



Professor Ted Belytschko (1943 – 2014)

See:

<http://www.tam.northwestern.edu/tb/tb.html>

http://en.wikipedia.org/wiki/Ted_Belytschko

<http://www.mech.northwestern.edu/web/people/faculty/belytschko/>

<http://www.civil.northwestern.edu/people/profiles/belytschko.html>

<http://www.ejge.com/1998/Ppr9801/tb.html>

<http://imechanica.org/node/215>

<http://65.54.113.26/Author/1775944/ted-belytschko>
<http://amresearch.blogspot.com/2006/04/2001-timoshenko-medal-lecture-by-ted.html>
<http://www.barnesandnoble.com/c/ted-belytschko>
http://en.wikipedia.org/wiki/Ted_Belytschko_Applied_Mechanics_Award
http://www.mccormick.northwestern.edu/news/articles/article_896.html
<http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291097-0207>
"images for ted belytschko" - GOOGLE

Theoretical and Applied Mechanics
Northwestern University

Walter P. Murphy Professor and McCormick Distinguished Professor of Computational Mechanics

Editor-in-Chief, International Journal for Numerical Methods in Engineering

Professor Belytschko is interested in computational methods for modeling the behavior of solids, with particular emphasis on failure and fracture. He has developed new meshfree methods and the extended finite element method for modeling arbitrary crack growth without remeshing and applied them to a variety of crack growth problems, both static and dynamic. He is also using molecular mechanics to study the fracture and behavior of nanotubes and developing methods for coupling heterogeneous subdomains, such as molecular and continuum models.

EDUCATION

B.S., Engineering Sciences, Illinois Institute of Technology (1965) Ph.D. Mechanics, Illinois Institute of Technology (1968)

CAREER

McCormick Distinguished Professor, Northwestern University, 2003-present Chairman, Department of Mechanical Engineering, Northwestern University, 1997-2002 Walter P. Murphy Professor of Computational Mechanics, Northwestern University,
1991- present Professor of Computational Mechanics, Northwestern University, 1977-1991 Professor of Structural Mechanics, University of Illinois at Chicago, 1976-1977 Associate Professor of Structural Mechanics, University of Illinois at Chicago, 1973-76 Assistant Professor of Structural Mechanics, University of Illinois at Chicago, 1968-1973

HONORS

Elected to National Academy of Sciences, 2011 William Prager Medal, Society of Engineering Science, 2011 Denhartog Lecture, "Multiscale Analysis of Failure," MIT, April 2, 2010 Appointed Editor-in-Chief, *International Journal for Numerical Methods in Engineering*, (Jan. 1, 2008) The ASME Applied Mechanics Award renamed the ASME Ted Belytschko Applied Mechanics Division Award, November 2007 Life Member, American Society of Civil Engineers, January 1, 2008 Re-elected Vice-President, International Association of Computational Mechanics, 2008 Honorary Doctorate,

INSA, Lyon, (Institut National des Sciences Appliquées de Lyon)

September 2006 American Academy of Arts and Sciences, 2002 U. S. National Academy of Engineering, elected 1992 Gauss Newton Medal, 2002, International Association for Computational Mechanics Timoshenko Medal, 2001, American Society of Mechanical Engineers

ISI citation record (as of 1/1/2010) 16,983 citations, H-index: H70 Named in ISI Database of 93 most highly cited engineering researchers – 2000/2001 4th most cited researcher in engineering in past decade, ISI, January 2004 Named in original ISI Database of 200 most highly cited researchers in their field – 2000/2001 John von Neumann Medal, U.S. Association for Computational Mechanics, August 2001 Theodore Von Karman Medal, American Society of Civil Engineers (ASCE), 1999 Melvin Baron Medal, Shock and Vibration Information Analysis Center, 1999 Honorary Doctorate, University of Liege, 1997 Honorary Doctorate, Ecole Normale, Paris 2004 ASME/Boeing 2003 Structures & Materials Award for Best Paper, “Large Deformation Atomistic-Based Continuum Analysis of Carbon Nanotubes,” co-authored with Dr. Marino Arroyo, presented by ASME, April 2003 Structural Computational Mechanics Award, U.S. Assn for Computational Mechanics, 1997 ICES Medal (Int. Conf. on Computational Engineering and Sciences), 1997 Computational Mechanics Award, Japanese Soc. of Mechanical Engineers, 1994 AIAA/ASCE ASCE Structural Dynamics and Materials Award, 1990 Thomas Jaeger Prize, International Assn for Structural Mechanics in Reactor Technology, 1983 Walter Huber Research Prize, American Society of Civil Engineers, 1977 Pi Tau Sigma Gold Medal, American Society of Mechanical Engineers, 1975 Fellow, American Academy of Mechanics, elected 1979 Fellow, American Society of Mechanical Engineers, elected 1978 Fellow, American Association for Advancement of Science, elected 1989 NDEA Fellow, 1965-1968 First in class, IIT, 1965

