BY KATHARINE MILLER

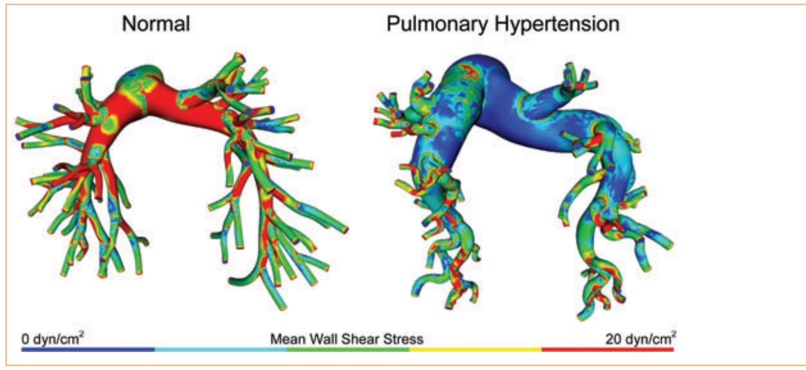
SimVascular to Simulate Cardiovascular Flow

On the computer screen, vessels throb realistically with each pump of the heart while the river of blood swirls and pools at curves and intersections. This is a simulation built with SimVascular—an integrated software system for doing cardiovascular modeling. Starting this summer, it will be available for testing by beta-users.

"Most people doing simulations of blood flow focus on several inches of the vascular system and treat it as a rigid tube," says Charles Taylor, PhD, assistant professor of bioengineering at Stanford University and PI for the cardiovascular dynamics project within Simbios. "This software allows you to do things that are much more extensive."

SimVascular creates geometric models from medical image data; converts those into finite element meshes; models blood flow through these different geometries; solves governing equations of blood flow, wall dynamics and pressure; and then visualizes the results. It is uniquely able to simultaneously model blood flow and muscle wall dynamics; handle patient-specific geometric modeling; and take into account the part of the cardiovascular system beyond the limits of the medical image data.

"Where SimVascular really shines is in handling complex modeling," says Bill Katz, MD, PhD, senior scientist for Simbios. At Stanford, over the last few years, the software has been used to help understand and quantify the relationship between blood flow and cardiovascular diseases such as atherosclerosis and aneurysms. And Taylor is working with clinicians to assess its ability to plan and predict the outcome of interventions for adults with cardiovascular disease as well as for children with congenital heart defects.



Here, SimVascular simulates mean wall shear stress in the pulmonary arteries of patients with (right) and without (left) pulmonary hypertension. The disease has altered the arterial geometry in the lungs.

ASPIRE TO BE A BETA-USER?

Taylor is currently planning a SimVascular user-training course for July or August of 2007. Contact Bill Katz, william.katz@stanford.edu, for more information.

Because SimVascular includes commercial components, its release to the scientific community as an open source project has posed some challenges, says Katz. "It required a good degree of encapsulation so that we can eventually allow open source alternatives to the commercial components." At the same time, he says, the various commercial entities they've dealt with have been very cooperative—UGS gave starter grants to alpha users for their solid modeling software, and companies have prenegotiated the terms of their relationships with future users.

For Taylor, the public release of the software feels like letting go of his baby. He conceived of the technology just over 11 years ago and has been nurturing it ever since. But, Taylor says, it's time to let others use it as well. "There are so many applications for this technology to different manifestations of congenital and acquired cardiovascular disease. We won't be able to do all the work here at Stanford."

WHAT IS SimVascular?

A software application for patient-specific cardiovascular modeling and simulation. It integrates best-in-class commercial components and custom open-source code, including an integrated flow solver with outflow boundary conditions and fluid-structure interaction for cardiovascular problems. SimVascular includes:

- Image processing and visualization using VTK and ITK from KitWare, Inc.;
- Patient-specific geometric modeling using the Parasolid® solid modeling kernel from UGS;
- Automatic mesh generation using MeshSim from Simmetrix, Inc.;
- Parallel finite element flow solver, developed jointly by RPI and Stanford, which incorporates an iterative solver library (LesLib) from AcuSim, Inc..

Simbios

Simbios is a National Center for Biomedical Computing located at Stanford University.