DREXEL UNIVERSITY
Mechanical Engineering and Mechanics

MEM SPRING SEMINAR SERIES

May 11st (Fri) 11:00 am

MEM Seminar Room, Curtis 162

Pizza and Refreshments Served

COMPUTATIONAL DESIGN OPTIMIZATION

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&

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Abstract

Our ability to manufacture now greatly exceeds our ability to design. Engineers are no longer merely inconvenienced by inefficient trial-and-error design; rather, they are nearly incapacitated by the vast space of possible designs afforded by Advanced Manufacturing (AM) technologies. There are no systematic methods to design systems with such complexity, especially those that exhibit nonlinear, transient, multiscale, and multiphysics phenomena with uncertain behavior.

The opportunity and need to fundamentally transform design is one of the most compelling frontiers of engineering research. To this end, the Lawrence Livermore National Laboratory's newly instantiated Center for Design and Optimization is developing algorithms that can optimize immensely complex systems in High Performance Computing (HPC) environments. The complexity comes from two sources, design and physics. Design complexity refers to the intricate shape and material layouts that are made possible by today's AM technologies; it can take the form of structural composites with intricate morphologies. It also refers to the multifunctional metrics that we optimize, e.g., we maximize electromagnetic response subject to local strength and global mass constraints. And finally, it refers to constraints dictated by the AM processes to ensure manufacturable designs. Physics complexity comes from the mathematical models that are used to predict the performance of our designs. Such models require the solution of partial differential equations that contain complicated nonlinearities, transients, multiple scales, multiple physics, and uncertainties. We iterate through the design space, solving the physics equations using numerical methods. Because our design Degrees-Of-Freedom (DOF) and physics DOF are in excess of 100 million, we must develop efficient, large- scale HPC algorithms. This effort will enable engineers to optimize designs that exhibit unprecedented performance relative to current practice; it is not optional: it is an absolute necessity if we want to drive future innovation. The work offers immense challenges in engineering, math and HPC.

Biography

Daniel A. Tortorelli is the Director for the Center of Design and Optimization at the Lawrence Livermore National Laboratory and the George B. Grim Professor Emeritus at the University of Illinois at Urbana-Champaign (UIUC). He received his BSME degree from the University of Notre Dame du Lac in 1984 and his MSME and PhD degrees from the UIUC in 1985 and 1988. His professional career began as senior project engineer for General Motors Advanced Engineering Staff. In 1990, he embarked on an academic career at UIUC and stayed there until he retired in 2016 to begin his new career at LLNL.