

*Computer Science & Electrical Engineering Seminar Series*

**Development, Verification, and Validation of Parametric and Probabilistic  
Musculoskeletal Finite Element Models**

*Dan Nicolella, Ph.D*

**Friday, Oct 10<sup>th</sup>, 2008 in FH 557 at 2:00 pm**

Computational analysis methods such as the finite element method (FEM) are widely accepted in musculoskeletal biomechanics as an important tool used to investigate the complex mechanisms of degenerative diseases such as osteoarthritis and osteoporosis, in the design and analysis of total joint replacements and other orthopaedic devices, and to predict the risk of injury. These methods are ideally suited to simulate the behavior of complex biological structures that often include complicated geometry, non-linear material behavior, and time dependent phenomenon. However, two limitations severely limit the efficient and reliable applications of finite element methods in biomechanics. Typical applications of finite element methods are limited in that each model represents a single subject and, in order to construct a model from a different subject, the complete model construction procedure must be repeated. The use of parametric modeling methods would greatly reduce the time required to construct individualized models without negatively impacting the predictive accuracy of the model. A second major limitation is the inability to account for modeling uncertainty and biological variability in critical model parameters such as joint loading, material properties, and failure properties and to describe how this uncertainty and variability affect model predictions.

In this talk, Dr. Nicolella will describe the ongoing development of a parametric, probabilistic finite element model of the human cervical spine to be used to predict the risk of injury to Navy pilots. As part of this development effort, a hierarchical model verification and validation methodology was defined and implemented to quantify the predictive accuracy of the computational model. In addition, Dr. Nicolella will describe a new parametric modeling method based on statistical shape modeling. The application of this method to predicting the risk of osteoporotic fracture will be described.

**Dan Nicolella, Ph.D.**



Dan Nicolella received his Ph.D. in Mechanical Engineering from Case Western Reserve University where he specialized in musculoskeletal biomechanics. He is currently a Staff Engineer in the Mechanical and Materials Engineering Division at Southwest Research Institute in San Antonio, TX and is also a member of the Biomedical Engineering Department faculty at the University of Texas at San Antonio. Dr. Nicolella is currently spending a three-month sabbatical as a Visiting Scientist in the Oral Biology Department at UMKC. He has received funding from the National Institutes of Health, the US Army, the US Navy, and numerous commercial companies. His current research interests are in computational modeling of the human musculoskeletal system, nano- and micro-mechanics of bone tissue and cells, tissue engineering, and bone cell mechanobiology.