ASME International

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AMD

Applied Mechanics Division Newsletter

Lori Graham, Editor

Summer 1999

Report of the Chair

L. Anand

I have been most pleased to have chaired the Applied Mechanics Division's Executive Committee during this past year. This year was another vibrant, strong, steady year for the Division. Current primary membership of the Applied Mechanics Division is the largest amongst the various divisions of the Basic Engineering Group (Applied Mechanics, 5,987; Fluids Engineering, 3,586; Bioengineering, 1732; Heat Transfer, 4,203; Tribology, 572). The Division has a small but reasonable custodial account (about $20,000) which we hope to grow with increasing contributions from the summer meetings. The *Journal of Applied Mechanics* continues to have the largest impact factor and the highest profitability relative to all other ASME transactions journals.

As the first item of business, I wish to express the Division's gratitude to Stan Berger, the former chair, who provided outstanding leadership while serving on the Executive Committee (EC). Secondly, I wish to welcome our new member of the EC, Hassan Aref, of the University of Illinois, Urbana-Champaign. Given Stan's departure, Hasan will maintain a strong Fluid Mechanics representation on the Executive Committee.

This past year there was no summer meeting, but a large percentage of the membership gathered at the 13th U.S. National Congress of Applied Mechanics in Gainesville, Florida (USNCAM is run independently of AMD, although AMD acts as a participant).

As usual, the major affair for the Division was the annual IMECE in Anaheim, California. At the IMECE there were 49 well-attended technical sessions, hundreds of papers, meetings of all the Technical Committees, and the Applied Mechanics Division Dinner. Thanks to Tom Hughes for his expert handling of every aspect of the technical part of the meeting, including scheduling and arrangements of the technical symposia, sessions and papers.

A highlight of the technical sessions was the first ever Koiter Lecture delivered by the 1998 Koiter Medalist, Professor Viggo Tvergaard, of the Technical University of Denmark. Professor Tvergaard was cited for seminal contributions to the understanding of instability and failure phenomenon in solids and structures. His lecture was entitled, "Studies of elastic-plastic instabilities." The complete text of Professor Tvergaard's lecture has recently appeared in the March issue of the *Journal of Applied Mechanics.*

The major event at the meeting is, of course, the Applied Mechanics Dinner, at which the Timoshenko Medal is presented and the medalist speaks about his career and work. The 1998 medalist was Professor O. C. Zienkiewicz, of the

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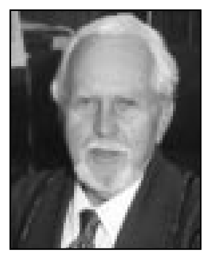
1998 Timoshenko Medal



Timoshenko Medal Recipient O.C. Zienkiewicz

Professor O.C. Zienkiewicz was awarded the Timoshenko Medal at the Applied Mechanics' Dinner at the 1998 IMECE in Anaheim. His pioneering work in applied mechanics includes the establishment of the Institute for Numerical Methods in Engineering at the University of Wales, and the publication of *The Finite Element Method in Structural Mechanics* and other texts which firmly positioned the finite element method within the engineering sciences. He is eminently deserving of the Timoshenko medal

Olgierd C. Zienkiewicz is Professor Emeritus and Director of the Institute for Numerical Methods in Engineering at the University of Wales, Swansea. He also holds the UNESCO Chair of Numerical Methods in Engineering at the Technical University of Catalunya, Barcelona, Spain and the Joe C. Walter Chair of Engineering at the University of Texas at Austin. Dr. Zienkiewicz earned a Baccalaureate from the Copernicus School in Katowice, Poland and his Ph.D. (Engineering) and D.I.C. (Diploma Imperial College) in 1945. He then worked as a Senior Engineer in design and construction of dams with the

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AS I REMEMBER*

by O. C. Zienkiewicz
University of Wales, Swansea

I. INTRODUCTION

It is a great pleasure and honour to be included in the distinguished list of recipients of the Stephen Timoshenko Medal. I would like to take this opportunity to thank the American Society of Mechanical Engineers and the various friends I have in it who must have been responsible for my selection.

Because of my age and my long involvement in the field I know personally, or have known, more than half of the previous recipients of this award. Indeed, the very first recipient and namesake of the award, Stephen Timoshenko, was one of these. We met in 1960 at Northwestern University when he visited one of his early doctoral students, much distinguished in the field, Professor Nick Hetenyi. Both of these acquaintances are now gone, having worked long and contributed much to the subject of applied mechanics. In the long list of recipients, now departed, I find my own Ph.D. supervisor, Sir Richard Southwe1l, and an old adviser and friend, Professor William Prager. Amongst those no longer here is another friend, James Lighthill. Though he received his medal as early as 1963, he was still healthy and fit this year. But many may not know that it is only a few months ago that he met his end - trying to swim round the Island of Sark in the Channel Islands, a feat much younger men would not attempt and which he, using his knowledge of the tides, previously accomplished more than once. I salute his courage and achievements.

TIMOSHENKO: TEACHING AND RESEARCH

Though my first personal encounter with Stephen was in 1960, he was well known to me by that time. In my Ph.D. studies, which started in 1943, his book on *Theory of Elasticity* became my bible. At the outset of my study with Professors Pippard and Southwell I had to acquaint myself with the earlier numerical solutions produced in 1910 by J. F. Richardson. As that work used the Airy stress function to formulate the solution, some introduction to elasticity was clearly necessary. I had many gaps in my knowledge having just completed the very brief, two-year, wartime degree at Imperial College. Therefore, after some unsuccessful encounters with various texts I followed the recommendation of a senior colleague and invested in Timoshendko's famous book, which today still holds a privileged place in my library. That text solved my problem completely. In the first two chapters I found all that was needed and it was only his excellent presentation which made me read further.

