New hands-on V&V software sessions!

Los Alamos Dynamics, Structural Dynamics Consultants (www.la-dynamics.com)

Announces a Three-Day Short-course:

Verification and Validation (V&V) of Computational Models

Nantes, France, July 5-7, 2014

Synopsis:

This short-course on the Verification and Validation (V&V) of computational models teaches techniques to quantify prediction uncertainty which includes the broad classes of, first, numerical uncertainty caused by truncation effects in the discretization of partial differential equations and, second, parametric uncertainty caused by the variability of model parameters. It focuses on applications in structural mechanics and structural dynamics. The quantification includes the propagation and assessment of how much uncertainty is present in the simulation of an application of interest (*"what are the sources, how much uncertainty is present?"*). It includes understanding which effects control the uncertainty (*"is it predominantly the mesh discretization, parameter variability, or other phenomena?"*) and what can be done to reduce the overall uncertainty (*"should the mesh be refined, should small-scale experiments be performed, should model parameters be calibrated and how?"*).

Goals:

- **Understand the objectives of code verification, model validation, and uncertainty quantification**
- **Develop procedures for practical solution verification**
- **Quantify the effects of truncation error in simulations**
- **Describe the validation paradigm of sensitivity analysis, correlation, and uncertainty analysis**
- **Understand techniques for global sensitivity analysis and effect screening using designs-of-experiments**
- **Learn to develop fast-running surrogate models**
- **Define appropriate test-analysis correlation metrics for model revision and calibration**
- **Reinforce lecture material through "hands-on" examples**

Topics Covered:

1) Overview of V&V
- Overview of V&V
- Definitions, organization of V&V
- What can be learned?

2) Application: Wind Turbine Simulation
- Code verification of the software
- Bounds of numerical uncertainty
- Sensitivity analysis of model predictions
- Model calibration using emulators

3) Code Verification
- Code verification activities
- Method of Manufactured Solutions
- Examples of code verification studies

4) Solution Verification
- Consistency, stability, convergence
- Modified Equation Analysis
- Grid Convergence Index
- Estimation of truncation error

5) Features for Structural Dynamics
- Linear, stationary dynamics
- Arbitrary time-series analysis
- Temporal moments for fast transients
- Principal Component Analysis

6) Design of Computer Experiments
- Principles of the design of experiments
- Full-factorial, fractional factorial designs
- Orthogonal arrays, central composite
- Diagnosing statistical aliasing

7) Sensitivity Analysis, Effect Screening
- Rationale for effect screening
- Simple approaches to effect screening
- Analysis-of-variance (ANOVA)
- Main-effect and interaction screening

8) Development of Surrogate Models
- Low-order, polynomial emulators
- Kernel regression
- Gaussian process modeling

9) Sampling of Parametric Uncertainty
- Monte Carlo sampling
- Latin Hypercube Sampling (LHS)
- Convergence of statistical estimates

10) Validation Metrics
- Metrics for structural dynamics
- General-purpose metrics
- Statistical testing
- Model calibration and inference

11) An End-to-end Example of V&V
- Engineering example of transient dynamics finite element simulations

12) Hands-on Exercises
- Code verification using exact solutions
- Method of Manufactured Solutions
- Quantification of truncation error
- Propagation of parametric uncertainty
- Optimization of model parameters to reproduce physical measurements

See course outline and instructor bios at www.la-dynamics.com.

This short-course is designed for those who seek an understanding of V&V and how to integrate various V&V techniques for their applications.