Professor J. Tinsley Oden, P.E.

See:
http://en.wikipedia.org/wiki/J._Tinsley_Oden
http://www.tx.altair.com/overview/oden.html
http://www.scholarpedia.org/article/User:J._Tinsley_Oden
http://www.utexas.edu/opa/experts/profile.php?id=290
http://www.ae.utexas.edu/faculty/faculty-directory/oden
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http://www.barnesandnoble.com/c/j.-tinsley-oden
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Department of Aerospace Engineering and Engineering Mechanics
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Professor, Aerospace Engineering and Engineering Mechanics
Professor, Mathematics
Professor, Computer Sciences
Cockrell Family Regents' Chair in Engineering #2
Peter O'Donnell, Jr. Chair in Computing Systems

J. Tinsley Oden (born December 25, 1936 in Alexandria, Louisiana) is the Associate Vice President for Research, the Director of the Institute for Computational Engineering and Sciences, the Cockrell Family Regents' Chair in Engineering #2, the Peter O'Donnell Jr. Centennial Chair in Computing Systems, a Professor of Aerospace Engineering and Engineering Mechanics and a Professor of Mathematics at The University of Texas at Austin. Oden has been listed as an ISI Highly Cited Author in Engineering by the ISI Web of Knowledge, Thomson Scientific Company.[1]

Dr. Oden was the founding Director of the Institute for Computational Engineering and Sciences (ICES), which was created in January 2003 as an expansion of the Texas Institute for Computational and Applied Mathematics, also directed by Oden for over a decade. The Institute supports broad interdisciplinary research and academic programs in computational engineering and sciences, involving four colleges and 17 academic departments within UT Austin.

He finished secondary school in Alexandria in 1955 and entered Louisiana State University in the fall of that year. He earned a B.S. degree in civil engineering from LSU in 1959. Dr. Oden earned a PhD in engineering mechanics from Oklahoma State University in 1962. He taught at OSU and The University of Alabama in Huntsville, where he was the head of the Department of Engineering Mechanics prior to going to Texas in 1973. He has held visiting professor positions at other universities in the United States, England, and Brazil.

An author of over 500 scientific publications: books, book chapters, conference papers, and monographs, Dr. Oden is an editor of the series, Finite Elements in Flow Problems and of Computational Methods in Nonlinear Mechanics. Among the 49 books and book chapters he has authored or edited are Contact Problems in Elasticity, a six-volume series: Finite Elements , An Introduction to the Mathematical Theory of Finite Elements, and several textbooks, including Applied Functional Analysis and Mechanics of Elastic Structures, and, more recently, A Posteriori Error Estimation in Finite Element Analysis, with M. Ainsworth. His treatise, Finite Elements of Nonlinear Continua, published in 1972 and subsequently translated into Russian, Chinese, and Japanese, is cited as having not only demonstrated the great potential of computational methods for producing quantitative realizations of the most complex theories of physical behavior of materials and mechanical systems, but also established computational mechanics as a new intellectually rich discipline that was built upon deep concepts in mathematics, computer sciences, physics, and mechanics. Computational Mechanics has since become a fundamentally important discipline throughout the world, taught in every major university, and the subject of continued research and intellectual activity. Dr. Oden has published extensively in this field and in related areas over the last three decades. (from Wikipedia)

Honors and awards

In 2005, Dr. Oden was informed that he would receive an Honorary Doctorate, honoris causa, from Ecole Normale Superieure Cachan (ENSC), France. The honorary degree will be presented by the Board of the Scientific Council of ENSC in recognition of his outstanding contributions to the field of Computational Mechanics. In 2004, Dr. Oden was among the seven UT-Austin engineering faculty listed as the most highly cited researchers in the world from 1981–1999 in refereed, peer-reviewed journals, according to the International Scientific Index.

Dr. Oden is an Honorary Member of the American Society of Mechanical Engineers and is a Fellow of six international scientific/technical societies: IACM, AAM, ASME, ASCE, SES, and BMIA. He is a Fellow, founding member, and first President of the U.S. Association for Computational Mechanics and the International Association for Computational Mechanics. He is a Fellow and past President of both the American Academy of Mechanics and the Society of Engineering Science. Among the numerous awards he has received for his work, Dr. Oden was awarded the A. C. Eringen Medal, the Worcester Reed Warner Medal, the Lohmann Medal, the Theodore von Karman Medal, the John von Neumann medal, the Newton/Gauss Congress Medal, and the Stephan P. Timoshenko Medal. He was also knighted as “Chevalier des Palmes Academiques” by the French government and he holds four honorary doctorates, honoris causa, from universities in Portugal (Technical University of Lisbon), Belgium (Faculte Polytechnique), Poland (Cracow University of Technology), and the United States (Presidential Citation, The University of Texas at Austin).

