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"Control of Technological Systems of Systems"
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Computational methods for uncertainty quantification and sensitivity analysis of complex systems

Abstract:
Computer simulation has become a central tool in the design of complex systems such as large civil engineering structures, nuclear power plants, aircrafts, weapons, etc. Virtual prototyping which is based on both advanced CAD and computational models representing the physics of subsystems has emerged as a powerful tool in order to decrease design costs and time to market. In order to increase the robustness of their systems engineers have realized that not only the "ideal" system should be optimized and assessed but also virtual systems whose geometry, material properties and environmental loading deviate from nominal values. Uncertainty quantification and sensitivity analysis which combine physical models and probabilistic methods have thus received considerable attention in the last ten years. In this talk a general framework is first described which allow the analyst to pose the problem of uncertainty quantification properly. Polynomial chaos expansions are then introduced as a powerful tool for uncertainty propagation and sensitivity analysis. The case of multiscale systems whose representation requires multiphysics approaches and nested modelling is then discussed, with emphasis on the inherent statistical dependence of the performance of the subsystems. Several civil and mechanical engineering applications are presented as an illustration.

Short Bio:
Bruno Sudret is currently Director of Research at the LaboratoireNavier(Ecole des PontsParisTech / IFSTTAR / CNRS) and Professor of Risk, Safety and Uncertainty Quantification at the Institute of Structural Engineering, ETH Zurich.
He is a practice-oriented scientist with many years' expertise in the management of various large engineering and industrial companies. His specialist area is the detection of uncertainties in numerical models:

- Uncertainty quantification in engineering
- Riskanalysis
- FiniteElementReliabilityMethods
- Time-variant Reliability
- Stochastic Finite Element methods and polynomial chaos expansions
- Advanced meta-models (kriging, support vector regression)
- Bayesianreassessment of existing structures
- Reliability-based design optimization / robust design
- Probabilistic fatigue assessment

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