meet knows something you do not know.
To deal successfully with someone, you need to know which of the four mindsets he falls into. Get your partner talking - this is the essential first step when it comes to identifying exactly who you're dealing with. The following steps will also give you a better chance of minimising negative exchanges and getting to the facts of what-ever is under discussion.

• Before responding to a person's question, comment, or suggestion, rephrase it in your own world to show that you have fully grasped what was said. Thereby clarifying in your own mind exactly what is under discussion, and you let the other person know that you are in fact interested in approaching the issue as they have laid it out.

• Ask truly open-ended questions "Are there any questions about this" may sound open ended, buy it still requires a yes-no response. When they're issued in a curt or brisk manner, especially by a superior, they are generally interpreted as orders - whether or not intended as such. "What can we do on our end to help you implement this?" or "So what do you think" encouraged discussion and finds out what level of proficiency exists and opens up new avenues of inquiry.

• When you are tempted to classify something the other person has said as wrong or inaccurate, ask for clarification before doing do. If you challenge him directly, by abruptly dismissing one of his points, you will probably completely shut down lines of communication. When you think you spot a mistake, try to respond with a comment like "I'm having a little trouble with so-and-so. Didn't the report indicate X instead?" Warning: such a comment must be delivered in neutral, non-threatening tone. If your comment is perceived as sarcastic, you will encourage your partner to retreat, and you will miss out on any new information that may encourage you to change your own view of the situation.

• During times of stress and conflict, make statements instead of asking questions. Stress is a part of business life; how we respond to it determines, among other things, how much information we get. We often unintentionally encourage others to "shut down" by issuing questions that are perceived as attacks. "Whose fault is this?" By using "Well, I guess I will need your help in redoing this work." says the same without the pointed finger.

• Look the other person in the eye; send "keep talking" signals. Eye contact and appropriate nodding cues will make sure that person knows you value their opinion. If you fall prey to someone who respects your time less than his own, simply set a time limit. "I can discuss this with you until one; then I have to finish this for Sheila."

• Without asking permission, take notes on what the other person is saying. This simple, startling effective technique demonstrates to your conversational partner that you are so interested in what's being said that you are willing to go to the trouble of making a permanent record of the conversation. Taking notes is one of the most powerful ways to assume a quiet position of understated control. This may seem a little low-tech but it carried significant advantages.

- it requires little or no practice.
- It virtually always gets the person talking
- It gives you something to do during those occasional awkward silences.
- It can point you toward key facts and leave you with hard copy.
- It puts you in the perfect position to suggest what could happen next as a result of the

information you've gathered.

Gathering clues as to your conversational partner's initial mindset.

If your conversational partner says things like:

"It will take me longer to explain it than it will for me to do it".
"I'm almost done with it. I think I'm going to stay late tonight".
"When do you need it by?"

... then you are, in all likelihood, dealing with a *Lone Ranger*.

"I found a problem."
"What happens if he uses it like this?"
"The figures don't add up."

... then you are, in all likelihood, dealing with a *Sharpshooter*.

"I've set up a form that will help us keep track of everything."
"Did you log this in yet?"
"Let me put it on my list."

... then you are, in all likelihood, dealing with a *Professor*.

"My people can work miracles with something like this. You watch."
"We've taken on tougher jobs."
"It was my fault. I should have told him to watch out for that."

... then you are, in all likelihood, dealing with a *Cheerleader*.

Mirroring.

Mirroring is simply a matter of knowing your partner's first-instinct mindset and making the effort to present your message in a way that complements and does not challenge the predisposition of your partner. Many of our unproductive interactions become tense because people send messages that are coded in the "language" of the sender, rather than the recipient. By learning the other person's likely first instinct in interpreting your basic message and altering your message accordingly, you take much of the pressure off the other person, and open the way toward harmonious exchanges.

Mirroring means making the effort to see a problem, issue or challenge as someone in a particular group would see it and altering the emphasis of one;'s message accordingly.

