Probabilistic and Uncertainty Quantification Methods for Model Verification & Validation *(MC146)*

A two-day Seminar held in conjunction with the ASME V&V Symposium

Presented by:
David Riha and Ben Thacker
Southwest Research Institute

15 Hours • 1.5 CEUs • 15 PDHs

Upon completion of this Seminar, attendees will be able to:

- Explain the concepts and methods used for quantifying and managing uncertainties in model verification, validation and prediction
- Identify uncertainties in models and data
- Represent uncertainties in models and inputs
- Explain how uncertainties impact model verification, validation and prediction
- Select methods to efficiently propagate uncertainties in the models
- Identify options to reduce uncertainties in model predictions

For more information and to register, go to http://go.asme.org/mc146

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About this Seminar

Probabilistic and Uncertainty Quantification Methods for Model Verification & Validation

This two-day seminar presents the concepts, methods, approaches, and strategies for characterizing and managing uncertainties within the context of model verification and validation (V&V).

Uncertainty quantification methods are presented in-depth followed by simple exercises to reinforce the material. Attendees will learn to use the NESSUS probabilistic analysis software and will apply it throughout the course to gain experience in problem formulation, results interpretation and communication. V&V case studies are discussed to illustrate model development within a V&V framework.

Upon completion, attendees will be able to:

- Identify potential uncertainties in models and data
- Represent uncertainties in models and inputs
- Explain how uncertainties impact model predictions
- Select methods to efficiently propagate uncertainties in the models
- Identify options to reduce uncertainties in the model predictions

Who Should Attend

This course is essential for engineers, scientists, and technical managers concerned with managing uncertainties in model predictions used to make decisions in the engineering design and evaluation process.

Course Materials Provided

Course attendees will be provided with print copies of the presentation as well as print copy of the charts used during the course. Attendees will also receive a 3-month license for the NESSUS® probabilistic analysis software.

Course Materials Required

Attendees will need a Windows or Apple based laptop computer to complete the course exercises. Download and installation instructions will be provided prior to the course or can be installed during the course if the attendee has administrator permissions.

About the Presenters

Ben H. Thacker, Ph.D., P.E., Director, Materials Engineering Department, Southwest Research Institute brings over 25 years of expertise in computational mechanics, structural reliability, and computer methods development. He has been heavily involved in the development and application of probabilistic methods and has applied probabilistic methods to geo-mechanics, biomechanics, and other transient non-linear problems.

Dr. Thacker is an active member of the AIAA Non-Deterministic Technical Committee and the ASME Standards Committee on Verification and Validation. He has instructed at the “Probabilistic Analysis and Design: Computational Methods and Applications” annual short course at the Southwest Research Institute since its inception. He received his Ph.D. in Civil Engineering from University of Texas at Austin.

David Riha is a Principal Engineer in the Mechanical Engineering Division at Southwest Research Institute. His technical expertise and interests are concentrated in the area of predicting the probabilistic response and reliability of engineered systems using advanced probabilistic and uncertainty methodologies. Since 1991, he has developed probabilistic methods and software tools including the NESSUS® probabilistic analysis software. Mr. Riha provides consulting for applied reliability problems, model verification and validation, and uncertainty quantification to various industry and government agencies in areas such as aerospace, automotive, biomechanics, geomechanics, and weapon systems. Mr. Riha also develops and presents training in the area of probabilistic analysis and design methods, uncertainty quantification, and approaches for model verification and validation. He has taught over 60 courses since 1991. He has a B.S in aerospace engineering from the University of Texas at Austin and M.S. in mechanical engineering from the University of Texas at San Antonio.

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AGENDA

The contents are presented in lectures organized as shown below. The two-day schedule allows for ample discussion and interaction with attendees. The instructors reserve the right to modify the contents to address the audience's needs and preferences.

Day One: 8:00 am – 5:00 pm

Background

- Verification and validation
- Validation metrics
- Validation requirements
- Predictions
- Decisions

Modeling uncertain variables

- Mathematical models for uncertainty (PDF/CDF)
- Data fitting

Propagating uncertainties

- Sampling methods
- Analytical methods

Formulating UQ problems

- Solution objectives
- Defining the model
- Modeling random variables
- Evaluating results

Sensitivity analysis

- Deterministic
- Probabilistic
- Global

(End of Day One)

Day Two: 8:00 am – 5:00 pm

UQ for numerical models

- Uncertain variables related to finite element
- Modeling spatial and temporal variables
- Solution approaches

Response surface models for efficient uncertainty propagation

- Basic principles
- Training data bounds/# points in practice
- Polynomial model fitting
- Gaussian process concepts
- Model assessment

Bayesian statistics for uncertainty quantification

- Identification and categorization of different types of uncertainty
- Modeling/quantification of uncertainty
- Bayesian analysis

Model Parameter Calibration

- Concepts
- Bayesian analysis for model calibration
- Evaluation of calibration assumptions

UQ solution strategy examples

- Turbine blade model overview
- Model and data uncertainties
- Solution strategies
- Results interpretation

V&V Case Study

- Model development within a V&V framework
- Temperature dependent yield strength model
- V&V plan and process, PIRTs, model hierarchy
- Verification, UQ, validation
- Model maturity

(End of Day Two)