Dr. Oden is a member of the U.S. National Academy of Engineering and the National Academies of Engineering of Mexico and of Brazil. He serves as Co-Chairman of the Accelerated Strategic Computing Initiative (ASCI) Panel for Sandia National Laboratories. He is a Member of the IUTAM Working Party 5 on Computational Mechanics and serves on numerous organizational, scientific and advisory committees for international conferences and symposia. He is an Editor of Computer Methods in Applied Mechanics and Engineering and serves on the editorial board of 27 scientific journals.

Dr. Oden has worked extensively on the mathematical theory and implementation of numerical methods applied to problems in solid and fluid mechanics and, particularly, nonlinear continuum mechanics. His current research focuses on the subject of multi-scale modeling and on new theories and methods his group has developed for what they refer to as adaptive modeling. The core of any computer simulation is the mathematical model used to study the physical system of interest. They have developed methods that estimate modeling error and adapt the choices of models to control error. This has proven to be a powerful approach for multi-scale problems. Applications include semiconductors manufacturing at the nanoscale. Dr. Oden, along with ICES researchers, is also working on adaptive control methods in laser treatment of cancer, particular prostate cancer. This work involves the use of dynamic-data-driven systems to predict and control the outcome of laser treatments using our adaptive modeling strategies. (from Wikipedia)

Books

Finite Elements of Nonlinear Continua, Dover Publications, 2006.
An Introduction to the Mathematical Theory of Finite Elements, with J. N. Reddy, John Wiley & Sons Inc., 1976.
Applied Functional Analysis, Prentice Hall, 1979.
Mechanics of Elastic Structures, 2nd ed., with E. A. Ripperger, McGraw-Hill Inc., 1981.
Finite Elements in Fluids, volume 2, with O. C. Zienkiewicz, R. H. Gallagher, and C. Taylor, John Wiley & Sons, New York, 1976.
Finite Elements in Fluids, volume 4 with R. H. Gallagher, D. N. Norrie, and O. C. Zienkiewicz, Wiley, Chichester, 1982.
Finite Elements in Fluids, volume 6, with R. H. Gallagher, G. F. Carey, and O.C. Zienkiewicz, Wiley, Chichester, 1985.
State of the Art Survey in Computational Fluid Mechanics, with A. K. Noor, ASME, 1988.
Computational Methods in Nonlinear Mechanics, North-Holland, Amsterdam, 1980.

Journal Articles, etc. (Over 500 papers)

1996 ASME Timoshenko Medal Acceptance Speech by J. Tinsley Oden

The Revolution in Applied Mechanics from Timoshenko to Computation

The Applied Mechanics Division of the ASME established the Timoshenko Medal in 1957 to recognize distinguished work in the field. The first recipient was Stephen P. Timoshenko himself, an individual who contributed enormously to the prestige and strength of mechanics in this country and a legend whom I, as a young student in mechanics, looked upon as a special hero, one to be admired and emulated. To be honored by being awarded the Timoshenko Medal by the AMD is a very special event for me and one for which I will be eternally grateful. I will do my utmost to uphold the honor of the award and to live up to the high standard exemplified by its past recipients.

I begin this presentation with the somewhat conspicuous observation that during my career in applied mechanics, a special revolution has taken place which will forever change the subject and which will affect the way all science is done for rest of time. It is, of course, the emergence of the computer: computation providing a third pillar to the classical two pillars of the scientific method, theory and experiment, a pillar overlapping the traditional two but expanding each in ways never dreamed of in the days of Timoshenko's work.

Before I comment further on this revolution, and my role in it, I will, as is customary in these events, first interject a few personal things that lay out the path that led me here. When I was young, a bout with pneumonia put me a year behind in school. When I got to college, I vowed to catch up, and so I finished a five-year program (154 semester hours) in three years, and a PhD in three more. So at the age of twenty five I began a career in research in mechanics and engineering computation. My own initiation into the modern computational side of mechanics came in the early 1960s. Equipped with a new PhD in traditional engineering mechanics from Oklahoma State, I joined the Research and Development Division of General Dynamics, Fort Worth in 1963, and was assigned to work with Gilbert C. Best to develop a computer program based on the finite element method, a promising new technology that GD thought might be of value in aircraft structural analysis and design. To work with Gil was an honor few had within the "bomber plant." A completely self-educated man with a superior intellect, he quietly included me in his work on the grand project that, we thought, would revolutionize structural mechanics in the company. Though both of us had only a meager knowledge of FORTRAN in the beginning, we launched into a project that today I would not start without a team of ten or so collaborators, with PhDs in three or four fields. In around ten months, working long hours, we developed C-28, one of the first general-purpose finite element programs developed in the aircraft industry in the 1960s. It was a trial by fire; working many hours each week, we developed a long catalogue of finite elements for plates, shells, three-dimensional bodies, laminated composites, for modal analysis in structural vibrations, transient structural dynamics, for structural optimization, hybrid elements based on complementary energy principles and Reissner principles, many of these representing results which would not appear in literature for another fifteen years. We received a bit of internal acclaim and rewards for our work, but I, and I think Gil also, were perplexed about the fact that some of our schemes simply didn't work. Convergence rates were impossible to predict, and the real mathematical bases of our schemes were obscure to us. We needed to learn more about the underlying mathematics, which at that time was unknown.