Here are some general guidelines on mirroring for use with members of all four groups:

Lone Ranger - frame issues in terms of deadlines - and in terms of your conversational partner's ability to summon persistence and sustained effort to achieve an important goal.

Sharpshooter - frame issues in terms of error eradication - and in terms of early resolution of potentially catastrophic problems, thanks to your conversational partners acknowledged mastery of technical detail.

Professor - frame issues in terms of systems,procedures, and checklists - and in terms of your conversational partner's ability to implement solutions that work well for groups.

Cheerleader - frame issues in terms o impending challenges that can be met only by means of pulling together as a team - and in terms of your conversational partner's ability to bring the best out in people.

A closing thought

Regardless of the conclusions you reach concerning your conversational partner's mindset or driving need, you should, if at all possible,make a point of noting one particular striking remark,joke or observation your conversational partner makes.

When you get the chance, jot down the person's intriguing remark, When, when you find yourself face to face with the person once again, you can work the remark in to the conversation in a complimentary way.

Quoting your conversational partner's own remarks in this way is a remarkably effective way to win allies. It proves to people that you really are paying attention to them and demonstrates to them that you're quite capable of recognising true intelligence (namely theirs) when you see it. ●

"... it demonstrates to them that you´r quite capable of recognising true intelligence."

He who would rule must hear and be deaf, see and be blind.
German proverb

"To lead people, walk behind them."
Lao-Tzu

Iberia Meeting

Meeting of Spanish and Portuguese Associations

Officers from SEMNI (Spanish Association for Numerical Methods in Engineering) and APMTAC (Portuguese Association of Theoretical, Applied and Computational Mechanics) met in Lisbon in September ´98. The objective of the meeting was to present research activities on computational mechanics carried out in different groups in Spain and Portugal and discuss possibilities for joint co-operation in the future. Participants in the meeting included the following:

SEMNI
G. Bugeda
M. Casteleiro
M. Cevera
M. Doblaré
J. Domínguez
J. Goicolea
A. Huerta
J. Oliver
E. Oñate (Chairman)

APMTAC
E.R. Arantes e Oliviera
A.J.R. Borges
L. Cruz
J. Freitas
C. Mota Soares (Chairman)
C. Pina
E.B. Pires
L. Trabucho
P. Vila Real

Decisions were taken to support the national conferences to be organised by SEMNI in Seville (7-9 June 1999) and APMTAC in Aveiro (17 - 19 April 2000). A programme of interchanges of scientists was also discussed. The next meeting between representatives of SEMNI and APMTAC will take place in La Coruña (Spain) in the fall of 1999. •

APACM

Asian Pacific Association for Computational Mechanics

The Asian Pacific Association for Computational Mechanics was formed in June this year. The members of the Executive Council elected are Y.K. Cheung *(Hong Kong)*, C.K. Choi *(Korea)*, T. Kawai *(Japan)*, G. Yagawa *(Japan)*, W. Zhong *(China)*, S. Valliappan *(Australia)*.

The association is in affiliation with the IACM as well as the National Association of the Asian Pacific region. It is proposed to set up a General Council which will include the specialists in computational mechanics in this region.

The objectives of APACM are:

1. to promote, foster, organise and co-ordinate various activities related to computational mechanics in the Asian Pacific region
2. to represent the interests of Asian Pacific scientific community engaged in computational mechanics, in the International Forum as an affiliate of the IACM
3. to co-ordinate conferences, symposia, workshops and other technical meetings in the Asian Pacific region
4. to promote research, commercial and academic activities in the general area of computational mechanics

For further details contacat S. Valliappan on Fax: (61) 2 385 61 39 •

book report

Structural Analysis of Historical Constructions II
Possibilities of numerical and experimental techniques

P. Roca, J.L. Gonzáles, E.Oñate and P.B. Lourenco (Eds.)
374 pages, 1997, US$ 80, CIMNE, Spain.

The growing concern about the preservation of the architectural heritage is motivating great innovation in the techniques of analysis, numerical or experimental, which can be applied to assess the state of conservation and determine the actual needs of repair of ancient constructions.

