Numerical Simulation Delivers Benefits to the Biomedical Industry

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Contours of strain rate on the aorta

Static pressure on the trachea during exhalation

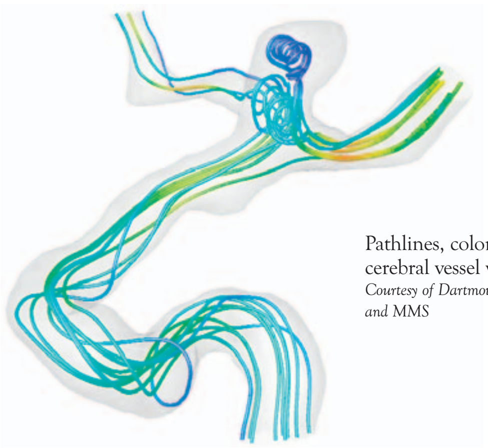
AT THE FLUENT CFD SUMMIT in June, 2006, a day-long Healthcare Symposium was held that drew more than 60 researchers from industry, academia, and federal regulatory agencies. The presentations during the symposium were focused on the use of computational modeling in the biomedical and biotechnology fields. The 2006 *Fluent News* Biomedical Supplement features summaries from the Symposium and from other researchers working in this exciting field of study. Biomedical applications are the focus of this issue; biotechnology stories are planned for publication in 2007.

Several of the articles in the supplement are related to drug delivery. Two illustrate the ability of CFD to predict drug delivery *in vivo*. An excellent overview of the challenges and issues associated with nasal modeling begins on page S3, and on page S8, the issues associated with drug delivery to the back of the eye are discussed. Both of these investigations include validation of the computational models against *in vivo* results and/or *in vitro* replicas of the physiologic condition. The deployment of and subsequent drug elution from a stent is the focus of a multi-physics calculation that is described on page S6. This project demonstrates the benefit of using a finite-element analysis as a realistic starting point for the subsequent drug-elution calculation. Drug delivery into a tooth during an endodontic procedure (page S13) is also shown to have fluid flow characteristics that could be improved as a result of CFD simulation.

Another multi-physics simulation is described in an article that begins on page S10. This fluid-structure interaction investigation of an abdominal aortic aneurysm couples the motion of blood flow to that of the elastic walls of the vessel.

Two articles are from more general areas of biomedical engineering. On page S14, a fluid-structure interaction simulation is applied to blood flow through an artificial heart valve during the cardiac cycle. The approach couples fluid-flow results to a six-degrees-of-freedom solver to calculate the leaflet motion at each time step. The flow and nutrient transport in a polymeric foam for connective cell tissue culture is the subject of an article on page S16. These investigators recreate the structure of the foam matrix from micro-CT scans to add a very high level of detail to the model, ultimately showing the effect of the micro-environment on cell growth.

The advanced modeling techniques demonstrated in the following pages are only a snapshot of the type of work that is being performed in the healthcare industry today. The enormous growth of engineering simulation in this field promises to yield a better understanding of many biological systems, ultimately resulting in better biomedical devices in the years to come. ■



Pathlines, colored by velocity, in a cerebral vessel with an aneurysm
Courtesy of Dartmouth Hitchcock Medical Center and MMS