COLLOQUIUM
MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

Dr. Alison Marsden

Assistant Professor
Department of Mechanical and Aerospace Engineering
University of California, San Diego
La Jolla, CA 92093

Friday, May 14th
11:10AM-12:00PM
Bourns Hall A265

Optimal Design and Uncertainty Quantification in Blood Flow Simulations for Congenital Heart Disease

Abstract: Recent work has demonstrated substantial progress in capabilities for patient-specific cardiovascular flow simulations, including increasingly complex geometries, physiological flow conditions, and fluid structure interaction. There is now potential for these tools to make a significant clinical impact in optimizing surgical designs for a wide range of diseases. This is particularly true in pediatric cardiology because of the wide range of anatomies that occur among patients. In this work, we present an automated and unified framework for handling shape optimization and uncertainty quantification for cardiovascular surgery design. Optimization is performed with an efficient surrogate pattern search method, and efficiency of the algorithm is explored. This method is then extended to the stochastic case to perform optimization under uncertainty. This method for performing robust design allows for inevitable "fudge-factors" in the operating room. We systematically account for uncertainties in simulations using adaptive stochastic collocation. This framework for simulation, optimization and robust design is demonstrated on several cardiovascular flow problems including Fontan surgery design, Kawasaki disease, and bypass graft optimization. In each disease case, we also explore links between fluid mechanics, including flow distribution and particle residence time, to clinically relevant parameters. In addition, we discuss the use of fluid structure interaction and physiologic boundary conditions to improve physiologic realism of patient specific simulations.

Bio: Alison Marsden is currently an assistant professor in the Mechanical and Aerospace Engineering department at UCSD. Prior to that, she graduated with a bachelor's degree in mechanical engineering from Princeton University in 1998, a PhD in mechanical engineering from Stanford in 2005, and did postdoctoral work at Stanford University in bioengineering and pediatric cardiology from 2005-07. She has been the recipient of an American Heart Association postdoctoral fellowship, an AHA beginning grant in aid award, as well as an Burroughs Wellcome Fund Career Award at the Scientific Interface. Her work focuses on the application of optimization to fluid mechanics with particular emphasis on cardiovascular surgery and congenital heart disease.