This book includes the transcription of the conferences presented by a set of specialists during the II International Seminar on Structural Analysis of Historical Constructions, held in Barcelona on November 4 - 6, 1998.

Together with its companion book - the previous volume issued after the first seminar on the same subject - it is intended to provide the reader with comprehensive and updated information on general methodology, analysis techniques and practical cases. •

Mechanical Engineer´s Handbook
Second Edition

M. Kutz, New York, USA (Ed.)
2,376 pages, 1998, US$ 165.00, John Wiley & Sons Ltd.

Because mechanical engineering encompasses such a range of topics, managers from a diverse spectrum of professions require access to the foundations of this broad knowledge base.

The Mechanical Engineers Handbook supplies all of the necessary critical information in an easy-to-use single volume format. In addition, the cross referencing of the Handbook adds extra searchability and utility.

This edition focuses on the explanation of the concepts and how to use them, as well as including new chapters covering Composites, Concurrent Engineering Technologies, Virtual Reality and Ergonomic Factors in Design. •

book report

Fluid Dynamics
Theoretical and Computational Approach

Z.U.A. Warsi, Mississippi State University, US (Ed.)
1998, US$ 89.95,
Springer - Verlag.

Fluid Dynamics presents the basic development of equations in coordinate-invariant form and their use in solving problems in laminar and turbulent flows. Topics include classical boundary layer theory and the Navier-Stokes solutions, structure of turbulent flows, turbulent boundary layers and the mean turbulent equations, as well as linear and non linear turbulence modelling.

This book presents a through examination of fluid dynamics by combining fundamental principles with systematic, mathematical and computational approaches.

Fluid Dynamics enables students and professionals to grasp and assimilate a constructive framework for modern fluid dynamics, providing a set of algorithmic tools to create useful physical and computational results. •

The Wiley Engineer´s Desk Reference
Second Edition

S.I. Heisler, Heisler Associates, California, USA (Ed.)
600 pages, 1998, UK£ 55.00,
John Wiley & Sons Ltd.

This is the second edition of a best selling book for any and all professional engineers and those students who are on track to becoming engineers. As with the first edition, coverage runs the scope of every topic that engineers need to apply in their day-to-day jobs. It has been said that this is the ¨one book that an engineer should pack when travelling¨- it is a reference that will be picked up and used daily.

This edition has been thoroughly updated to include new information on composite materials, semiconductors and computer appliances. It also contains new material covering air pollution as related to combustion engineering. •

iacm news

Olgierd C. Zienkiewicz Award

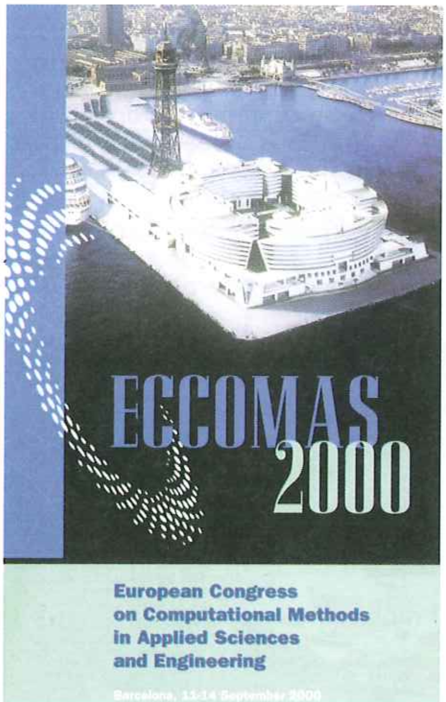
Dr Sanjay Govindjee, Assistant Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley, USA has been nominated for the Olgierd C. Zienkiewicz Award. The silver medal, and a cheque of £1,000, both donated by Wiley, and a certificate from the Institute of Civil Engineers was presented at the Institute in London on 3 November 1998. The award paper entitled "Computational Methods for Inverse Deformations in Quasi-incompressible Finite Elasticity", is published in the Int. Journal for Numerical Methods in Eng., Vol 43, Issue 5 (Oct 1998).

