Uncertainty Quantification in Computational Predictions for Complex Aero-mechanical Systems

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http://engweb.swan.ac.uk/~adhikaris/stochastic.html

Numerical computer codes implementing physics based models are the backbone of today's mechanical/aerospace engineering analysis and design methods. Such computational codes can be extremely expensive consisting of several millions of degrees of freedom. However, large models even with very detailed physics are often not enough to produce credible numerical results because of several types of uncertainties which exist in the whole process of physics based computational predictions. Such uncertainties include, but not limited to (a) parametric uncertainty (b) model inadequacy; (c) uncertain model calibration error coming from experiments (d) computational uncertainty and (e) model uncertainty. These uncertainties must be assessed and systematically managed for credible computational predictions. The main challenges to incorporate uncertainty in computational predictions are: (a) the computational time can be prohibitively high compared to a corresponding deterministic analysis, (b) the volume of input data can be unrealistic to obtain for a credible probabilistic analysis, and (c) the predictive accuracy can be poor if considerable resources are not spend on the previous two items. This lecture is aimed at addressing these issues for complex structural dynamic systems. Three methods, namely (1) spectral stochastic finite element method, (2) random matrix theory, and (3) Gaussian emulator based approaches will be discussed.