This episode - and indeed later contact with the works of Timoshenko - made two important impressions on me. *First,* I realised that even quite complex ideas could be presented in a lucid form. This was most helpful to me later when I was compiling my own first book on the finite element method. Of course this was some 20 years later, but I have always tried to follow the master by avoiding the alternative process, very popular among some scientific writers. They follow the maxim quite probably coined by a German philosopher, which simply said: "*Warum einfach machen wenn man auch kompliziert sein kann.*"

Second, which perhaps took me longer to realise, was the fact that good teaching cannot be practised properly without underlying research. Certainly the example of Timoshenko provided an example for me when I became a young teacher.

The conflict between the two directions of teaching and research, still much discussed in Academia, was originally the subject that I wanted to discuss in this talk - but, enough has been said on this matter. It was after reading Timoshenko's autobiography that I changed my mind and in true "plagiaristic" spirit I adopted his title for the present talk – "*As I Remember*". This will allow me (1) to reminisce a little on my own origins and (2) to discuss the development of my own research and how this led to my present involvement with the finite element method.

3. AS I REMEMBER - THE LINKING OF LIFE'S STRANDS

Timoshenko's autobiography was written in Paris in 1963 and was translated into English with his help five years later when he reached the ripe old age of 90. Reading this book was a most interesting experience, especially when I realised that our own life's strands were interlinked and even intersected on many occasions. Timoshenko was born in the Ukraine in 1878, five years after the birth of my father. The places of their birth, as far as I can trace from the available atlases, were about 100 miles apart and each a similar distance from Kiev. Both of them were citizens of Imperial Russia at the time of their birth, but their nationalities were different. Timoshenko was basically Ukrainian and my father was Polish - both facts quite well recognised at that time when nationalities and citizenships were separate entities.

Though my father was a lawyer and Timoshenko an engineer, it is interesting to speculate whether their paths at one time or another crossed. Certainly, for a limited period both of them lived in Kiev and it is also certain that during later years both were much involved with St. Petersburg where, after the Revolution, the first liberal, provisional government in Russia was formed under the premiership of Kerenski.

It was during that provisional government time that the divergence of their paths occurred. My father, perhaps because of his English wife and knowledge of the English language, was chosen to be the Consul in England of Kerenski's provisional Russian government. However, my father was stranded and started a new life when the Bolshevik revolution erupted in Russia. It was in England that both my sister and I were born. Timoshenko, on the other hand, left Russia by a completely different route. This led him later, via Turkey and Serbia to Zagreb in Croatia where he became a professor at the Technical University for some time, before moving finally to the U.S.A. in 1922.

Those who read his autobiography will find full details of the adventures of his life at that time, and the story of his rise to fame in the American continent and indeed in Europe. He first established his position firmly as an engineer and teacher at Westinghouse, then became a professor at the University of Michigan in Ann Arbor in 1927. Finally, in 1936 he reached Stanford University. The Chair he held there became his last permanent employment although he finished his life in Switzerland - a country he had much loved in his younger days.

So how did our life strands interlink again? Well, I have already mentioned the importance of his text in producing my doctoral work under Professors Pippard and Southwell. It is through the work of the latter that the connection will arise again.

Professor (later Sir) Richard Southwell was, at the time of my doctorate studies, leading a research team concerned with the solution of finite difference equations in elasticity for various problems of realistic application. Indeed many of these problems were concerned with the war effort and therefore confidential. Others were not - like my own analysis of a dam - though the methodology was not publishable during the war. Even the proceedings of the Royal Society were at that time "confidential". It was then that I acquired a general interest, not only in elasticity, but also in fluid mechanics, which to Sir Richard presented just one more problem to be dealt with by a general numerical procedure.

It happened that Southwell was one of Timoshenko's guests at the University of Michigan as early as 1935. This in turn led to a later encounter after the war in 1949 and again at Ann Arbor. At Timoshenko's invitation both were involved in a summer course and this meeting was to be more important. Certainly Timoshenko was always the engineer, and being at that stage engaged in the quantitative solution of problems, he was much impressed by the generality which was established by using numerical, finite difference solutions. I believe this caused him to write an extensive appendix when the second edition of his book on *Theory of Elasticity*, now co-authored by J. N. Goodier, appeared in 1951. This appendix included a full description of Southwell's procedures and solutions. He remained at all times a protagonist of numerical solutions, and it was here that our interests began to overlap.

4. THE ENGINEERING BEGINNINGS OF NUMERICAL ANALYSIS

The first finite difference solutions of equations of elasticity dated back to the work of Runge in 1908 and Richardson in 1910. The latter indeed solved the problem of stress distribution in a gravity dam, a subject of much interest at the time in view of the construction of the Aswan Dam in Egypt. Indeed, during the same period, inconsistencies and difficulties of using standard, "cantilever" approximations were realised and a true elastic solution was obviously needed to settle the controversy.

As Southwell's relaxation methods were available, Professor Pippard - my doctoral Supervisor - set me the goal of providing a very accurate answer to the above question. I was eventually successful and in 1945 I duly handed in my thesis solving that problem, as well as others on meshes very much finer than those initially used by Richardson. The success was due to the use of relaxation methods, but why were they so successful and where-in lay their magic?

