Why 'Large Worlds' Require New Tools for Decision Modeling and Analysis in Engineering Design

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Abstract:
Engineers make decisions that define the built world and improve peoples' lives. Yet decisions are made, and resources are allocated, before the outcomes—and ramifications—can be known. Uncertainty is therefore an inherent part of engineering decision-making. Existing decision analysis tools use normative approaches where uncertainties are modeled using objective or subjective probabilities. This approach is based on Savage's scholarly work from the 1950's where decision problems were framed as a 'small world' and the decision-maker could "look before you leap."
As we address the global challenges of the 21st century, engineers work in an entangled world where systems have complex and irreducible coupling, system performance is impacted by human behavior, and time and resource constraints prevent uncertainties from being resolved. While engineers may recognize the presence of some uncertainties, quantifying them becomes impossible. Savage describes such decision scenarios as requiring a 'large world' frame where the calculus of probabilities cannot be applied.
This talk will describe why new tools are needed for modeling the decision-making process and for analyzing system architectures. We will explore why conviction narratives provide a more complete model of engineering decision-making and the role that engineering judgment plays in arriving at a state of action. We will also discuss how unresolvable uncertainties require the reframing of system architecture decisions, and the role of design margins in this process. The talk will conclude with a vision for how these tools can enable improved computational design and yield adaptable solutions that respond to unexpected futures.

Biography:
Scott Ferguson is an Associate Professor in the Department of Mechanical and Aerospace Engineering at NC State University. His research program explores how engineers weigh evidence when making design decisions, how system architecture should be defined in the face of uncertain requirements, and how product variety should be managed in market-driven environments. He is the recipient of the NSF CAREER award (2011), the NC State Outstanding Teacher Award (2012), the ASME Design Automation Young Investigator Award (2014), and the ASEE New Mechanical Engineering Educator Award (2015). He is an Associate Editor for the Journal of Engineering Design and a former Associate Editor for the Journal of Mechanical Design. Currently, he is a member of the ASME Design Engineering Division Executive Committee and is the past chair of the ASME Design Automation Conference Executive Committee. He previously served on the AIAA MDO TC. Dr. Ferguson has received funding from NSF, NASA, DOE, the American Public Power Association, General Motors, Under Armour, and other private industry.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**
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