PROFESSIONAL ACTIVITIES

Editor-in-Chief, *International Journal for Numerical Methods in Engineering*, (Jan. 1, 2008- present) Editor, *International Journal for Numerical Methods in Engineering*, (1997-present) Honorary Editor, *International Journal of Computational Methods*, (2003-present)

Editor, *Nuclear Engineering and Design*, (1980-1997) Editor, *Engineering with Computers*, *International Journal for Computer-aided Structural and Mechanical Engineering*, (January 1984-1998) President, American Academy of Mechanics, 2004 Vice President of the Americas, International Association for Computational Mechanics (2002- present) Chairman, U.S. National Committee on Theoretical and Applied Mechanics, 2005-2006 NSF Panel on Simulation Based Engineering Science, January 2005 - present Co-Chairman, U.S. Paper Selection Committee, International Congress for Theoretical & Applied Mechanics, 2004 Associate Editor, *Computer Methods in Applied Mechanics and Engineering* (1977-1997) Editorial Boards, *International Journal of Solids and Structures* (2005– present), *International Journal of Computational Methods* (2004-); *Multiscale Computational Engineering* (2002- present); *Acta Mechanica Solida Sinica* (1997-present); *Numerical and Analytical Methods in Geomechanics* (formerly *Mechanics of Cohesive-Frictional Materials and Structures* (1995-present); *Archives of Computational Methods in Engineering* (1994-present); *Manufacturing Engineering Review* (1991-present); *Computational Mechanics*, (1990-present); *Computers and Structures* (1990-present); *Mathematical Modeling and Scientific Computing*(1990-present); *Computer-Aided Civil and Infrastructure Engineering*, (formerly *Microcomputers in Civil Engineering*, 1986-1997) 1986-present); *Engineering Computations*, (1984-present); *Communications in Numerical Methods in Engineering*, (1984-present); *SIAM series on Computational Science and Engineering* (2006 – 2009); *Structural Mechanics Software Series*, (1976-86); *Nuclear Engineering and Design*, (1977-1981); *Journal of Engineering Mechanics*, ASCE, (1977-1981), *Interaction and Multiscale Mechanics* (2007 – present)

Review Committee, Department of Mechanical Engineering, University California, San Diego, (Jan. 2006 – present) International Associate Editor, *Latin American Journal of Solids and Structures*, (2003 -present)

Associate Editor, *Journal of Applied Mechanics*, (1979-1985 and 1990-1991)

Associate Editor, *Applied Mechanics Reviews*, (1988-1997) Member, Case School of Engineering External Strategic Advisory Committee (2004 - 2005) Chairman, Engineering Mechanics Division, ASCE, (1981-1982) Chairman, Applied Mechanics Division, ASME, (1990-1991) President, U.S. Association for Computational Mechanics, (1992-1994) U.S. National Committee of Theoretical and Applied Mechanics, (1985-1995) *U.S. National Research Council Committees*: Computational Mechanics Committee, (1981- 1984); Committee for Earthquake Engineering Facilities and Instrumentation, (1984); Chairman, Planning Committee for National Earthquake Hazard Models, (1985); Underground Structures Technology, (1990) Chairman, Technical Program Committee for Joint ASME/ASCE Mechanics Conference, (June 1981, Boulder, Colorado) Director, Seminar on "Fluid-Structure Interaction of LWR System" and related titles, (August 1979, Berlin; August 1981, Paris; August 1983, Chicago) Chairman, Computational Methods in Applied Mechanics Committee, Applied Mechanics Division, ASME, (1978-1980) Chairman, Computational Methods Committee, Society of Engineering Science, (1978-81) Charter Member, International Society for the Study of the Lumbar Spine Division Coordinator, Division B: Thermal and Fluid Structure Dynamic Analysis, Structural Mechanics in Reactor Technology Conference, (1977-1991) Member, American Society of Civil Engineers Mechanical Engineering Advisory Board, Illinois Institute of Technology, 2000-present Nominated as a Member of the Executive Council of the International Association for Computational Mechanics 1/28/00 Member of the International Advisory Committee of the 15th International Conference on Finite Elements in Flow Problems (FEF09), Chuo University, Tokyo, Japan (2007-present) Member, International Advisory Committee of the 4th International Conference on Advances in Structural Engineering and Mechanics (ASEM'08) – (2007–present) Member, CST2008 Athens Editorial Board (2007–present) Member, Advisory Scientific Committee (ASC), Particle-Based Methods Conference (PARTICLES 2009), (2008-) Member, International Advisory Board of ECCM 2010, Fourth European Conference on Computational Mechanics (Solids, Structures and Coupled Problems in Engineering), Paris, May 16-21, 2010 (2008 -)