It is my belief that the ideas introduced by Southwell, which were of considerable importance could be summarised as:

(i) The recognition that the finite difference equations could be made equivalent to an analogous discrete structural system, and
(ii) The solution of the structural discrete system could be performed most efficiently by an iterative process.

As is well known, discrete structural systems, which provide the basic work for all civil, aeronautical and structural engineers, can be formulated using either the so-called "displacement" method or the "force" method. The first of these methods is obvious and direct, though it is well known that the second (the force method) is also useful in many simple cases of redundant structures for which it provides an economical and elegant solution. It is difficult to say who first formulated the direct displacement (or direct stiffness) approach. Certainly the method was well known at the beginning of this century and certainly it was included in the education of engineers in the 1930's. In this approach stiffness coefficients were obtained for each element of the structure and the system equation was obtained by a simple addition of such coefficients. Matrix ideas were useful in this process and certainly provided a shorthand. They were not, however, essential to the understanding or indeed to the solution of the equations. Fraser, Duncan and Collar in the 1930's appeared to be the first to use matrices for such problems in structural engineering in the aeronautical industry.

The procedures used in the direct stiffness approach were precisely the same for many other engineering systems, typically those that occurred in the solution of pipe network systems or electric networks. In each of these exactly the same formulation applied and in all cases the procedures were the same. It is therefore worthwhile to talk about a *standard discrete system* in this context and we observe in the literature a rapid diffusion of ideas from one area of application to another.

Southwell's method of relaxation used for iterative solution of structures, or similar problems formulated in a discrete system, was a procedure he named "systematic relaxation of constraints" in 1934. In this process, each "nodal" displacement or similar system quantity was first assumed to be fixed in an arbitrary position by imaginary constraints (which he often described as "jacks"). On "relaxing" of such a constraint by removing the "jack", the load was transferred to adjacent nodes and the node in question then was displaced by an amount which was easily calculable. Obviously, in the continuing process of constraint relaxation the load transfer in the structure would ultimately lead to correct solutions when all the load was thus transferred to the supports.

Mathematically, of course, the procedure was carried out in a sequence similar to that of the Gauss-Seidel iteration, but in a manner guided by the user. However, the physical interpretation of the process made it very understandable and such methods as moving a whole group of nodes simultaneously etc. could be used effectually by an intelligent operator to accelerate convergence.

The "structural" relaxation procedure of the Southwell type was apparently used as early as 1922 in Zagreb by a man called Calisev, (viz. Timoshenko). However, much more important was the development of the so-called "method of moment distribution" by Hardy Cross in the U.S.A. in 1932. This preceded the Southwell process by only two years but the *Hardy Cross Method* gained fame internationally and became the standard process for solution of framed buildings, etc. in the 1930's and 1940's.

It is of interest to make a marginal remark that there is a good reason for the success of the Hardy Cross moment distribution method vis-à-vis the Southwell relaxation method then applied to tension bar structures. The "carry over" factor in bending computations was one half rather than unity in bar structures and this of course led to a very much more rapid convergence.

When Southwell entered the area of finite difference computations he generally endowed the discrete equations with a structural interpretation. Thus the Poisson equation, which was well known could represent the deformation of stretched membrane, became in the finite difference net the deformation of a string net with given tensions. The string net being a simple structure could of course be solved by precisely the same procedures as Southwell applied earlier to actual discrete structures and thus the *Systematic Relaxation Constraints of 1934* could be used again.

It is of interest to note that such a physical interpretation of finite difference equations, when used for elasticity, was simultaneously and independently derived in the U.S.A. The conditions of wartime secrecy and the resulting restrictions on exchange of documents prevented Southwell's work with this being widely known there. However, two important developments were derived in the U.S.A. The first one was arrived at by Hrenikoff who in 1941 established a so-called *framework analogy* to the finite difference equations of elasticity, and the second was arrived at by McHenry who in 1943 presented the *lattice analogy*. Clearly engineers liked this physical manner of interpreting equations which also simplified boundary conditions which were now purely physical. These analogue procedures were the precursor of the concept of *finite elements.*

In the classic paper of 1956, Turner, Clough, Martin and Topp presented the idea of dividing the real continuum directly into *elements* of arbitrary shape and directly establishing their stiffness. This became known as the method of Finite Elements only in 1960, following a paper presented by Ray Clough. In the original work very explicit physical models were used, thus completely avoiding the writing down of either finite difference or differential equations.

Much later the finite element method was to become based on the use of variational or weighted residual procedures of Galerkin type applied directly to the differential equations used to model rationally the elements of a continuum. Though most engineers applied this initially to the elasticity equations, it must be remarked that Courant did this much earlier in 1943 - i.e. precisely when Southwell, Hrenikoff and McHenry were active. In his work he showed that such direct procedures could be used for the Poisson equation. Courant introduced what is essentially the same linear triangle as that derived in 1956. Being, however, a mathematician he did not see the need nor did he have the desire to seek a physical interpretation. This perhaps accounts for the fact that his work was only unearthed several years after the mainstream engineers had been happily using the finite element procedure for solving their structural problems.

5. IS F.E.M.'s SUCCESS DUE TO ITS INTUITIVE APPEAL OR ITS GENERALITY?

There is no doubt that it is the intuitive appeal of the finite element process which makes it so popular today. When in the late 1950s I met Ray Clough and for the first time encountered his idea of splitting a continuum into "physical lumps", the procedure did not appeal to me. Surely it all could be done more precisely and conveniently with finite processes I learned from Southwell and used successfully over many years? We did, however, agree that one problem remained which needed solution. That problem was *the analysis of shells of arbitrary shape* as these were much encountered at the time in the design of arch dams and in architectural flights of fancy.

