Mechanical &
Aerospace Engineering

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MPDC member of a winning team on an AFOSR MURI

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MPDC was selected as a team member of a multi-university effort (Brown University (lead), Cornell University, Massachusetts Institute of Technology and California Institute of Technology) for an AFOSR (Computational Mathematics) MURI (Multidisciplinary University Research Initiative) project on uncertainty quantification in Complex systems.

Our project entitled `Multi-Scale Fusion of Information for Uncertainty Quantification and Management in Large-Scale Simulations' was selected among several proposals submitted by competing university teams. Prof. N. Zabaras will lead the Cornell team that also includes Prof. P.-S. Koutsourelakis (CEE). Prof. Zabaras serves as a Co-PI and member of the executive team for this project. Other members include from Brown: Profs. G. Karniadakis (PI), B. Rozovsky and J. Hesthaven, from Caltech: T. Hou, and from MIT: A. Patera and K. Willcox. The announcement from the department of defense can be found here. As part of this project, MPDC will receive up to two million dollars in support of several graduate students.

This project will address the fundamental mathematical problems associated with the analysis/synthesis/design of engineering processes and systems in the presence of uncertainty. An integrated methodology will be developed that proceeds from the initial data-driven problem definition to ultimate engineering applications. This general methodology will treat problems of real interest without sacrificing computational efficiency or mathematical rigor, in particular with regards to error assessment at all levels. It is based on a dynamic integration of five areas: (1) Mathematical Analysis of stochastic partial differential equations (SPDEs) and Multiscale Modeling; (2) Numerical

Solution of SPDEs; (3) Reduced-Order Modeling and Synthesis of SPDEs; (4) Multiscale Property Estimation; and (5) Optimization/Control in the Presence of Uncertainty.

The integrated methodology will lead to certified simulation models, which can be confidently applied to the design, control, and optimization of system performance in the presence of — and realistically incorporating — uncertainty. The applications that will drive the mathematical developments represent key interests of the United States Air Force and include multiscale modeling and design of random heterogeneous materials, automatic identification and EMC/EMI safety certification in electromagnetic problems, minimizing the generation of acoustic noise, and flow-structure interaction in the design of revolutionary air vehicles.