Member of the International Scientific Committee of ICHMM-2008 (2006-present) Member of the International Scientific Committee for the first Asian Pacific Congress on Computational Mechanics (2000) Member, International Scientific Committee, ESCO 2008 Member, International Scientific Committee of the Conference on Computer Methods in Mechanics, CMM 2009 Member, International Scientific Committee, 9th International Conference on Computational Plasticity - COMPLAS 2007, (2006-present) Member of the new session of the International Advisory Editorial Board (IAEB) on *Acta Mechanica Solida Sinica* (2000) Member of the Board of Visitors of the Institute for Computational Engineering and Sciences (ICES), (2003 – present) Scientific Advisory Board, World Congress on Computational Mechanics (WCCM-VII) (2004- present) Scientific Committee, 10th National Congress on Computational Mechanics (USNCCM-X) (2007) Scientific Committee, 8th National Congress on Computational Mechanics (USNCCM8) (2003- 2005) Scientific Advisory Board, 16th European Conference of Fracture (ECF16) (2003-2006) Scientific Advisory Board, 2004 WCCM6 MiniSymposium on Meshfree Methods, Beijing, China 2004 (2003-2004) Technical Advisory Panel, Complas 2003, VII International Conference on Computational Plasticity, Barcelona, Spain Scientific Committee, 4th South African Conference on Applied Mechanics, SACAM '04 (2003- 2004) Member, Scientific Committee for the 2003 International Workshop on Meshfree Methods, Bonn, Germany Member, Scientific Committee for the 2001 International Workshop on Meshfree Methods, Bonn, Germany Member, Scientific Committee, EASEC International Advisory Committee (EASEC-ISC), (2006-present) Member, Advisory Board, ECCOMAS Thematic Conference on the XFEM from 28th to 30th of September 2009, Aachen, Germany - (2008-present) Member, Advisory Committee of PACAM XI (January 4-8, 2010), Foz do Iguacu, Brazil – (2008-present) Member, Predictive Engineering Science Panel (PESP) for Sandia National Laboratories (2008 – present) Member, Scientific Committee, ECCOMAS 2012, Vienna, Austria (2009 – present) Member, Editorial Board, 10th International Conference on Computational Structures Technology, Valencia, Spain, September

2010 (2009 – present) Member, International Scientific Committee, The First International Conference on Advances in Interaction and Multiscale Mechanics (AIMM'10), Jeju Island, Korea, May 2010 (2009 – present) Member, Advisory Scientific Committee, PARTICLES 2011, ECCOMAS Thematic Conference, Barcelona, Spain October 2011 (2010-present) Member, Technical Advisory Panel, COMPLAS XI, Barcelona, Spain September 2011 (2010- present)
Member, Scientific Committee, ICHMM 2011, The Third International Conference of Heterogeneous Materials Mechanics, ChongMing Island, Shanghai, China, May 22-26, 2011 (2010-present)