The twin difficulties of the finite difference approach that I had been using were: (a) deciding which set of governing equations to use. Here the choice was wide with many authors contributing different approximations, and (b) establishing analytically the co-ordinates of an arbitrary shell in which the governing equations were to be approximated.

Both Ray and I agreed that here the finite element approach could well be used, employing as elements flat facets of a triangular or rectangular shape with the former of course being needed for arbitrary shells. In such a manner both difficulties could be simultaneously avoided.

For such a finite element formulation the "in-plane" stiffnesses were already well established and surely the corresponding bending stiffnesses based on the Kirchhoff thin plate theory could easily be added.

It was on these problems that Ray's and my own research students spent much time during the early 1960's. By 1965 both of the groups were successful and found suitable formulations for triangular plates. Two years later they established the possibility, and indeed were successful in solving arbitrarily shaped shells. The thin shell modelling by flat facets proved convergent despite a few variational crimes committed on the way, but both the problem and its solution were overtaken by events which occurred in parallel.

My colleague, Bruce Irons, and myself also developed in 1965 the first three-dimensional solution using higher order elements, which could be curved by an isoparametric mapping to fit almost any shape. Clearly, by making such elements thin, any curved shell or plate could be modelled without introducing the super-human efforts needed to establish Cl continuity or the necessity of introducing thin plate and shell theory assumptions.

This development resulted in the fact that by the end of the decade the thin plate and shell problem disappeared, being today largely of historical interest. But many difficulties still were encountered in establishing a robust formulation. I shall not dwell on them except to say that by the mid-1980s all of these were overcome.

Did intuition or mathematics drive the second development to success? Who knows? But without the proper and precise use of mathematics the present case of dealing with thin wall structures would not exist. Further, the developments of rational approaches to such new fields as those of fluid mechanics, electro-magnetism, etc. would not be possible.

Which way should we direct our research now?

6. WHICH WAY NOW?

It is recognised by many that the finite element process of today is but a particular form of the weighted residual approach. The latter was classified well by Stephen Crandall in his excellent book of 1955, though the fundamentals were established by Galerkin somewhat earlier in 1915. (This occurred I believe in St. Petersburg and must have coincided with the time Stephen Timoshenko was there!)

The difference between the various approximation procedures that are today still used is that of the specific trial or weighting functions that are employed. Much of the research done today centres on finding better, newer, and more efficient designs.

Von Karman said:

"The Scientist studies what is, the engineer creates what has never been."

Surely this requires more efficient analysis procedures to design what "never has been".

Charles H. Duell, commissioner of U.S. Office of Patents in 1899 mentioned at the time that

"Everything that can be invented has been invented."

I do not share this pessimistic view and I think we shall see many exciting developments in the coming years. It is evident that both applied mechanicians and mathematicians will continue to contribute to the numerical analysis field.

However, I have reservations about making predictions for the future, especially since in public speeches these may lead to such mistakes as the famous one of Thomas Watson, Chairman of IBM in 1943. His prediction was that

"I think there is a world market for maybe five computers."

. . . . probably more than a trivial miscalculation.

This could only be rivalled, however, by a statement by the famous British scientist, Lord Kelvin, who was the President of the Royal Society in 1895 and apparently said:

"Heavier-than-air flying machines are impossible. "

Perhaps silence on matters of predicting the future is golden – and here I shall rest.

*The text of the Timoshenko Medal Acceptance Speech delivered at the Applied Mechanics Dinner of the 1998 IMECE in Anaheim, CA.

Applied Mechanics Reviews

Applied Mechanics Reviews continues its function of locating, organizing and summarizing the research literature in the field of mechanics, as published worldwide in all languages. In 1998 it contained 27 review articles devoted to various topics in solid and fluid mechanics, as well as a Special Issue on "Fluid Mechanics Problems in Biotechnology" in the January issue, organized by Ryszard Pohorecki of Warsaw. We were also pleased to be able to pass along the thinking of four senior scientists in the form of Retrospectives.

A typical monthly issue contained about 10 reviews of books and about 25 "Notes" (publications such as conference proceedings or handbooks, which are not reviewed, but have their contents summarized). The largest part of each issue continues to be abstracts of articles published in research journals, organized in our detailed classification scheme. Typically, nearly 1600 abstracts appear per month, drawn from the 475 journals received by our publications staff. The Annual Index assembled at the end of the year lists all 19,000 abstracts that appeared both by subject classification and by author.

For more than two years our Editorial Advisory Board and the ASME staff have been strongly interested in making AMR available on the Internet. Current tables of contents (review articles, special issues, Retrospectives, book reviews), as well as those for recent years, are now available online without charge at www.asme.org/pubs/journals, where one finds the link to AMR. We hope to be able to expand the online coverage by the end of 1999 to make available the Journal Literature (abstracts) Sections. Looking to the future, we see AMR to appear in both electronic and printed forms, as long as sufficient subscriber interests justify both types of publication. Readers of AMR are asked to help us determine the future directions of the journal by taking a few minutes to fill out the Readership Survey form located online at www.asme.org/surveys/amr-html.