25 Years at Georgia Institute

The Computational Mechanics Centre at Georgia Institute of Technology recently celebrated its 25th anniversary. Under the direction of **Prof. S.N. Atluri** the centre gained considerable international recognition for its innovative and sustained contributions to the field of computational mechanics.

New IACM Officers

Prof. T.J.R. Hughes (Stanford University, USA) has become the new President of IACM. He replaces **Prof. A. Samuelsson** (Chalmers University, Sweden) who has held this position for the period 1994 - 1990. **Prof. H. Mang** (T.U. Vienna, Austria) has been appointed Vice-President of IACM Europe. **Prof. E.Oñate** (Univ. Polit. Catalunya, Spain) has been reappointed Secretary General of IACM. The number of IACM Executive Council members has been extended to 10 ordinary members. The Executive Council will also include the past IACM presidents who will become Permanent Members of the Council.



ECCOMAS 2000 Meeting

Chairmen from scientific and industrial application committees from the forthcomming ECCOMAS 2000 Congress organised with the support from IACM, met at CIMNE in Barcelona, Spain on 22 January 1999. Topics discussed included the scientific organisation of the comgress and the accompanying exhivition at the new Barcelona World Trade Centre.
Delegates who attended are listed below:

Prof. R. Carbó -Dorca Universitat de Girona,
Prof. R. D. Graglia -Politècnico di Torino,
Prof. C. Hirsch -VUB Brussels, *Prof. S.R. Idelsohn* - Ass. Argentina de Mec. Comp., *Prof. D. Knörzer* - Commission of the European Communities,
Prof. O. Mahrenholtz -Technische Univ. Hamburg,
Prof. H. A. Mang -Technische Universität Wien,
Prof. R. Mennicken -Universität Regensburg,
Prof. P. G. Mezey-University of Saskatchewan,
Prof. K. Morgan -University College of Swansea,
Prof. J.R. Mosig -Swiss Federal Inst. of Technology,
Prof. D.R.J. Owen -Univ. College of Swansea,
Prof. J. Periaux -Dassault Aviation, *Prof. O. Pironneau* -University de Paris 6, *Mr. H. Sierra* -Empresa Nacional Bazan de Construcciones. *Prof G. Bugeda, Prof. A Huerta, Prof. B. Suarez, Prof. E. Oñate* - Universita Politecanica Catalunya.

conference debrief

10th GIMC Italian Group of Computational Mechanics

Following a well consolidated tradition, the Italian Group of Computational Mechanics (GIMC) has recently held its annual meeting. This time the meeting (10th) took place in **Trento** from **July 13 to 15 1998**. Over the years the meeting became a more and more precious occasion for exchanging ideas, and checking the national state of art in the field of Computational Mechanics. Moreover it is also a challenging occasion for young researchers, who have the possibility to present their work in a friendly and relaxed environment.

This year there were more than fifty speakers. Among them the presence of the two invited ones have to be cited: Prof. P. Wriggers from the University of Darmstadt, who presented his recent work on adaptivity, and Prof. M. Geradin, from the ISPRA Research Centre who talked about his research on multibody dynamics.

The lectures have covered a wide spectrum of interests in the field of computational mechanics. Both the quality of the contributions and the ensuing lively discussions have to be remarked.

