Beyond Finite Elements: Addressing Challenges in Computational Mechanics

Professor Dan Simkins
University of South Florida

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ARMS 1109

Abstract
The venerable Finite Element Method (FEM) has been a mainstay in the solution of many engineering problems since the 1950’s. This presentation will discuss two aspects arising in current research applications that challenge FEM, and novel approaches to solving them.

Systems with an evolving topology, e.g. fracture modeling, have challenged FEM for many years. The difficulty lies with the fact that FEM is built upon a mesh which represents the topology of the system. As a crack opens and propagates, it changes the topology of the object, which generally means a change to the underlying mesh. Cases that exhibit complicated crack morphologies can require an extensive re-meshing procedure. Not only can the resulting re-mesh itself be difficult, but internal state variables, e.g. accumulated plastic strain, generally must be re-mapped from one domain to the next and this mapping often introduces significant error. Meshfree methodologies represent the domain by a collection of interacting nodes or particles and do not suffer from this limitation. Recent success in using this approach to ductile fracture in shell-type structures and laminated composites will be presented.

Common engineering analysis applications generally involve geometries that are well defined mathematically, either analytically, or through the use of a computer aided-design (CAD) system. However, life science and nanotechnology applications generally have their geometries defined by discrete point sets, often coming from such diagnostic techniques as computed tomography (CT), or atomic force microscopes (AFM). While a discrete point set can generally be meshed, the resulting mesh is not usually directly usable by FEM, i.e. is not an analysis-suitable representation. A new approach to determining an analysis-suitable representation will be presented.

Bio
Daniel Simkins earned a PhD in Civil Engineering at the University of California-Berkeley in 2004. After a short respite from academia, he joined the faculty at the University of South Florida in 2005 as an Assistant Professor. Prior to entering Berkeley, he spent 8 years at the Lawrence Livermore National Laboratory and 2 years in Silicon Valley. His research focuses on computational modeling and simulation.

An informal coffee & cookie reception will be held prior to the lecture at 2:30 p.m. in the AAE/ARMS undergraduate lounge (directly in front of ARMS 3rd floor elevators)