ARTHUR W. LEISSA, Editor-in-Chief

Report of the Chair

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University of Wales, Swansea. He was cited "for pioneering work in applied mechanics, the establishment of the Institute for Numerical Methods in Engineering at the University of Wales, and the publication of The Finite Element Method in Structural Mechanics, and other texts which firmly positioned the finite element method within the engineering sciences, presenting finite element analysis as a complete and useful methodology for numerical solution of partial differential equations." Professor Zienkiewicz's acceptance speech was entitled, "As I Remember." The text of his lecture appears in this newsletter; it will also appear in a forthcoming issue of the *Journal of Applied Mechanics.*

This past year was the year to recognize the central role of "the finite element method" in Applied Mechanics. Along with the awarding of the Timoshenko Medal to Professor Zienkiewicz at the dinner, the 1998 Applied Mechanics Award was presented to Dr. John Swanson in recognition of his role in developing and disseminating the widely-used commercial finite element program ANSYS.

Last year Stan Berger reported on the establishment of a new Division award called the "Special Achievement Award for Young Investigators in Applied Mechanics," to be bestowed on researchers age 40 or younger, in recognition of contributions to applied mechanics in the form of published papers, and the demonstration of considerable potential for significant future work. The first awardee selected by the Executive Committee was Professor Mary C. Boyce, of the Massachusetts Institute of Technology. The award was presented to her at the Applied Mechanics dinner. Nominations for this award for the year 2000 and beyond should be sent to the AMD Awards Nomination Committee, which is currently being chaired by J. T. Oden.

I am pleased to announce the most recent honors voted by the Committee on Honors. The '99 Timoshenko Medalist is Anatol Roshko of California Institute of Technology, the '99 (and third) Koiter Medalist is Charles Steele of Stanford, and the '99 (and second) Drucker Medalist is Ascher Shapiro of Massachusetts Institute of Technology.

Concerning publication of volumes of technical papers for the AMD-sponsored symposia at the IMECE. A few years ago ASME altered its publication policies. However, due to the size and nature of the IMECE, there is more flexibility in these publications. After discussions with staff in the ASME Technical Publications Department, the EC of AMD now encourages symposia organizers for the IMECE to publish high quality "near archival" bound volumes of their technical papers. The "Book of Abstracts" that was tried as a feeble alternative last year will no longer be published.

At the IMECE, ASME imposes only two constraints: the number of sessions, and when they are scheduled. The Technical Committees of AMD provide a forum for the direct participation of the members in the essential activities of the Division. In my view, not only should the "essential activities" include organizing technical sessions on critical and timely subjects, but they should also contain a reflective and planning component concerning prioritized future directions for research and education as perceived by the members of the AMD. I would like to encourage the Technical Committees to include a few discussion and planning sessions concerning future directions for their respective areas. It is only with this kind of input that the Executive Committee can convey the collective sense of its mission for the future to the outside world.

In closing, my term on the EC will come to an end during the summer of 1999. My replacement will be Alan Needleman of Brown University. With Alan Needleman, Tom Hughes, Dusan Krajcinovic, Hasan Aref, and Stelios Kyriakides on the EC for the next year, the Division is in excellent hands.

USNC/TAM

USNC/TAM celebrates its 50th birthday this year. The USNC/TAM was established in 1949 for the purpose of representing the United States in international activities related to mechanics and to serve as a focal point for the U.S. engineering science and mathematical communities which have common interests in mechanics.

The web site for the USNCTAM is www.iastate.edu/~usnctam/. The 13th US National Congress of Applied Mechanics was held at the University of Florida in June 1998, and the 14th Congress will be held at Virginia Tech, June 23–28, 2002. The United States is also hosting the next International Congress on Theoretical and Applied Mechanics (ICTAM2000) in Chicago, Aug. 27–Sept. 2, 2000. The web site for ICTAM2000 is www.tam.uiuc.edu/ICTAM2000. Hassan Aref is General Chair of ICTAM2000.

A new volume on Research Directions in Solid Mechanics will be published in 1999 under the editorship of George Dvorak. The current officers of the USNC-TAM are Ron Adrian, Chair, Jim Hill, Vice- Chair, and Philip Hodge, Secretary. Of special interest to members of the Applied Mechanics Division is the news that Philip Hodge has announced that he will step down as Secretary of the USNC/TAM after completion of his current term in the year 2000. Phil will have completed 18 years as Secretary when he steps down.

The USNC/TAM Newsletter is available on the USNC/TAM website. It includes a listing of future IUTAM symposia. More information and application materials for IUTAM symposia can be obtained from Alan Pierce at adp@enga.bu.edu. The current U.S. delegation to the General Assembly of IUTAM in Chicago consists of Earl Dowell (chair), Ron Adrian, Hasan Aref, Philip Hodge, and Carl Herakovich. The USNC/TAM represents fourteen societies with an interest in mechanics. The list of these societies and links to their web pages can also be found on the USNC/TAM webpage.

CARL T. HERAKOVICH,
ASME Representative

Koiter Medal to Tvergaard

Professor Viggo Tvergaard has made seminal contributions to the understanding of instability and failure phenomena in solids and structures having broad significance for mechanical engineering practice. In recognition of these contributions, he was awarded the 1998 Koiter Medal at the 1998 IMECE in Anaheim.

Dr. Tvergaard is Professor in the Department of Solid Mechanics of the Technical University of Denmark. He earned his Ph. D. in Solid Mechanics from the Technical University of Denmark in 1971 and has served on the faculty there since then. He has also held the position of Visiting Professor of Engineering at Brown University.

Dr. Tvergaard is the author of over 190 scientific papers on structural buckling, tensile instabilities, creep, fracture, and composite materials mechanics. He has pioneered the use of computational methods to elucidate aspects of mechanical behavior that are difficult, if not impossible, to address by other approaches.

