Full-Field Methods for Characterizing the Non-Linear Anisotropic Response of the Anterior Cruciate Ligament of the Knee

The Anterior cruciate ligament, or ACL, of the knee is a soft tissue structure comprised of two main bundles of hierarchical collagenous structures. As with all soft tissue, the ACL is extremely difficult to mechanically test, and determining its non-linear, anisotropic mechanical response has remained elusive. Yet, obtaining the mechanical properties of the ACL is exceedingly clinically relevant to the design of better replacement grafts for torn ACLs or to prevent ACL tears in the first place. This talk will focus on our recent efforts to characterize the ACL response utilizing full-field displacement measurement techniques that offer more accurate, repeatable, and comprehensive experimental data than traditional testing methods. We’ve pioneered full-volume characterization techniques that provide much needed insight into the inaccuracies associated with many current experimental protocols and also the shortcomings of some popular constitutive models in capturing the full 3D response of the ACL. I will describe how we use these data to develop an ACL constitutive model for implementation into computational models of the knee during regular gait and under impact loading simulations. Accurate computational models of the knee such as ours may one day be used to guide clinical practice to intervene to prevent an ACL injury or to determine the best course of action to repair an injury.

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Professor Arruda teaches and conducts research in the areas of theoretical and experimental mechanics of macromolecular materials, including polymers, elastomers, composites, soft tissues and proteins, and in tissue engineering of soft tissues and tissue interfaces. Her recent honors and awards include the 2019 Nadai medal from the American Society of Mechanical Engineers, the 2018 Rice medal from the Society of Engineering Science, the 2015 Outstanding Engineering Alumnus Award from the Pennsylvania State University, the 2014 Distinguished Faculty Achievement Award from the University of Michigan, the Ann Arbor Spark Best of Boot Camp award 2012, and the 2012 Excellence in Research Award by the American Orthopaedic Society for Sports Medicine.

Professor Arruda has more than 100 papers in scientific journals. She also holds eleven patents. Her H-index is 32 (ISI). Professor Arruda is a Fellow of the American Society of Mechanical Engineers, the American Academy of Mechanics, and the Society of Engineering Science. She is a member of the National Academy of Engineering (class of 2017). She is currently President of the American Academy of Mechanics.

Ellen M. Arruda, Ph.D.

Please join us for the reception immediately following the seminar