Finally, I wish to thank the University of Trento for the warm hospitality, and all the staff, who took care of the perfect organisation. Trento is a beautifully located town in the Alps, and is was a pleasure to spend time visiting it and its surroundings. •

B.A. Schrefler
Coordinator of GIMC

Delegates from the 10th Italian Meeting enjoying an open air lunch

ICES98 International Conference on Computational Engineering Science

The 7th biennial International Conference on Computational Engineering Science (ICES98) was held in **Atlanta, Georgia** from **October 5 to 9 1998**. This conference attracted a large international audience with the participation of over three hundred of the leading researchers in the area of computational engineering sceince from thrity five countries. For additional information, please contact the Chairman of the Scientific Program Committee, Prof. P. O´Donoghue, National University of Galway, Ireland, at padraic.odonoghue@nuigalway.ie.

The conference provided an excellent forum to discuss all the recent exciting developments in computational mechanics, with a large number of high quality papers in topics ranging from solid mechanics to fluid to electronics to biomedical applications. It was clearly evident that modelling and simulation based engineering is now a maturing technology and is beginning to have a measurable impact on the design of complex manufacturing processes and the development of products.

In recognition of the tremendous advances in computational mechanics, the ICES Scientific Program Committee always honours a number of leading researchers who have made significant contributions to the advancement of computational engineering science. The awardees this year are as follows:

ICES Medal: Prof. E. Stein, *University of Hannover, Germany*
Eric Reissner Medal: Dr S.W. Attaway, *Sandia National Lab. USA*
T.H.H. Pian Medal: Dr. K.-Y. Sze, *University of Hong Kong*
K. Washizu Medal: Prof Y. Tomita, *Kobe Univ. of Mercantile Marine, Japan.*

Following the success of ICES98 in Atlanta, the next conference in this series will be held at the University of California at Los Angeles in August 2000. •

notices

THERMAL STRESSES´99 Third International Congress on Thermal Stresses

Hosted by Tadeusz Ko´sciuszo Cracow University of Technology and organized in cooperation with the Committee of Mechanics of the Polish Academy of Science, this congress will be held on **13 - 17 June 1999** on the campus of **Cracow University of Technology, Poland**.

The objective of the Congress is to provide a forum for engineers and scientists engaged in industrial application and basic research in the field of thermal stresses to exchange ideas and to extend further cooperation among the participants. The congress enables researchers and engineers to meet in one place and conduct discussions, as well partaking in a stimulating social programme including a trip to the Wieliczka salt mines and a raft ride down the Dunajec River.

For further information contact:
Prof Jacek J. Skrzypek
Tel/Fax: +48 12 648 45 31
Email: ts99@pk.edu.pl
http://www.pk.edu.pl/~ts99 •

IASS-IACM 2000 Fourth International Colloquium on Computation of Shell & Spatial Structures

IASS-IACM 2000 will be held at **Chiania**, on the Island of Crete in **Greece** on **5 - 7 June 2000**. This series of colloquia is a forum for discussion of the recent advances on various aspects of the analysis and design of shell & spatial structures. Researchers and designers are incited to exchange their achievements and experience on related topics.

The scope of the Colloquium encompasses the role of computational methods and tools in the analysis and design of shell and spatal structures and will include the following topics: geometric & material nonlinear analysis, static & dynamic buckling analysis, dynamic & chaotic behaviour, computer aided design & visualisation, form finding & potimization, sensitivity analysis, shape, topology & sizing, optimization, composite structures, stochastic & reliability analysis, and error control & adaptivity.

Call Prof. Papadrakakis for details:
Tel: + 03 - 1 772 16 94
Fax: + 03 - 1 772 16 93
Email: coll2000@central.ntua.gr •

IUTAM / IACM / IABEM

Symposium on Advanced Mathematical and Computational Mechanics Aspects of the Boundary Element Method

To be held in **Cracow, Poland** at the Polish Academy of Arts and Sciences from **30 May to 3 June 1999**. This conference has been organized by the Silesian Technical University of Gliwice, Cracow University of Technology and the Committee of Mechanics of the Polish Academy of Science.

The objectives of the Symposium is to provide a forum for researchers in the boundary element method (BEM) and boundary integral formulations in general to present contemporary concepts and techniques leading to the advancements of capabilities and understanding of the mathematical and computational aspects of the method in mechanics.

