# DISTINGUISHED SEMINAR SERIES

**Hosted by the Department of Civil and Environmental Engineering**
at Northeastern University

## Probabilistic Approaches to Model Calibration: State-Aware Bayesian Inference


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12PM - 1PM Eastern

## Churchill Hall 103

*We look forward to you joining us.*


**ABSTRACT:** This presentation entails three components. First, it overviews the curricular innovations taken place at Penn State's Architectural Engineering department along with the resulting increases in student enrollments, retention, and graduation rate as well as successes in career placements before graduation. Next, it offers a sample of example research areas undertaken by Penn State's Architectural Engineering faculty. Finally, the presentation concludes with a discussion on the recent advances in the use of probabilistic model calibration, validation, and verification approaches referred to as state-aware inference.

*State Aware Bayesian Inference:* Computer models of engineering systems simulate the behavior of a system under various operational conditions by defining a representation of physics linking state variables (loads, temperature, etc.) to relevant output responses (deformation, stresses, etc.). In this process, additional input parameters that reflect the properties of the engineering system must be defined, even if they are not well known or understood. Problems arise when relationships between these input parameters and state variables are insufficiently understood and are thus, excluded from the model or simplified with empirical models. Herein, we present an entirely new statistical analysis method capable of using available observations to identify the nature of previously unknown relationships between input parameters and state variables, referred to as state-aware calibration. The proposed approach effectively combines a mechanistic approach of improving models' predictive capability using physics knowledge and an empirical approach of training statistical emulators to discover the nature of discrepancies between model simulations and observations. Through the proposed approach, we not only significantly reduce the systematic bias between model predictions and experimental observations remaining after traditional calibration, but also enhance the engineer's knowledge of the physics principles governing the system behavior, thus improving our physics-based models, and furthering our scientific understanding of advanced systems. The major benefit of state-aware calibration is the ability to guide model developers by pinpointing the most influential, mechanistically relevant processes that are absent from the models, thereby offering a definitive guide to the prioritization of future model developments as well as the design of new experiments to explore the nature of these physical relationships under the constraints of limited resources.


**Bio:** Dr. Sez Atamturktur Russcher is the Harry and Arlene Schell Professor and Department Head of Architectural Engineering at Pennsylvania State University. Prior to joining Penn State, she served at Clemson University as Associate VP for Research founded the Office of Research Development. Previously, she was at Los Alamos National Laboratory as an LTV technical staff member. She holds a MS in architectural engineering and a PhD in civil and environmental engineering from the Penn State. Her research is focused on uncertainty quantification and experimental calibration of predictive models of engineering systems. She is a member of the board of directors for the National Institute for Building Science. Dr. Atamturktur also holds lead advisory roles for the UN's High Performance Building initiative. She has served as the inaugural director of the NSF-funded ADVANCE project.