Anatomy Students use Engineering Software to Study the Human Body at University of Tennessee

While engineering software is commonly used to analyze and test parts found in cars, airplanes, or other complex mechanical systems, its ability to model continuous motion lends itself to studying motion of the human body's joints as well. At the University of Tennessee at Memphis' School of Biomedical Engineering, graduate students in an anatomy course study the human body's muscular and skeletal systems using engineering concepts and a mechanical model based on Working Model software.

Biomedical engineers hope that their research will lead to a better understanding of the human body's motion, resulting in improved rehabilitation techniques and increased mobility for people with joint problems. Their research may even lead to improvements in the manufacture of artificial joints.

"The basis for understanding joint movement is linkage theory," says Denis DiAngelo, a mechanical engineer and assistant professor in the Biomedical Engineering department. "While it would be possible to study linkages using hand calculations, Working Model enables a user to study the continuous motion of a joint, whether the knee, elbow, hip, or spine."

The graduate program is located on the school's medical campus, and is one of only a few programs in the U.S. focusing on biomedical engineering, a broad area of study combining engineering and physics to solve medical-related problems. Some biomedical engineers specialize in imaging, radiography, or digital scanners, while others focus on rehabilitation—solving feeding problems, studying wheelchair dynamics, or developing mechanical walking devices.

Motion Study Solutions

According to DiAngelo, biomedical engineers have developed software programs for joint motion study. The problem with these applications is that they are mathematical, not dynamic nor graphical. One simulation program for the body is based on a pin-to-joint body model, which provides only limited understanding of joint movement because it assumes joints to be pinned, and they are not. For students, being able to visualize realistic movement of joints is critical to understanding anatomy.

While several solid modeling programs, such as Pro/Engineer, could be used for looking at the mechanical movement of joints, the University's budget does not support expensive, workstation-based software.

The University considered its alternatives and installed Working Model software. Today, biomedical engineering students work on a network of PCs running Working Model 2D software.

"We're really excited about the discoveries we're making with Working Model," DiAngelo says. "At the same time, we're frustrated by biomedical engineers that still rely on the mathematical solutions. We hope they'll come around when they see how we're using Working Model."

While DiAngelo praises Working Model, he also stresses to his students the importance of never relying exclusively on software-generated data because the parameters they set using the software may affect the solution they achieve. The message DiAngelo gives his students is "check yourself." "I also want students to check Working Model solutions so that they'll understand how the software works," DiAngelo continues.

Modeling Joint Movement

DiAngelo's class has studied spine contact problems using Working Model 2D and 3D. The class looked at the upper vertebra of the spine, the cervical spine, which undergoes a great deal of movement. According to DiAngelo, this part of the spine has not been well studied.

First, DiAngelo and his students scanned in X-rays of a spine into CAD design software and exported it directly into Working Model for simulation. Using Working Model, students modeled the spine as a rigid body with points of rotation. After studying the spine's simulated movement, students found that some data reported in medical literature were incorrect. One student won second place in a poster contest for this study.

Real World Applications

DiAngelo sees many real-world Working Model applications for orthopedic surgeons, physical therapists, and others who work in rehabilitation medicine. For example, using Working Model, orthopedic surgeons can model the ligaments as "collapsible links" and see how the knee joint is affected when ligaments change.

In a clinic setting, Working Model would enable physical therapists working with knee injury patients to understand and identify injury patterns. People tend to move their bodies in certain repetitive patterns. According to DiAngelo, it would be valuable to demonstrate these patterns to physical therapists so they can tailor patient therapy accordingly.

Future Directions

Eventually, biomedical engineers believe that by understanding how joints move, they'll be able to design artificial joints that work very well in the human body. They'll also understand how the ligaments and muscles interact with and attach to the joints. While researchers say they'll solve these problems, biomedical engineers at the University of Tennessee believe their work with Working Model will help refine and validate those solutions, saving valuable research time and improving patient's lives.