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On the Aggregation and Extrapolation of Uncertainty from Component to System Level Models

Angel Urbina, Richard Hills and Adam Hetzler
Sandia National Laboratories*
Albuquerque, NM 87185

Abstract

The use of computational models to simulate the behavior of complex mechanical systems is ubiquitous in many high consequence applications such as aerospace systems. Results from these simulations are being used, among other things, to inform decisions regarding system reliability and margin assessment. In order to properly support these decisions, uncertainty needs to be accounted for. To this end, it is necessary to identify, quantify and propagate different sources of uncertainty as they relate to these modeling efforts. Some sources of uncertainty arise from the following: (1) modeling assumptions and approximations, (2) solution convergence, (3) differences between model predictions and experiments, (4) physical variability, (5) the coupling of various components and (6) and unknown unknowns. An additional aspect of the problem is the limited information available at the full system level in the application space. This is offset, in some instances, by information on individual components at testable conditions. In this paper, we focus on the quantification of uncertainty due to mesh convergence, parametric uncertainty, and differences in model prediction and experiments, and present a technique to aggregate and propagate these sources from the component level to the applications space. A numerical example based on a structural dynamics application is used to demonstrate the technique.

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