The symposium will put special emphasis on the theoretical and numerical issues, as well as new formulations and approaches for special and important fields of mechanics.

For more details contact:
DSM&CM
Silesian Technical Univ. of Gliwice
Tel: +48 32 237 12 04
Fax: +48 32 237 12 82
Email: burczyns@zeus.polsl.gliwice.pl
www.kwmimkm.polsl.gliwice.pl/iutam´99 •

IV IACM World Congress

Computational Methods meets Tango at the IV World Congress on Computational Mechanics

The IV. World Congress on Computational Mechanics of IACM took place from **29 June - 2 July 1998** in the city of **Buenos Aires, Argentina**. The congress was jointly organized by the Argentinean Association for Computational Mechanics (AMCA) and the Spanish Association for Numerical Methods in Engineering (SEMNI).

The IV WCCM was held in the Sheraton Hotel which provided excellent congress facilities. The Congress was attended by some 900 participants from 65 countries. Technical presentations included 121 sessions with a total of 720 papers covering most fields in computational solid and structural mechanics, fluid dynamics, forming processes, numerical methods and electromagnetics, among others.

Plenary lectures were given by the following invited speakers K.J. Bathe (MIT, USA), C.A. Felippa (Univ. Of Colorado at Boulder, USA), T.J.R. Hughes (Stranford Univ., USA), T. Kawai (Science University of Tokyo, Japan), J.I. Lions (College of France and Dassault Aviation, France), T. Oden (The University of Texas at Austin and O.C. Zienkiewicz (Univ. College of Swansea, Wales).

Group of Delegates enjoying the WCCM Banquet and the Tango Show in Buenos Aires

The full papers of most presentations have been collected in a CD-Rom Proceedings including some 14000 pages. Copies of the CD-Rom are available from the IACM Secretariat.

The WCCM Congress ran very smoothly under the careful and excellent supervision of the local organisers. The social programme included a reception and a banquet at a local restaurant including a Tango show. This was certainly one of the memorable events of the Congress. The banquet was also the occasion chosen to present the different IACM Awards.

A list of the awardees is shown in the Table below. A meeting of the IACM Executive Council and the General Assembly took place during the WCCM. Among other important discussions it was decided to hold the WCCM in the city of Vienna at the beginning of Summer 2002. Prof. H. Mang and Rammerstorfer will be the co-chairmen of this important IACM event. We wish them the best of luck.

1998 IACM AWARDEES

IACM Congress Medal *(Gauss-Newton Medal)*
Hughes, T.J.R., Stein, F.

IACM Award
Kawai, T., Oñate, E., Samuelsson, A.

IACM Computational Mechanics Award
Belytschko, T., De Borst, R., Morgan, K. Taylor, R., Tezduyar, T.

IACM Award for Young Investigators in Computational Mechanics
Farhat, C., Peraire, R.

IACM Fellows Award
Arantes e Oliveira, E.R., Argyris, J.H., Atluri, S.N., Belytschko, T., Bicanic, N., Carey, G., Cheung, Y.K., Dautray, R., Dvorkin, E.N., Felippa, C., Geradin, M., Hinton, E., Hughes, T.J.R., Idelsohn, S., Kawahara, M., Kawai, T., Kleiber, M., Kroplin, B., Liebowitz, G., Liu, W.K., Maier, G., Mang, H.A., Oden, T.J., Ohayon, R., Oñate, E., Owen, D.R.J., Periaux, J., Reddy, J.N., Samuelsson, A., Schlefler, A., Shephard, M., Stein, E., Strang, G., Taylor, R., Valliappan, S., Wiberg, N.E., Wunderlich, W., Yagawa, G., Zhong, W., Zienkiewicz, O.C. ●

