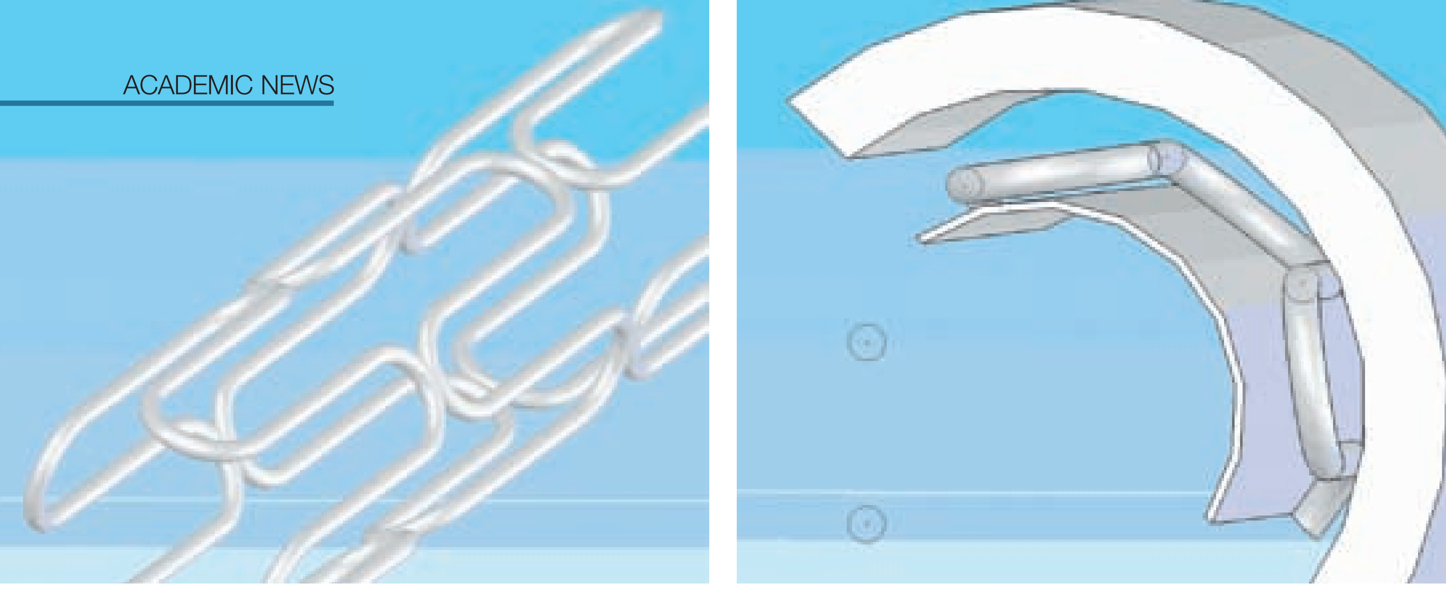

Students at the University of Pittsburgh used the ANSYS Workbench platform in modeling the complex weave geometry of an intravascular stent (left) as well as the deployment procedure (right) in which a balloon expands the device against the artery wall.

Stent Analyses **Expand Students' Exposure** to Biomedical Engineering

Engineering students gain insight into the physics of medical devices and add to the body of knowledge on stenting procedures.

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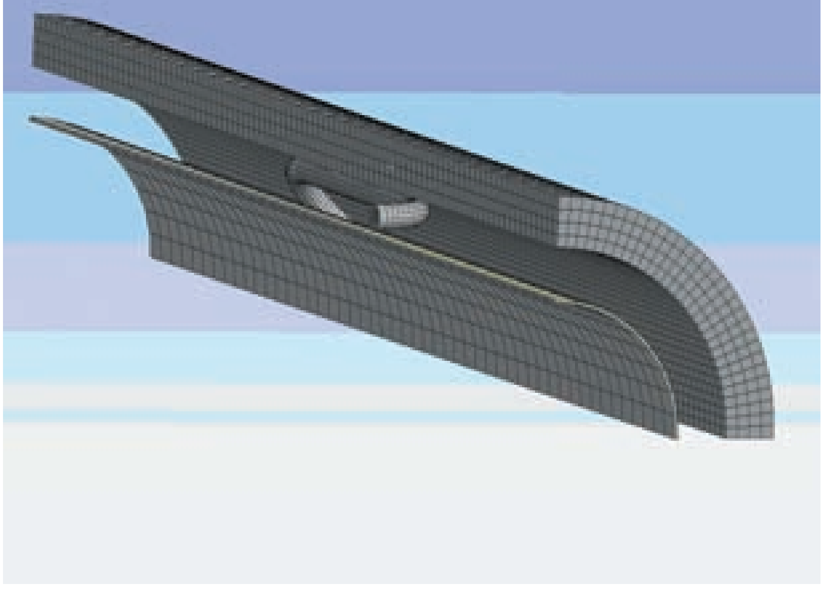
Professor Michael Lovell directed the student research on intravascular stents