CONSULTANCIES

Argonne National Laboratory, Argonne, Illinois (1972-present); **IIT Research Institute**, Chicago, Illinois (1968-1977); **Sargent & Lundy Engineers**, Chicago, IL (1974-1977); **Fluor Pioneer Service and Consulting**, Chicago, Illinois (1968-1970); **Atlantic Richfield, Inc.**, Hanford, Washington (1968); **U.S. Army-Rock Island Arsenal**, Rock Island, Illinois (1970); **General Motors**, Detroit, Michigan (1974-1978); **J.J. Woolley, Co.**, Chicago, Illinois (1975); **Pratt-Whitney Aircraft**, East Hartford, Connecticut (1975-1985); **Science Applications, Inc.**, Oakland, California (1975-1980); **Siemens, A.G.**, Erlanger, Germany (1975-1978); **Engineering Systems International**, Paris, France (1976); **Stanford Research Institute**, Palo Alto, California (1977-1981); **Defense Nuclear Agency** (1973-present); **John Deere**, Waterloo, Iowa (1977-1979); **Defense Intelligence Agency** (1981-1985); **United Technologies Research Center**, East Hartford, Connecticut (1977-1980); **Westinghouse Advanced Reactor Division** (1980-present); **Battelle Memorial Laboratories**, Columbus, Ohio (1980-present); **BDM Inc.(Merritt - Cases, Inc.)**, Redlands, California (1980-present); **U.S. National Regulatory Commission** (1984-1980); **MacNeal Schwendler** (1984-1989); **I.B.M.** (1990)

BOOKS, CHAPTERS IN BOOKS AND SPECIAL ISSUES OF JOURNALS (EDITED)

T. Belytschko, J. R. Osias and P. V. Marcal, *Finite Element Analysis of Transient Nonlinear Structural Behavior*, ASME, AMD-Vol. 14, New York (1975)
T. Belytschko and T. L. Geers, *Computational Methods for Fluid-Structure Interaction Problems*, ASME, AMD-Vol. 26, New York (1977)
T. Ting, R. J. Clifton and T. Belytschko, *Proc. of Workshop on Nonlinear Wave Propagation* (1979)
T. Belytschko and T. J. R. Hughes, *Computational Methods for Transient Analysis*, North- Holland, Amsterdam (1983)
W. K. Liu, T. Belytschko and K. C. Park, *Innovative Methods for Nonlinear Problems*, Pineridge Press, Swansea, U. K. (1984)
S. N. Atluri, T. Belytschko, J. T. Oden and J. N. Reddy, *Adaptive Methods*, special issue of *Computer Methods in Applied Mechanics and Engineering* North-Holland, Amsterdam, Vol. 55, Nos. 1-2 (1986)
T. Belytschko, *Topical Issue Dedicated to Dr. Stanley H. Fiedis*, special issue of *Nuclear Engineering and Design*, North-Holland Physics Publishing, Amsterdam, Vol. 106, No. 1 (1988)
W. K. Liu and T. Belytschko, *Computational Mechanics of Probabilistic and Reliability Analysis*, Elmepress International, Lausanne, Switzerland (1989) A. K. Noor, T. Belytschko and J. C. Simo, *Analytical and Computational Models of Shells*, ASME, CED-Vol. 3, New York (1989)
T. Aizawa, T. Belytschko, and W. K. Liu, "ALE Finite Elements with Hydrodynamic Lubrication for Metal Forming," *Nuclear Engineering and Design*, North-Holland Physics, Amsterdam, Vol. 138, N o. 1 (1992)
T. Belytschko, W. K. Liu, and B. Moran, *Nonlinear Finite Elements for Continua and Structures*, John Wiley & Sons, Ltd., Chichester, England (2000)

T. Belytschko, G. Ventura, J. Xu, "New Methods for Discontinuity and Crack Modeling in EFG," in Meshfree Methods for Partial Differential Equations, Michael Griebel and Marc Alexander Schweitzer, editors, Springer Verlag, Berlin, Germany (2000)

T. Belytschko, G. Zi, J. Xu and J. Chessa, "The extended finite element method for arbitrary discontinuities," in Computational Mechanics – Theory and Practice, K.M. Mathisen, T. Kvamsdal, and K.M. Okstad, editors, CIMNE, Barcelona, Spain (2004).

