

BY JOY P. KU, PhD, DIRECTOR OF SIMBIOS

Grand Challenge Competition Provides Rich Data Set to Improve Joint Contact Force Predictions

There are numerous modeling methods available to make predictions of muscle and joint contact forces. While such predictions can help improve treatments for movement-related disorders such as stroke or osteoarthritis, there's a problem: choosing which one to use. The research community hasn't had a way to easily evaluate different approaches. The Grand Challenge Competition to Predict *In Vivo* Knee Loads—now in its third year—changes that by motivating researchers to critically evaluate their simulations of contact forces in the knee, and by providing a wealth of experimental data to do so.

“Through the competition, I hope that we as a research community will be a little more critical of ourselves—in a good way—so that we can really gain confidence in what we're predicting and our models can become much more useful clinically,” says **B.J. Fregly, PhD**, professor of mechanical and aerospace engineering at the University of Florida. He and **Darryl D'Lima, MD, PhD**, at Scripps Clinic are principal investigators of the grand challenge grant.

Each fall, the competition organizers make available a comprehensive data set for one subject who has received an instrumented, force-measuring knee implant. The data includes pre-surgery MRI and CT data, surface marker trajectory data, electromyography signals, and dynamic x-ray images of knee motion, just to list a few. But the competition's participants are not given the *in vivo* contact force measurements. These they must predict and submit to the American Society of Mechanical Engineers (ASME) and the competition organizers. Presentations and discussions of the competition submissions and the announcement of the winner occur at ASME's Summer Bioengineering Meeting.

While other research areas have held similar competitions, “this grand challenge competition is the only one I'm aware of in biomechanics,” says **Grace Peng, PhD**, a program director at the NIH's National Institute of Biomedical Imaging and Bioengineering, which funds the knee grand challenge grant. “In that way, it's really unique.”

The government has recently been pushing the use of prizes and challenges, especially for science and technology. “Challenges like this help benchmark some of the many techniques available and determine best practices,” says Peng. “It is help-

ful to discuss the methods openly and publicly and have the technology converge.”

That's what **Stephen Piazza, PhD**, associate professor of kinesiology at Pennsylvania State University, and his then-graduate student **Michael Hast, PhD**, discovered when they participated in (and won) last year's competition. “When multiple groups are working on the same problem, the same data, there's a potential for sharing and learning that can't occur otherwise,” says Piazza.

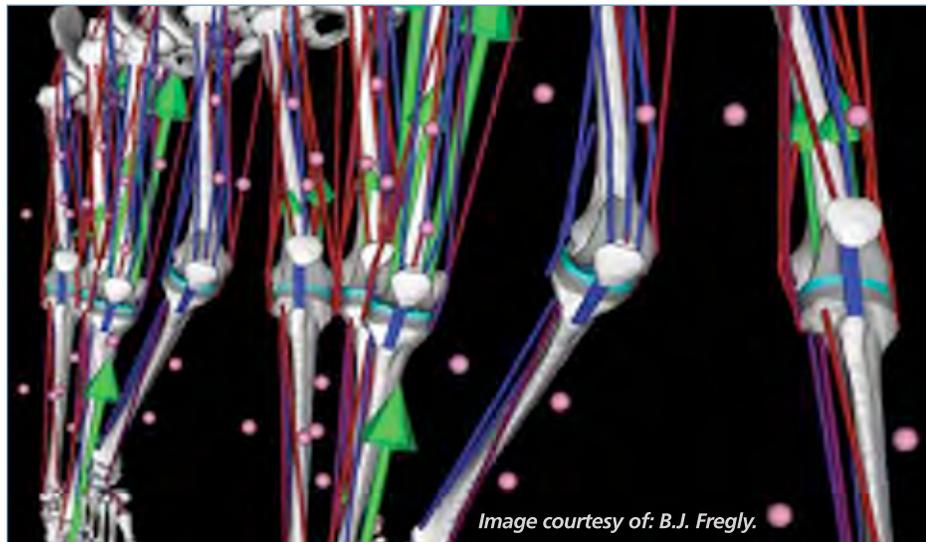


Image courtesy of B.J. Fregly.

Hast agrees: “Sometimes it feels like you're in a cave working on these problems. Being able to see how others approached the same problem was a good experience.”

Piazza and Hast actually waited one year after learning about the competition before entering. “We couldn't do it the first year. Our simulation wasn't where we wanted it to be,” says Piazza. The competition motivated them to extend their simulations, which had previously been used to predict forces for a highly constrained mechanical knee simulator, to work with the more variable human data.

For Hast, the competition was the capstone to his PhD. The competition's data set, which is synchronized and captures subjects performing different activities and using different walking motions, was much more extensive than he had the time or opportunity to collect for his thesis.

“It is really an embarrassment of riches as far as the data is concerned,” says Hast, who plans to use the data in his future research. As for the competition, he says, “It's cost-effective and helps the greater orthopedic community. It's a really great cause.” □



DETAILS

The publication “Grand Challenge Competition to Predict *In Vivo* Knee Loads” in the *Journal of Orthopaedic Research* provides a detailed description of the project and data. To access the data, visit <http://simtk.org/home/kneeloads>.