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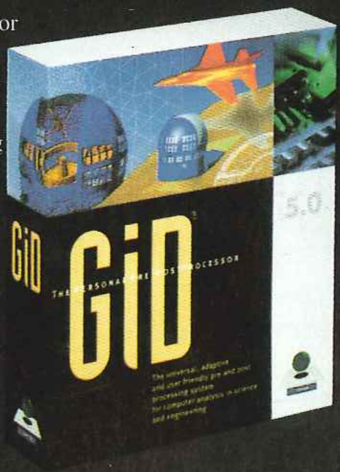

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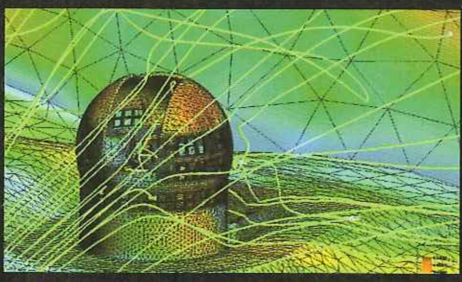

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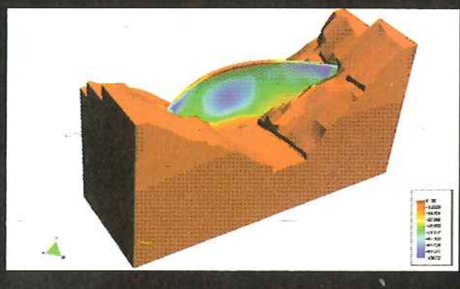
User friendly: The development of GiD has been focused on the needs of the user and on the simplicity, speed, effectiveness and accuracy he or she demands at input data preparation and results visualisation levels.



