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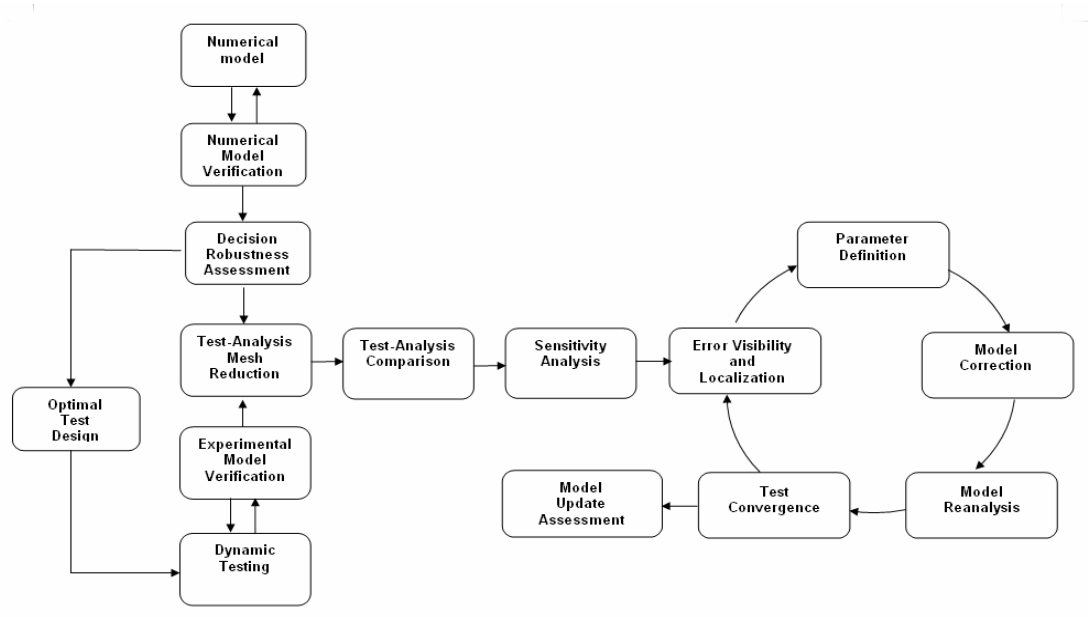
Model Updating for Validation: A Tutorial Course

Mathematical modeling of physical phenomena is used in all fields of scientific investigation and represents not only a tool for better understanding the world around us but also serves as a basis for making informed decisions that influence the way we act. The confidence we place in the information gleaned from simulated data largely depends on two factors. Firstly, the adequacy of past experience when analytical predictions are confronted with real world observations under laboratory conditions. And secondly, on our appreciation of the different sources or uncertainties present in the mathematical modeling, real world phenomena and experimental feature extraction processes. Model verification[1] and validation[2] is the field of inquiry concerned with determining the level of confidence one can reasonably have in simulated results and how one might go about improving an unreliable model. Model updating is defined here as a subtask of the model validation process and is concerned with revising the model form and characteristic values based on a set of reference data which is generally obtained experimentally.

This 1-day tutorial presents the different steps of the model updating activity (see flowchart below) in the context of solid mechanics and in particular for structures having an elastodynamic behavior. The emphasis will be placed on the different problems that arise in the process and the current state-of-the-art for addressing these issues as well as some guidelines for best practice. Academic and industrial examples will be used to illustrate the different methodologies.



[1] *Verification* is the process of insuring that the physical concepts have been correctly implemented and solved in a numerical framework.

[2] *Validation* is the process of insuring that the essential physical effects have been introduced in the mathematical formulation based on a confrontation between analytical and experimental results.

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When and Where

Time and Date: Sunday 10 May 2009, 09:00 - 12:00, 13:00-16:00.
Place: Room 282, Lady Davis Building (Faculty of Mechanical Engineering), Technion, Haifa.
Registration and additional information: Yakov Ben-Haim, yakov@technion.ac.il, 04-829-3262, 050-750-1402 .
Sponsorship: The Israel Association for Computational Methods in Mechanics (IACMM), The Technion—Israel Institute of Technology, and three Technion Faculties: Aerospace, Mechanical, and Civil & Environmental Engineering.

List of Topics

- Info-gap decision robustness assessment
- Optimal versus robust pickup and exciter test design
- Test verification and diagnostics
- Feature definition and distance metrics for linear and nonlinear dynamics
- Mesh reduction for model comparison
- Local and global sensitivity analyses for effects screening
- Reinitialization of local stiffnesses
- Model error visibility and localization based on a constitutive relation error
- Deterministic and stochastic model updating
- Approximate reanalysis using enriched Ritz bases

Industrial applications taken from automobile and aerospace fields.

Instructor

Dr. Scott Cogan is a Senior Research Fellow with the CNRS in France. He has directed and co-directed 20 PhD students and worked with the automobile and aerospace industry on over 30 projects over the past 20 years on the topics of model validation and robust design in the domain of structural dynamics.

Selected Bibliography

Ben-Haim Y., Cogan S., Sanseigne L., *Usability of mathematical models in mechanical engineering decision processes*, Mechanical Systems and Signal Processing, 12(1), 121-134, 1998.

Vinot P., Cogan S., *A robust model-based test planning procedure*, Journal of Sound and Vibration, 288, 571-585, 2005.

E. Pillet, N. Bouhaddi, S. Cogan, *Bayesian experimental design for parametric identification of dynamical structures*, Proceeding of the Eighth International Conference on Computational Structures Technology, Edited by B.H.V Topping, G. Montero and R. Montenegro, Civil-Comp Press, 2006.

Dupont B., Pillet E., Cogan S., *Superelement verification in complex structural models*, Shock and Vibration, Vol 15,Number 3-4, pp 369-381, 2008.