Northwestern | McCORMICK SCHOOL OF ENGINEERING

Sponsored by the Departments of Civil and Environmental Engineering and Mechanical Engineering

The Ted Belytschko Lecture

Tuesday, November 1 - 4:00pm - Ford ITW Room

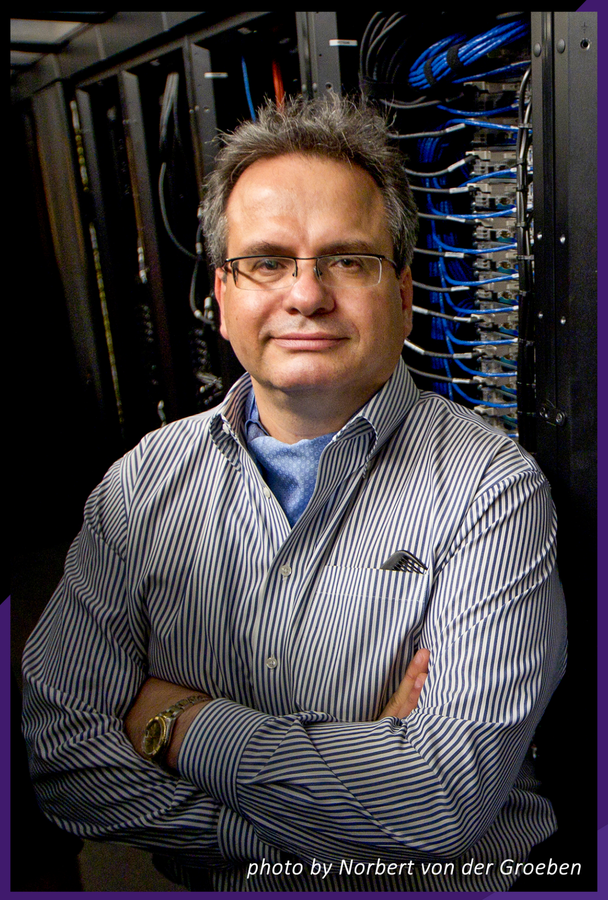

photo by Norbert von der Groeben

Parametric Nonlinear Model Order Reduction in Computational Mechanics

ABSTRACT: Parametric, projection-based, Model Order Reduction (MOR) is a mathematical tool for constructing a parametric low-dimensional model by projecting a high-dimensional counterpart onto a reduced-order basis. It is rapidly becoming indispensable for a large number of applications including, among others, computational-based design and optimization, multiscale analysis, statistical analysis, uncertainty quantification, and model predictive control. It is also essential for scenarios where real-time simulation responses are desired. During the last two decades, linear, projection-based, parametric MOR has matured and made a major impact in many fields of engineering including electrical engineering, acoustics, structural acoustics and structural dynamics, to name only a few. By comparison, parametric, nonlinear, projection-based, MOR remains in its infancy. Nevertheless, giant strides have been recently achieved in many of its theoretical, algorithmic, and offline/online organizational aspects. The main purpose of this lecture is twofold. First, to highlight some of these advances and discuss their mathematical and computer science underpinnings. Second, and most importantly, to report on their significant impact for an important class of problems in aerodynamics, fluid mechanics, nonlinear solid mechanics, nonlinear structural dynamics, failure analysis, multiscale analysis, uncertainty quantification, and design optimization.

Charbel Farhat

Department of Aeronautics & Astronautics

Department of Mechanical Engineering and Institute for Computational and Mathematical Engineering

Stanford University

BIOGRAPHY: Charbel Farhat is the Vivian Church Hoff Professor of Aircraft Structures, Chairman of the Department of Aeronautics and Astronautics, Director of the Army High Performance Computing Research Center, and Director of the of the King Abdullah City of Science and Technology Center of Excellence for Aeronautics and Astronautics at Stanford University. He is a member of the National Academy of Engineering, a member of the Royal Academy of Engineering, a Fellow of AIAA, ASME, IACM, SIAM, and USACM, and an ISI Highly Cited Author in Engineering. He was knighted by the Prime Minister of France in the Order of Academic Palms and awarded the Medal of Chevalier dans l'Ordre des Palmes Academiques. He is also the recipient of many other professional and academic distinctions including the Lifetime Achievement Award from ASME, the Structures, Structural Dynamics and Materials Award from AIAA, the John von Neumann Medal from USACM, the Gauss-Newton Medal from IACM, the Gordon Bell Prize and Sidney Fernbach Award from IEEE, and the Modeling and Simulation Award from DoD. He was selected by the US Navy as a Primary Key-Influencer, flown by the Blue Angels during Fleet Week 2014, and appointed to the Air Force Science Advisory Board.

ABOUT TED BELYTSCHKO: A treasured member of the Northwestern faculty from 1977 until his death in 2014, Ted Belytschko was a central figure in the McCormick community and an internationally renowned researcher who made major contributions to the field of computational structural mechanics.

One of the most cited researchers in engineering science, Belystchko developed explicit finite element methods that are widely used in crashworthiness analysis and virtual prototyping in the auto industry. He received numerous honors, including membership in the U.S. National Academy of Engineering, U.S. National Academy of Science, and the American Academy of Arts and Sciences. He was a founding director of the U.S. Association for Computational Mechanics, and in 2012, the association named a medal in his honor. The ASME Applied Mechanics Award was renamed the ASME Ted Belytschko Applied Mechanics Division Award in November 2007. Belytschko also served as editor-in-chief of the International Journal for Numerical Methods in Engineering, and he was co-author of the books "Nonlinear Finite Elements for Continua and Structures," and, "A First Course in Finite Elements."

Ted Belytschko

January 13, 1943 - September 15, 2014

The Ted Belytschko Lecture Endowment is made possible by the generosity of Professor Belytschko's friends, colleagues and former students, and by the McCormick School of Engineering and Applied Sciences, the Department of Civil and Environmental Engineering, and the Department of Mechanical Engineering.