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http://gid.cimne.upc.es

International Center for Numerical Methods in Engineering

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Gran Capitán s/n

08034 Barcelona, Spain
Tel: +34 932 057 016 Fax: +34 934 016 517
e.mail: cimne@etseccpb.upc.es

conference diary planner

13 - 17 April 1999	**2nd ESAFORM Conference on Material Forming** *Venue:* Giumataes, Portugal. *Contact:* O.S. Carneiro, Tel: (351) 53 501 245, Fax: (351) 53 501 249, Email: esaform@dep.uminho.pt
24 - 26 May 1999	**4th International Symposium on Engineering Turbulence Modelling and Measurements** *Venue:* Hotel Frantour Corse Marina, Corsica, France. *Contact:* D. Laurence Tel: (33) 1-30 87 72 57, Email: Dominique.Laurence@der.edfgdf.fr
24 - 26 May 1999	**International Symposium on Discountinuous Galerkin** *Venue:* Newport, RI, USA. *Contact:* M. Brewster Tel: (1) 401 863 1414, Fax: (1) 401 863 2722, Email: dgm@cfm.brown.edu
30 May - 3 June 1999	**Symposium on Advanced Mathematical and Computational Mechanics Aspects of the Boundary Element Method** *Venue:* Polish Academy of Arts and Sciences, Cracow, Poland. *Contact:* Tel: (48) 32 237 12 04, Fax: (48) 32 237 12 82, Email: burczyns@zeus.polsl.gliwice.pl
Spring 1999	**7th International Conference on Civil & Structural Engineering Computing *and*** **5th International Conference on the Application of Artificial Intelligence to Civil & Structural Engineering** *Venue:* Edinburgh, Scotland. *Contact:* Prof.B.H.V. Topping. Tel: (44) 131-451 3141, Fax: (44) 131-451 3593, http://www.saxe-coburg.co.uk
7 - 10 June 1999	**IV Congreso - Métodos Numéricos en Ingeniería** *Venue:* Sevilla, Spain. *Contact:* IACM Secretariat. Tel: (34) 93-401 6036. Fax: (34) 93-401 6517, Email: semni@etseccpb.upc.es
13 - 17 June 1999	**3rd International Congress on Thermal Stresses** *Venue:* Cracow University of Technology, Cracow, Poland. *Contact:* J. Pawta, Tel: (48) 12 648 45 31, Fax: (48) 12 648 45 31, Email: ts99@pk.edu.pl
16 - 18 June 1999	**4th International Conference and Exhibition on The Recycling of Metals** *Venue:* Vienna, Austria. *Contact:* ASM, Fax: (32) 2 743 15 50, Email: asm@asssociationhq.com
5 - 9 July 1999	**ICCM - 12th International Conference on Composite Materials** *Venue:* Le Palais des Congrés, Paris, France *Contact:* Tel: (33) 5-57 26 53 42, Email: orga@iccm12.org Web: http://www.iccm12.org
4 - 6 August 1999	**The Fifth U.S. Congress on Computational Mechanics** *Venue:* University of Colorado at Boulder, U.S.A.. *Contact:* Tel: (1) 303-492 7011, Fax: (1) 303-492 7317, Email: william@colorado.edu
2 - 5 August 1999	**EPMESC VII - International Conference on Enhancement and Promotion of Computational Methods in Engineering and Science** *Venue:* The University of Macao, China. *Contact:* J. Bento, Portugal, Fax: (351) 848 84 81, Email: epmesc@civil.ist.utl.pt
10 - 13 August 1999	**ASEM '99 - Advances in Structural Engineering and Mechanics** *Venue:* Sheraton Walker-Hill Hotel, Seoul, Korea. *Contact:* Tel: (82) 42-869 8451, Fax: (82) 42-869 8450, Email: technop@chollian.net
31 August - 3 September 1999	**ECCM '99 - European Conference on Computational Mechanics** Solids, Structures and Coupled Problemsin Engineering *Venue:* Munich, Germany Contact: Prof. W. Wunderlich Tel: (49) 89-289 224 22, Fax: (49) 89 - 289 224 21
27 August - 2 September 2000	**ICTAM 2000 - 20th International Congress of Theoretical and Applied Mechanics** *Venue:* Chicago Marriott Downtown, Chicago, Illinios, USA. *Contact:* J.W. Phillips, Tel: (1) 217-333 2322, Fax: (1) 217-244 5707, Email: ICTAM2000@tam.uiue.edu
5 - 10 September 1999	**IUTAM Symposium on Theoretical and Numerical Methods in Continuum Mechanics of Porous Materials** *Venue:* Stuttgart, Germany. *Contact:* S. Diebels, Fax: (49) 711 685 63 47, Email: IUTAM-99@cechbau.uni-stuttgart.de
15 - 17 September 1999	**Second International Workshop on the Trefftz Method** *Venue:* Sintra, Portugal. *Contact:* J.A. Teixeira de Freitas, Fax: (351) 1 849 76 50
3 - 5 November 1999	**XXX CILAMCE - 20th Iberian Latin-American Congress on Computational Methods in Engineering** *Venue:* Sao Paulo, Brazil. Contact: P. se Mattos Pimenta, Tel/Fax: (55) 11 3104 64 12, Email: cilamce@usp.br
16 - 18 November 1999	**UHMK '98 - Third Turkish National Conference on Computational Mechanics** *Venue:* Ayazaga Campus of Istanbul Technical University, Turkey Contact: Mehmet Bakioglu, Tel: (90) 212-285 3700, Email: gakioglu@sariyer.cc.itu.edu.tr
5 - 7 June 2000	**IASS-IACM 2000 - 4th International Colloquium on Computation of Shell & Spatial Structures** *Venue:* Chania, Crete, Greece Contact: M. Papadrakakis, Tel: (30) 1-772 1694, Fax: (30) 1-772 1693, Email: mpapadra@cebtral.ntua.gr
12 - 15 September 2000	**ECCOMAS 2000 - European Congress on Computational Methods in Engineering and Applied Science** *Venue:* Barcelona, Spain Contact: Barbara Schmitt, Tel: (34) 93-401 6037, Fax: (34) 93 - 401 6517, Email: semni@etseccpb.upc.es