Dr. Tvergaard is a Member of the Danish Academy of Technical Sciences. In 1978, he was awarded a Dr. techn. Degree by the Technical University of Denmark for his research contributions in Solid Mechanics and in 1982, the Esso Prize in recognition of his outstanding technical and scientific contributions. In 1989, he received the Villum Kann Rasmussen scholarship for his contributions to materials mechanics and fracture mechanics. Dr. Tvergaard was appointed to a Research Professorship at the Technical University for the years 1989-1994. The Royal Institute of Technology awarded Dr. Tvergaard an Honorary Doctorate in 1993.

Dr. Tvergaard is editor-in-chief of the *European Journal of Mechanics Solids* and serves on the editorial boards of six other international journals.

Applied Mechanics Award to Swanson

In recognition of his distinguished contributions to mechanics and service to the engineering community, Dr. John A. Swanson was awarded the 1998 Applied Mechanics Award at the 1998 IMECE in Anaheim. Dr. Swanson holds B.S. and M.S. degrees in Mechanical Engineering from Cornell University and received a Ph.D. in Applied Mechanics from the University of Pittsburgh. He is chief technologist of ANSYS, Inc., a company he founded in 1970 to develop, market and support the ANSYS finite element program, which is widely used in engineering practice.

Dr. Swanson is an internationally recognized authority in the application of finite element methods to engineering. Prior to founding ANSYS, Inc., he was employed at Westinghouse Astronuclear Laboratory. Early on, Dr. Swanson recognized the savings that could be attained from the use of general purpose finite element software to do the calculations that engineers were doing manually.

Dr. Swanson has received numerous awards for his contributions to engineering and to the computing industry. In 1990, he won the Computers in Engineering Award for his outsanding contributions; in 1994 he was named Top 5 out of Top 50 R&D stars in the US by Industry Week and in 1998 he received a Distinguished Alumnus Award from the University of Pittsburgh School of Engineering. He is a Fellow of ASME and in 1987 was named Pittsburgh Engineer of the Year by ASME.

AMD Honors and Awards

The following AMD members were recently elected to Fellow Grade:

AMD Fellows:
Choon Fong Shih,
Vladimir Lembersky
Mohammad N. Noori
Alexander Solan
Alan S. Wineman

The following AMD members have received these ASME Awards:

Applied Mechanics Award:
1997: R. Skalak
1998: J. Swanson
1999: K. Pister

Honorary Members:
1997: W. Goldsmith; C. D. Mote, Jr.
1999: M. Carroll; J. Dundurs

ASME Medalists:
1997: D. Kamen
1999: H.N. Abramson

Heat Transfer Memorial Award:
1999: S. Banerjee

Internal Combustion Engine Award:
1999: S. Gratch

Pi Tau Sigma Gold Medal:
1998: W. Chen

Drucker Medal:
1998: D. Drucker
1999 A. Shapiro

Koiter Medal:
1997: W.T. Koiter:
1998: V. Tvergaard
1999: C.R. Steele

Pressure Vessel and Piping Award:
1997: J.W. Lincoln
1999: F.J. Moody

Ben C. Sparks Award:
1999: P.E. Doepker

Lissner Award:
1999: S. Cowin

Worcester Reed Warner Medal
1997: Z. Bazant
1998: T.J.R. Hughes

George Westinghouse Medals
(Gold):1999:
A.S. Rao

Young Investigator Award
1998 M. C. Boyce
1999 H. Gao

Journal of Applied Mechanics

I wish to extend my continued gratitude to the authors, Associated Editors, and reviewers who have contributed to the success of the *Journal.* The backlog of papers awaiting publication in New York remains low, while the pages allocated to the *Journal* stand at a healthy 1200 per year. It is an excellent time for authors who are concerned by a long wait for papers to show up in print to submit articles to the *Journal of Applied Mechanics.*

The board of Associate Editors, as ever, plays an important part in the successful operation of the *Journal of Applied Mechanics.* An Associate Editor serves for a term of three years, once renewable, plus an additional year reserved for clearing paper evaluations. R. Becker, S. Lichter and J.N. Reddy completed their service as Associate Editors on July 1, 1998. We would like to welcome to the Editorial Board as new Associate Editors, A.K. Mal, A. Needleman and C.G. Speziale, who joined us on July 1, 1998.

In closing, I would like to reiterate my thanks to all who have helped to make 1998 a productive year. I look forward to maintaining the high standard of excellence expected of the *Journal* in the coming year.

LEWIS WHEELER, Technical Editor

1998 Timoshenko Medal

(continued from page 1)

consulting engineering firm of Sir William Halcrow & Partners in London. From 1949 to 1957 Dr. Zienkiewicz was a Lecturer in Engineering at the University of Edinburgh. He then spent four years as Professor of Civil Engineering at Northwestern. In 1961, he was appointed Professor and Head of Civil Engineering at the University of Wales, Swansea, becoming Emeritus in 1988.

Professor Zienkiewicz has published over 500 papers and written or edited 25 books on topics covering a wide range of mechanics and engineering topics. He is one of the pioneers of the finite element method and early on realized its potential for the solution of problems outside the area of solid mechanics. Together with the team of researchers around him, Professor Zienkiewicz contributed many fundamental developments to the finite element method.

He personally supervised some 70 Ph.D. students, many of whom went on to hold leading positions in academia and industry. In addition, his books on the finite element method have had a profound influence on several generations of researchers and practitioners world-wide.