J. Xu, T. Belytschko, "Discontinuous Radial Basis Function Approximations for Meshfree Methods" in Meshfree Methods for Partial Differential Equations II, Michael Griebel and Marc Alexander Schweitzer, editors, Springer Verlag, Berlin, Germany (2005)

A. Combescure, R. de Borst, T. Belytschko, editors, IUTAM Symposium on Discretization Methods for Evolving Discontinuities: Proceedings of the IUTAM Symposium held in Lyon, France, 4-5 September, 2006, Springer, Dordrecht, The Netherlands (2007)

J. Fish, T. Belytschko, A First Course in Finite Elements, John Wiley & Sons, Ltd., Chichester, England (2007)

PUBLISHED PAPERS (hundreds of archived papers; Google Ted Belytschko Northwestern)

2001 ASME Timoshenko Medal Acceptance Speech by Ted Belytschko

Well I have been sitting in the audience of Applied Mechanics dinners for more than 30 years now, never even dreaming that I would get the Timoshenko medal. I have enjoyed many of the talks, and heard many nuggets of wisdom to guide me in research and life. I still vividly remember one of the first talks I heard by Den Hartog- in those days every Timoshenko lecturer could still start with a reminiscence of their contact with Timoshenko. Den Hartog had worked for Timoshenko one summer, and when he wrote his study up as a report, Timoshenko told him to submit it for publication. Den Hartog responded that he did not think that this work was something the world was waiting for. Timoshenko replied- "How many publications that have appeared in the literature do you think the world was waiting for?" One outcome was that I proceeded to publish too many papers, but it is interesting that many of the papers I did not think much of had some impact, whereas many that I liked had no impact .

In preparing this talk, I noticed that many of the talks were autobiographical. But I quickly decided not to make mine autobiographical because I still remember that when I was program chairman, a very witty and brilliant Timoshenko medallist chose his autobiography as the topic. He was only eighteen by 10 PM, and I was at the edge of my chair because I was Program Chairman and the union crew that was waiting at the doors of the banquet hall to clean up.

So I will not give an autobiography, but I would like to say a few words about my teachers. The most important teacher in any research career is the Ph.D. advisor. My advisor was Phil Hodge, who many of you know and who was also advisor of Carl Herakovich, a former member of the Executive Committee who is sitting at the center table. Phil came from Brown, trained by William Prager, and he taught us many things: the importance of clarity and conciseness, personal integrity, and the joys of a career in research and teaching.

Phil also gave us some maxims that you might find useful. One was: "Any research worth doing is worth doing well." The other, which I have found even more useful, went something like this: "Academic paperwork has to be done, but it is usually not worth doing well."

My other mentor was Ernie Masur, who was Chair in my first position at the University of Illinois at Chicago. Ernie was quite different from Phil-whereas Phil trudged to the computer center every day with a box of cards for his daily run- in those days you were a computer jock if your computer cards filled one box, a superjock if it required two or more boxes -Ernie disdained to even type, saying that gentlemen did not type. But Ernie had impeccable taste and a terrific nose for what he called "substance", and he taught me to recognize the substance from the chaff. He also had a great sense of humor, though wit, like principles, can't be taught

A Timoshenko talk I really enjoyed was Roshko's talk "Think Small." There were many precepts in his talk that I found very appealing, so I have decided to take a similar vein but call it "Think Big Persistently." Now you might think I am contradicting him, but some of the things I will say echo what he said.

I will address only two facets of thinking big persistently-what it means for young people, and what it means for our society, the Applied Mechanics Division.

First let me address the Applied Mechanics Division. Over the thirty years that I have been associated with this Division, the research of this group has continued to flower: the impact of this Division on the applied and theoretical issues of engineering and science has been simply amazing. Fracture mechanics, the theory of plasticity (which really underlies almost all rational nonlinear material models), micromechanics, composites, the finite element method have either originated here or owe a large part of their development to this Division. Yet, during this time, funding from NSF, which is still the best place for research support and supports many pure and applied fields very generously, has almost shrunk to zero.

This is astounding when one considers the impact of this Division on basic knowledge, basic knowledge that is not only intellectually beautiful, but has had tremendous impact on our society. This one of the most talented groups in analytic thinking in the world and the closed form solutions that have been produced by this group have provided the basic understanding of a host of important phenomena. I might add that although I am a computational mechanician, I often say that: "A good closed form solution is worth a thousand of computations."

