News

Press Releases
Event Announcements
CCT Weekly
Grants and Funding
Student News
Archived News

LSU Assistant Professor Shawn Walker Addresses Free Boundary Problems

A recently funded project will explore the math behind the movement of fluids and other objects with complex moving boundaries. Results of the research will improve the control and design of industrial processes.

Shawn Walker, assistant professor of the LSU Department of Mathematics and the Center for Computation & Technology (CCT), was awarded a grant from the National Science Foundation for the project "Numerical Methods for Free Boundary Problems: Two-Phase Flows and Contact Line Dynamics." The award is $90,657 over the course of three years.

Free boundary problems, such as modeling fish movements in water or how sprayed paint droplets land on a surface, arise in many areas of mathematics, physics, and engineering. The project will bring together cutting-edge modeling, analysis tools, and computational free boundary techniques in key application areas to expand and investigate the mathematical framework that models these time-dependent, domain-deforming problems.

The research will enable better design, optimization, and control of electrowetting-assisted flow of liquid droplets, droplet-impacting processes, and films coating solids.

"The project will make these processes more efficient and productive," Walker said. "It will also create new methods for automatic grid generation of complex shapes that efficiently capture moving boundaries. Grid generation is an expensive task in terms of man-hours and money."

"One result of the research will be an automatic meshing tool that will be made available on my Web site," Walker said. "Also, I'm teaching a fall 2011 course on shape optimization with partial differential equation (PDE)-constraints to give graduate students expertise in optimization with continuum models."

The project's broader impact arises from its connection to many types of physical and industrial processes that involve moving boundaries. Examples include industrial coating flows that apply a protective layer to a surface; fluid flows in micro-fluidic devices driven by electric fields, which is important in biomedicine; motion of rigid bodies in a fluid, such as particulate flows; dynamics of lipid bio-membranes, which has applications in biology; and the peeling of adhesive tape from a rigid support.

For more information on this or other research being done at the LSU Center for Computation & Technology, visit www.cct.lsu.edu/home. Walker's Web site is www.math.lsu.edu/~walker/.

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