In 1964, I joined the Research Institute of the University of Alabama at Huntsville, home of the Marshall Space Flight Center, the Army Missile Command, and a hotbed of science and technology, with a new graduate program in engineering mechanics. There was no undergraduate program, eleven hundred excellent graduate students who had to learn enough to get a man on the moon in five years, and a graduate engineering faculty of around twenty five to thirty people. I taught virtually everything, from partial differential equations to complex analysis to continuum mechanics, to the beginnings of functional analysis and approximation theory, including a first full course, with personal notes, on finite elements, and another on finite element methods applied to nonlinear continuum mechanics. Gerry Wempner was a colleague there, and he provided counsel and criticism of my work, for which I am forever grateful. It was then that I began to understand and unravel the mathematical properties underlying finite element methods, and to apply them to problems in nonlinear continuum mechanics, particularly in finite elasticity, and beginning in around 1970, incompressible viscous flows. I moved to Texas in 1973, and have worked there on these and related subjects ever since, but my early inquiries into the mathematical basis of the computations led me to also venture into the mathematical side of theoretical mechanics.

But with the explosion in computational mechanics, beginning the 1960s, came an era in which computation was viewed with suspicion and mistrust by some of the mechanics community; the new methodologies and computing devices, put into the hands of inexperienced and untrained practitioners powerful tools that are easily misused and which, at first glance, could reduce the dignity and importance of the science. But, while abuses are always possible, a more mature appraisal reveals that computation has extended the vistas of mechanics to boundaries far beyond those of yesteryear to limits not yet known or well defined. I should say that the Applied Mechanics Divisoin has always appreciated the value of computation to mechanics; indeed, other computational mechanicians have been recognized as Timoshenko Medalists: Sir Richard Southwell in 1959, John Argyris in 1981, and perhaps others.

I think it is quite clear that computational mechanics has created a much more basic and fundamental view of mechanics than was traditionally thought possible. It has forced the mechanics community to reappraise the foundations of the subject as an engineering tool and to be conscious of the greater role played by mathematical modeling in engineering practice. Aside from some sentimental value, many of the approximate theories of mechanics, cherished when you and I were students, are reduced in their importance compared to a couple of decades ago, if not quickly becoming obsolete.

The successful engineering mechanician, these days, must have a more fundamental knowledge of basic mechanics than did his predecessors. Today, practitioners must understand and often deal with daily the fundamental concepts of kinematics, deformation, strain, stress, material behavior, thermal effects, etc.; and, they must have the mathematical machinery to characterize and cope with these concepts and to construct reliable numerical approximation. Thus, computation, this new tool, has forced us to develop a better, clearer idea of the processes we must use to do mechanics. The theory of the mechanical behavior of solids and fluids provides the basis for the development of mathematical models, and the understanding of the qualitative properties of these models and their numerical approximation has understandably exerted a greater demand on our use of mathematics and, perhaps surprisingly, has heightened rather than suppressed the need for deeper mathematics and more rigid adherence to mathematical rigor.

Timoshenko frequently expounded on the importance of mathematics as an inseparable thread interwoven into the fabric of mechanics. His work demonstrated time and again the interplay of mathematical modeling of mechanical events and the use of mathematics, not only as a language to communicate scientific thought, but also as a guide to physical experiments for measuring the behavior of material bodies under the actions of forces.

In my own experience, mathematics has transcended its classical role of merely the language used to describe models of nature; it has been elevated to a strange metascience, emerging in an almost spiritual way, that can provide insight into the very rules that nature imposes on the way physical events occur. I have experienced this phenomena many times. I am constantly amazed by it; but, find it difficult to explain or rationalize. How can these physical events that manifest themselves around us and which depend on the forces and material make-up of the physical universe be subordinate in any way to abstract rules of mathematics which are purely products of the human mind? This question, you see, elevates the role of mathematics far beyond that of a script we use to translate mental concoctions of how we expect nature to behave into models, but to a much more important role of actually dictating the features of models that are necessary to correctly depict physical events.

Perhaps this is because theoretical mechanics has itself influenced mathematics. This was certainly true a century ago and more, but the influence is less conspicuous today than it was in the days of early natural philosophy when mechanics and mathematics were so closely intertwined as to be almost indistinguishable. The fundamentally sound theories of mechanics, those which survived debate, study, scrutiny, testing, those which formed the foundations of the subject and were passed on to later generations, form the measuring stick against which good mathematics is measured. The interesting and often unexpected thing is that once the mathematics is established, it, in turn, provides a framework into which new mechanical theories must fit.