Now it is difficult to ascertain to what to exactly ascribe this decline, but I have long felt that it is not strictly due to external forces. I believe it stems from our lack of self knowledge, our lack of identity and our reluctance to sell ourselves. Many disciplines, like computer science, have actually hired lobbyists to plead their cause, but as a Division, we almost never talk to the upper echelons of NSF or Congressional staffers. There have been a few attempts at this, but they always seem to wane, and that is why I have added that we must think big persistently-the benefits of interactions do not come overnight

Another source of our difficulties is our fuzzy self-identity. For many years, this Division has attempted to represent fields that were no longer a part of it- the fluid mechanicians have departed for the American Physical Society, but we still included fluids, and most dynamicists are in other places, but we still pretend that it is part of our Division. Perhaps even the name of our division is no longer appropriate. For one thing, the name is not appealing to younger people-most young people starting careers in research and teaching want a more attractive name, they don't want to be confused with those who fix their cars. Furthermore, most of us are not really engineers-much of our work is indistinguishable from physics or from materials science. I daresay the contributions of some members of the Applied Mechanics Division, such as Jim Rice and John Hutchinson, rank with the most important in materials science. So maybe we should look at another name-it was very

beneficial for soils engineers, who changed their name to geotechnical engineering, and have much improved their image with the public.

What should such a name be? I have asked a number of people. Some would not even give it an attempt, because they consider it sacrilegious. Lalit Anand, a former member of the Executive Committee, proposed "Solid and Mechanical Engineering and Sciences." He suggested we would then go by the acronym SMEC. My preference is "Science and Engineering of Solids" -SES. I think it is high time we recognize that we are scientist as well as engineers, and that we get a name that accurately reflects what we do and what we have done!

But more important, the Executive Committee and its past members should be in constant contact with people at Congressional staffers, NSF and other funding agencies. There are 10,000 of us in ASME and more in ASCE, and I think we should have a strong voice. We have to let them know what we do, why it is important, and what we can do for the country. This can not be a one-shot effort, it needs to be done persistently. (for example, Mathematics has just won a commitment for a fourfold increase in funding through such long-term efforts)

My second theme pertains to young people, to whom I would like to give some advice based on my past successes and mistakes. To think big is to look for important problems at the cutting edge. Too many young researchers choose their topics by reading a paper and seeing how they can extend it- that is not how the important problems are found. You have to talk with many people, read both the literature of your disciplines and other fields, and identify the emerging fields and important problems. I fortunately stumbled into nonlinear finite elements through my consulting work early in my career-I wrote a crash code in 1971 when a visionary in DOT initiated a research program by selling the idea that crash testing could be replaced by computer simulation. Well at that time, computers were so slow that even a 500 element simulation (500,000 are customarily used today) cost more than a test, so the program was quickly shelved. But it gave me the opportunity to do some work in a new area that had considerable impact.

To highlight the importance of working on new problems, I quote Arno Penzias, the Noble Prize winner who discovered the background radiation that underpins the big bang theory: " there are two types of scientists: 2% discover new things and blaze new frontiers, the other 98% fix up their mistakes; the accolades go to the former."

It is also crucial for the success of this Division that we nurture our young researchers- our future obviously lies with them. In this, I think that we must de-emphasize the role of money in our promotion criteria. We have now reached the point where in many schools, the volume of money supersedes all other factors in a professor's promotions and recognition. This is really quite absurd, since a university does not exist to make money- our purpose is to teach and do research, and money is only a means to that end. But in many places, right at the top of your annual report is your dollars spent. Everyone seems to have become obsessed with the U.S. New and World Report ratings, in which money plays a dominant role. If this trend continues, I can see two young assistant professor talking one day and wondering: "What is the fuss over Einstein all about?- I hear he never brought in 100k per year."

So I think we ought to persistently remind our administrators that our goals are not to bring in money. Administrators have incorporated indirect funds into operating budgets, so they are becoming addicted to large research fund flows. It will be a big job to bring this to an end, but if we can think big and persistently, we can at least moderate this.

There are tremendous opportunities for us in emerging fields such as micromechanics, nanomechanics, cellular mechanics, biomechanics, computer simulation, and many that are only barely visible on the horizon today. But to enjoy these, we must do the things that need to be done persistently.

To conclude, I would like to thank my family, my wife Gail and my children Peter, Nicole, and Justine; my colleagues at Northwestern in the field of mechanics, Wing Kam Liu, Brian Moran, Jan Achenbach, Cate Brinson, Zdenek Bazant, Jian Cao, Isaac Daniel, and John Rudnicki (we have the best group in the world, and their collaboration, collegiality and competitiveness have helped me immensely), my students and post-docs, and my professional colleagues, particularly Tom Hughes and Tinsley Oden, who were so instrumental in my winning this award.