College of Engineering
Department of
Mechanical & Industrial Engineering

The Sidney E. Fuchs Seminar Series

3:00-3:50pm, Friday, February 26th, 2016
Frank H. Walk Design Presentation Room

Detailed and Reduced Modeling of Combustion

by Joseph Powers*

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The simulation of a reacting mixture of ideal gases is considered. The competition between advection, reaction, and diffusion in an unsteady spatially inhomogeneous geometry often induces phenomena which evolve on multiple length and time scales. While the continuum model equations are generally well accepted, analytical solutions are generally not available, and computational solution is difficult due to the plethora of scales. It is demonstrated that a detailed solution of the model equations is able to capture some of the observable harmonies in nature; in particular, predictions of oscillating detonations in a hydrogen-air mixture are able to match well with experiment. Also discussed are reduction strategies for systematically removing stiffness from reacting systems in the absence of advection and diffusion.

* Joseph M. Powers obtained his BSME, MSME, and PhD, all in Mechanical Engineering, from the University of Illinois at Urbana-Champaign, graduating in 1983, 1985, and 1988, respectively. He has been a member of the faculty of Aerospace and Mechanical Engineering at the University of Notre Dame since 1989, where he serves as Professor and Associate Chair. He is also a concurrent faculty in the Department of Applied and Computational Mathematics and Statistics. He has done visiting terms at the NASA Lewis Research Center, Air Force Research Laboratory, Los Alamos National Laboratory, Argonne National Laboratory, and the Chinese Academy of Sciences. He is Editor-in-Chief of the Journal of Propulsion and Power. He is a member of AIAA, ASME, SIAM, the Combustion Institute, and ASEE. He is the lead author of the 2015 textbook "Mathematical Methods in Engineering," and his monograph "Combustion Thermodynamics and Dynamics" will appear later in 2016.