In 1968, Professor Zienkiewicz, together with Professor R.H. Gallagher, founded the *International Journal of Numerical Methods in Engineering* which soon came to be the leading journal for engineering computational research. He also serves on the editorial boards of over 25 journals.

Included among the many honors Professor Zienkiewicz has received are the title of Commander of the British Empire; the Royal Medal from HM Queen Elizabeth II; the Carl Friedrich Gauss Medal of the West German Academy of Science; the Nathan Newmark medal of ASCE; the James Alfred Ewing Medal of the UK Institution of Civil Engineers; the Leonardo da Vinci medal of the European Society for Engineering Education; and the Worcester Warner Reed Medal of ASME. In 1996, he was awarded *Chevalier dans l'ordre des Palmes Académiques* by decree of the French Prime Minister.

First Drucker Medal Awarded

The Applied Mechanics Division is very pleased to announce that the newly established Drucker Medal has been awarded to its namesake, Dan Drucker. Dan is a former president of ASME (1973–74), a leader in engineering education, and an outstanding scholar in the field of applied mechanics. This new ASME medal will honor an individual who has made fundamental and lasting contributions to the field of solid mechanics as well as being a national and international leader in applied mechanics, engineering education and the American Society of Mechanical Engineers.

Dan Drucker was born in New York city in 1918. He received all three of his degrees from Columbia University with BS and CE degrees in Civil Engineering and a Ph.D. in Applied Mechanics. He has held academic appointments at Cornell University, Illinois Institute of Technology, Brown University (L. Herbert Ballou University Professor, 1963–68), University of Illinois (Dean of Engineering, 1968–84), and the University of Florida.

Professor Drucker is known for his many publications in solids mechanics, primarily in plasticity. His fundamental work in plasticity which serves as the bases for plastic flow theories is referred to as “Drucker’s postulate”. He is a Member of the National Academy of Engineering, the American Academy of Arts and Sciences, the National Research Council, the General Assembly of the International Union of Theoretical and Applied Mechanics (President 1980–84), the U.S. National Committee on Theoretical and Applied Mechanics, a past-Chair of the Applied Mechanics Division (1964), and Honorary Member of ASME, the Society of Experimental Mechanics, the International Cooperative Fracture Institute and the Illinois Society of Professional Engineers.

News from the Technical Committees

Most committees maintain an open policy toward membership. Please contact the Committee Chair if you wish to join and or participate in the activities of the Committee.

- **AMD-MD Joint Committee on Constitutive Equations**

In August 1998 Martin Ostoja-Starzewski (Institute of Paper Science and Technology, and Georgia Tech) took over as Chair of the committee from George Voyiadjis (Louisiana State University). Subsequently, Hussein Zbib (Washington State University) was elected Vice-Chair; he will begin in that function in the summer 1999. At the last meeting the operational rules of this committee were amended to emphasize publication of high quality results in both *Journal of Applied Mechanics* and *Journal of Engineering Materials and Technology*.

The committee members have been active putting together various symposia at the ASME conferences. At the '98 IMECE (Anaheim, CA) three symposia were organized by the committee members.

For the ASME summer 1999 Mechanics and Materials meeting to be held at Virginia Tech, Blacksburg, VA, H. Haslach, G. Kyanka, M.K. Ramasubramanian and R. Perkins are organizing a "Symposium on Mechanics of Cellulosic Materials."

Finally, for the 99 IMECE, one symposium is being organized: "Symposium on Physical Modeling of Dynamic Failure Processes" by T. W. Wright, A. M. Rajendran, and M. Zikry.

The webpage of the committee also lists other conference activities that our members are involved with - welcome to www.asme.org/divisions/amd/constit.html.

MARTIN OSTOJA-STARZEWSKI, Chair

- **Committee on Computing in Applied Mechanics (CONCAM)**

CONCAM is sponsoring a symposia at the 99 IMECE on Porous Media organized by Salomon, Sullivan, Keyhani & White.

More information on these symposia and other CONCAM activities are available on the CONCAM web site www.sonic.net/lschwer/CONCAM/concam.html

Prof. Greg Hulbert (hulbert@umich.edu) will chair CONCAM after the Summer Meeting.

LEN SCHWER, Chair

- **Elasticity Committee**

The committee welcomed Dr. Ken Chong as a new member of the committee and unanimously approved the request from Professor James Casey to organize a 4-session symposium on Thermoelasticity for the 99 IMECE. Various candidates were discussed for nomination as Fellows and other honors.

ROMESH BATRA, Chair

- **Experimental Mechanics Committee**

The committee met at the 98 IMECE. With eighteen people in attendance, we can be encouraged about the well being of the committee. The main items of business consisted of setting up symposia for future meetings, electing new officers and discussion of future directions for the committee.

Three symposia will be sponsored by the Experimental Mechanics Committee at the 99 IMECE:

"Smart Materials and Their Composites," A. Wass and J. Shaw (2 sessions), "Experimental Methods in Electronic Packaging," J. Suhling and M. Larson (1 "industrial highlight" session), and "Mechanics of Multi-Layered Materials," J. Beuth and K. Liechti

The term of the current officers expires in June, 1999. In accordance with the rules of the committee, M. Larson, the current secretary, will succeed K. Liechti as chair. K. Ravi-Chandar (University of Houston) was elected to become the new secretary. The new officers will take up their positions at an informal committee meeting at the Joint ASME Mechanics and Materials Conference in Blacksburg, VA June 27–30, 1999.

K. Ravi-Chandar offered to send a copy of the Institute for Mechanics of Materials (IMM) Report on the state of experimental mechanics in US graduate education and research, authored by W. G. Knauss, K. Ravi-Chandar and S. Kyriakides. The report can also be found at the following web site: www-immm.ucsd.edu.