This idea of the role of mathematics is, as far as I know, a relatively new thing, but it may be ancient. I can cite many examples, but one that frequently comes to mind emerged in my work on friction models for dynamic contact in solid mechanics. The Signorini problem of linear elasticity, for example, provides a quite reasonable classical model of frictional contact of an elastic body with a rigid foundation. This is a perfectly satisfactory model for studying a variety of contact phenomena and has proved to be useful for more than a half century. But, when you add to the picture frictional phenomena governed by Columb's law, an extension quite natural to beginning students of classical mechanics, the model completely degenerates! The very existence of solutions comes into question and was an open mathematical problem for 25 years. We know now that for certain ideal boundary and loading conditions, most of the solutions of frictional contact problems with Columb's law found in the literature are probably correct, albeit not physically realistic, but we now also have concrete nonexistence results: solutions actually do not exist in some cases that, on the surface, might appear physically realistic, and this fact underscores that the crude characterization afforded by Columb should, in general, be used with great care or not at all.

To develop a model of frictional contact that is covered by a tractable existence theory, the mathematical characterization of friction and contact themselves had to be changed. I will never forget the excitement that came over me when I realized that the modifications of the model sufficient to allow existence of solutions and, in a sense, the well-posedness of the mathematical theory, were precisely those observed in many laboratory experiments. The physical parameters, for example, characterizing compliant interfaces were precisely those characterizing function spaces of traces of the stress vector on contact surfaces. This revealed an eerie and, to me, a special connection between the issues of modeling and the physical behavior observed in laboratory tests. Once this connection was observed, of course, the entire mechanics underlying the concept of dynamic frictional contact on elastic interfaces unraveled and became openly exposed and understood: physical insight, or hindsight as it may be, prevailed and old paradoxes and conflicts between theory and experiment were resolved, everything consistent with so-called engineering judgment; but the resolution of the paradoxes were uncovered by starting from a largely mathematical argument.

By the way, don't confuse what I am saying about mathematical mechanics as any endorsement of the goal to axiomatize mechanics, a goal dating back to Aristotle and passionately followed during the 1960's and an enterprise which some say failed. While I do not necessarily agree with that appraisal, here I am merely pointing to the fact that theoretical mechanics, indeed all of theoretical physics, is based on theories which are generally described in the mathematical framework that permits the construction of so-called mathematical models. These are mathematical abstractions that mimic idealizations of physical phenomena. This modeling, which again is a product of purely man's intellect, of the human mind, has produced untold benefit to modern science and technology and has helped mankind exercise its control of its environment and its understanding of some of the secrets of nature. There is, in applying these models, a definite set of rules, a rigid dogma that must be followed if these models are to work, and this dogma itself is founded in mathematics.

Nowadays, there is a growing literature on methods to actually select the mathematical model itself. I view this as one of the most important developments in mechanics this century. It embodies a scientific method that addresses head on the most fundamental questions in applied mechanics—indeed in mathematical physics: what mathematical model must one choose in order to effectively study a well-defined class of mechanical phenomena? What spatial and temporal scales in the micromechanics affect the observed results in a substantial way? How do these subscale phenomena interact to produce meso or macro scale observations?

The resolution of these questions resides in the notion of hierarchical modeling, of a posteriori modeling error estimation, and of adaptive modeling, mathematical notions that arise naturally in proper mathematical frameworks of important problems in theoretical and applied mechanics, but which, when properly implemented, will require cutting-edge computational science as well. It is a subject that, for example, will revise completely the way we deal with composite materials, multi-phase flows, damage mechanics, and eventually even turbulence. It is a subject of great interest to me and one I am convinced will have a fundamental impact on theoretical and applied mechanics in the future.

As I reflect on this event, I share the sentiments of a recent Timoshenko Medalist, John Lumley, who said, "As I have gotten older, I have found that more and more I am a research administrator. I am sure I am not unique-this happens to all of us, but it is a bit sad. That is, I have less and less opportunities to do things for myself. I am supervising others who have all the fun." Nevertheless, there is too much new, exciting, worthwhile, and challenging opportunities to let others have all the fun. I plan to find time to be in on some of the great things in store for Applied Mechanics in the future.

Once again, I thank the Applied Mechanics Division for this singular honor. I know that such awards do not happen accidentally, but require the generous support of friends and individuals in the mechanics community, and for these unnamed supporters, I give my most sincere thanks. I reiterate my promise to steadfastly uphold the honor of this award, and to hold it with the dignity exemplified in its namesake, Stephen P. Timoshenko. Thank you all for your generosity and, to all, my best wishes.