With medical costs skyrocketing and health care systems overburdened by an aging population, experts acknowledge that the way diseases are treated must be changed radically. Undoubtedly, heavy investments must be made into addressing largely preventable diseases such as diabetes, heart disease and lung cancer. Furthermore, approaches must be established to detect diseases earlier in their course and regenerate functions as much as possible in patients rather than solely ameliorate symptoms.

One significant barrier for the medical community in this critical cycle of effective prevention, early diagnosis and functional regeneration has been a lack of sufficient analysis capability and computer processing power for real-time simulations of these procedures, which typically include complex mechanical structures and biomaterials. Recently, however, advanced analysis technologies and powerful computational resources have converged, enabling engineers and scientists to simulate device performance and regenerative medical procedures in ways previously thought unimaginable.



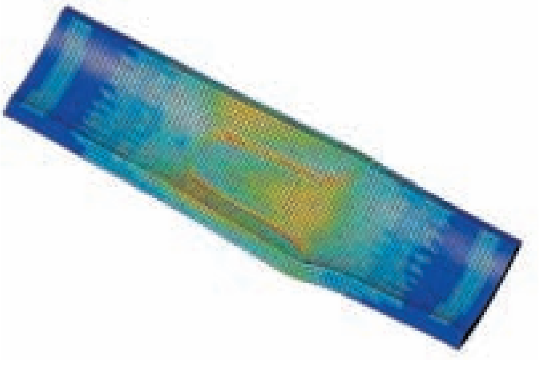
The detailed ANSYS model includes elastin and collagen fibers for the artery, a hyperelastic model for the balloon and an isotropic model for the stent.

The ability to use commercial analysis packages such as ANSYS software has allowed the scientific community to treat diseases in radical new ways using a broad range of multidisciplinary approaches. By having the capability of simulating complex medical treatments that include phenomena such as dynamic contact, nonlinear materials and fluid structure interaction, the bioengineering community has been able to bring products and technology from the bench to the bedside in a fraction of time that it did a few years ago.

At the University of Pittsburgh in the United States, these critical issues are being integrated into engineering curricula. In one class research project, students utilized the ANSYS Workbench suite of design and structural analysis software to simulate the deployment of intravascular stents: devices inserted into blocked arteries and radially expanded with a small balloon to open the artery and enhance blood flow. Through these simulations, the design of the device was optimized to maintain proper blood flow while preventing elastic recoil of the artery. ANSYS Workbench also provided a better understanding of the stresses developed between the stent and artery so that mechanical injury to the artery can be reduced. Such insight is significant in minimizing the risk of neointimal hyperplasia, an inflammation and subsequent build-up of excess cells that eventually result in restonosis, the narrowing and eventual closing of the artery.

Based on solid models of the device at various stages of the deployment, finite element models of the stent — as well as the deployment balloon and arterial wall — were effectively developed, with the quality of the mesh produced by the ANSYS Workbench platform having a dramatic impact on the solution time and accuracy of the simulations. Utilizing an advanced material model that includes elastin and collagen fibers for the artery, a hyperelastic model for the balloon and an isotropic model for the stent, student researchers were able to obtain detailed stress distributions in the artery wall when the balloon was expanded into the stent. Such information is critical to optimizing the design of the stent and the stenting procedure, which will ultimately eliminate the occurrence of restonosis.

Projects such as this add significantly to the body of information in the medical community on stenting procedures while having a tremendous education value for engineering students. Simulation provides insight into the physics of stents, better understanding of the behavior of artery walls so potential problems can be spotted quickly and alternative designs readily evaluated. Moreover, while performing this work, students learn firsthand how to use advanced analysis tools such as ANSYS software that are widely used throughout industry. ■



ANSYS simulation provided detailed stress distributions in the artery wall when the balloon expanded the intravascular stent.