The next meeting of the Experimental Mechanics Committee will take place at the 99 IMECE.

KENNETH LIECHTI, Chair

- **Fluid Mechanics Committee**

In the past year the committee named a new assistant chair: Professor Amitabh Narain, from the Michigan Technological University, Department of Mechanical Engineering and Engineering Mechanics (narain@mtu.edu). New members to the committee include Professors William Schultz and Ana Sirviente, who are both from the University of Michigan. We welcome the addition of other new members. Interested colleagues should contact the TC chair.

Professor Schultz is the new chair of the AMD Awards Committee. Nominations for awards and honors related to Fluid Mechanics should be addressed to him at schultz@engin.umich.edu.

The committee will sponsor two sessions on Fluid-Structure Interactions which is being organized by Professor Michael Paidoussis for the 2000 IMECE. We welcome ideas for sponsorship of other symposia in the area of Fluid Mechanics in upcoming meetings. Requests can be forwarded to the TC chair at corke@mae.iit.edu.

THOMAS C. CORKE, Chair

- **Committee on Instability in Solids and Structures**

The Committee organized two symposia in the 1998 Thirteenth US National Congress of Applied Mechanics, which was held at the University of Florida in Gainsville last June. The first was a four-session symposium entitled "Nonlinear Mechanics of Composites," co-organized by S. Kyriakides and Y. Rajapakse and the second was a two session symposium entitled "Stability Problems in Thermo-elastic and Frictional Contact," organized by N. Triantafyllidis. During the 98 IMECE, we participated with symposia on Stability of Solids and Structures and a two-session symposium on Micromechanical Failure of Composites. For the summer of 1999, we have organized a symposium as well.

Our technical committee continues its strong yearly presence at both the Winter and Summer Annual Meetings of the ASME. Any colleague interested in our activities is welcomed in our TC meetings and is also encouraged to contact the committee chair at any time to share ideas and volunteer his/her help.

NICOLAS TRIANTAFYLLIDIS, Chair

- **Composites Committee**

The last Composites Committee meeting, held during the 98 IMECE was very well attended, and had over 30 participants. The committee discussed and voted on sponsoring or co-sponsoring symposia at the 99 IMECE. Four symposia will be co-sponsored by this committee. At the 1998 IMECE meeting, the Composites Committee co-sponsored three symposia.

The next meeting of the Composites Committee will be held during the 99 IMECE meeting. Current members, and other interested persons, are invited to participate. Proposals for symposia dealing with mechanics of composites are encouraged for future conferences. Potential organizers are encouraged to highlight emerging areas of composites research.

YAPA D.S. RAJAPAKSE, Chair

World Wide Web URLs

ASME Homepage
www.asme.org

Applied Mechanics Division
www.asme.org/divisions/amd

A copy of this Newsletter may now be accessed electronically through the Applied Mechanics Division homepage.

Applied Mechanics Division

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Future Meetings

1999 IMECE (ASME, Winter Annual Meeting), November 14-19, 1999. The following symposia will be sponsored by the Applied Mechanics Division at the 1999 IMECE, Opryland Hotel, Nashville, TN, AMD Program Chair, Professor Dusan Krajeinovic

Please contact the individual organizer for more information on the individual symposia. For brevity, only one of the organizers for each symposium is listed as the point of contact.

Crashworthiness, Occupant Protection, and Biomechanics in Transportation, H.F. Mahmood, (313)594-2300.

Recent Advances of Ultrasonic NDE for Industrial Applications, T. Kundu, tkundu@u.arizona.edu , (520) 621-6573.

Physical Modeling of Dynamic Failure Processes, T.W. Wright, tww@arl.mil, (410) 278-6046.

Smart Materials and Their Composites, A. Waas

Experimental Methods in Electronic Packaging, J. Suhling, jsuhling@eng.auburn.edu, (334) 278-6046.

Mechanics of Multi-Layered Materials, J. Beuth, beuth@andrew.cmu.edu, (412) 268-3873.

Application of Porous Media Methods for Engineered Materials, N.J. Salamon, njsalamon@psu.edu.

Recent Developments in Nonlinear Thermoelasticity, J. Casey, casey@euler.berkeley.edu.

Symposium Honoring the 70th Birthdays of Profs. Charles W. Bert and Jack R. Vinson, V. Birman, vbirman@umr.edu , (314) 516-5436

Thick Composites for Load Bearing Structures, Y. D. S. Rajapakse, rajapay@onr.navy.mil rajapay@onr.navy.mil , (703)696-4405.

Durability and Damage Tolerance of Composite Materials and Structures, A.A. Pelegri, pelegri@jove.rutgers.edu, (732) 445-0691

Design and Manufacture of Composites, S. White, swhite@uiuc.edu, (217) 333-1077

Summer 2000: IUTAM International Congress on Theoretical and Applied Mechanics, August 27 –September 2, 2000, Chicago, Illinois. Chair: Hassan Aref, http://www.tam.uiuc.edu/ICTAM2000.

2000 IMECE, November 5-10, 2000, Orlando, Florida.

2001 IMECE, November 11–16, 2001, New York, NY

Procedures for Requesting AMD-Sponsored Sessions at IMECE or Summer Meetings See the AMD homepage (URL http://www.asme.org/divisions/amd/index.html). The next round of requests should be made to Professor Hassan Araf for the 2000 IMECE (WAM) to be held in Orlando.