

# Uncertainty Modeling and Quantification

**KEYWORDS**

Probabilistic Risk Assessment

Confidence Bounds

Estimation of Extremes

Model Uncertainty

Imprecise Data

Expert Opinion

Bayesian Statistics

Random Field Modeling

Time-Dependent Reliability

Stochastic Optimization

Decision Making

Design of Experiments

Certification by Analysis

Verification and Validation

**S**outhwest Research Institute® (SwRI®) staff members develop and apply state-of-the-art probabilistic analysis tools to address challenging technology questions. These tools have been used successfully in complex, large-scale engineering applications for a wide variety of commercial and government clients. Many of these tools are implemented in our reliability and integrity software codes, such as the NESSUS software.

The SwRI staff has extensive experience and expertise with developing accurate and efficient probabilistic analysis techniques for predicting reliability in high-consequence engineering applications. When sufficient data are available, sophisticated and highly accurate statistical models of the inputs are developed and incorporated in the probabilistic analysis. In other cases where only sparse data are available, the staff has developed a novel method to incorporate expert opinion into the probabilistic analysis without introducing biases in the representation of the data using standard probabilistic models.

**Capabilities**

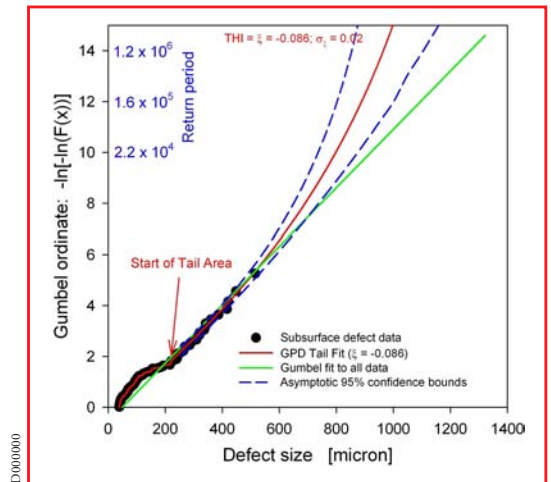
- Statistical quantification of uncertainty
- Estimation of extreme events
- Time-series analysis
- Random field modeling
- Integration of expert opinion into probabilistic analysis
- Optimal decision making with incomplete information

**Experience and Applications**

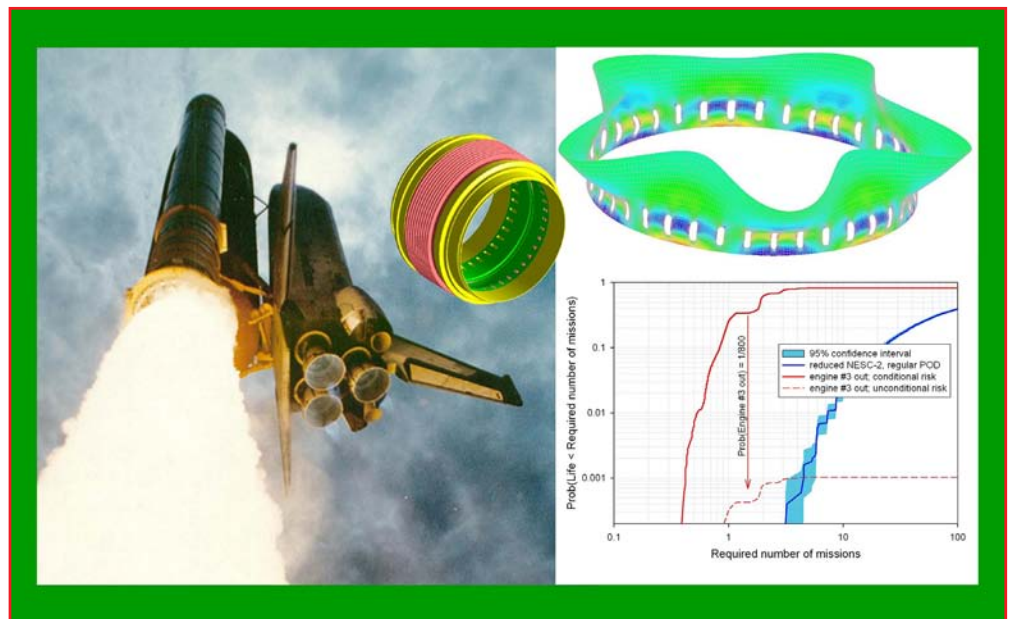
- Development and implementation of new probabilistic algorithms
- Simulation of complex systems
- Tailored probabilistic solutions
- Application in a wide range of sectors (government, automotive, aerospace, others)

**Analysis Tools**

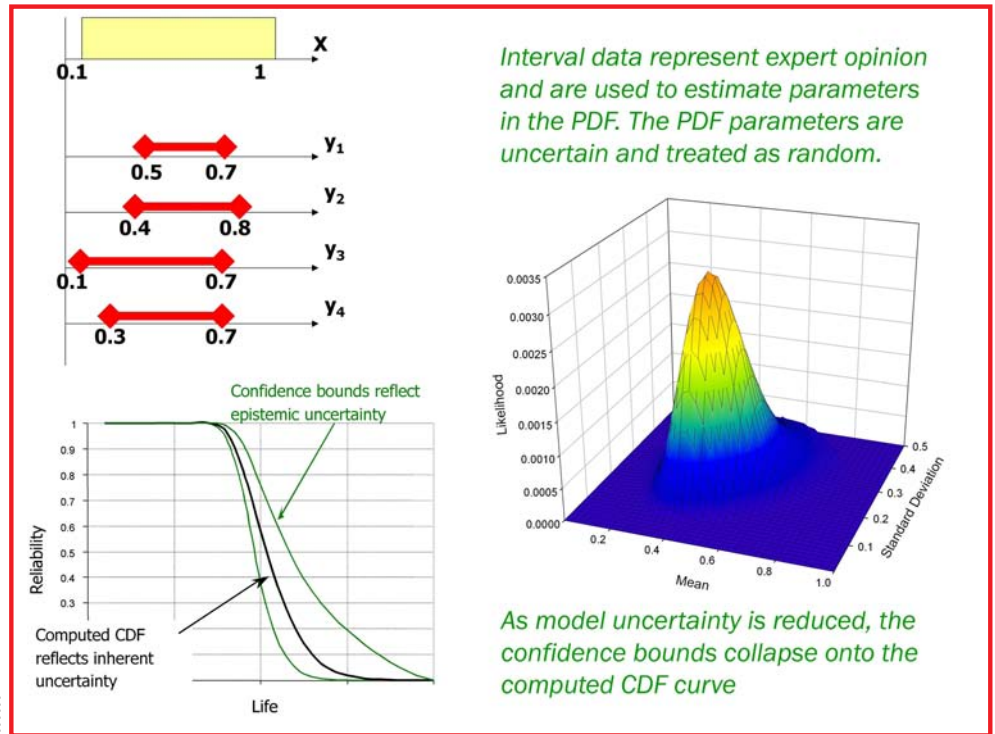
- NESSUS software development
- Integration of existing deterministic software in probabilistic tools
- Development of customized routines and tools (FORTRAN, Matlab, etc.)



*Extreme events and their confidence bounds can be estimated on the basis of limited data sets.*



*SwRI used statistical quantification of time series in a dynamic analysis to estimate the probability of fracture of mission-critical components.*



*Expert opinion introduces epistemic (or model) uncertainty. SwRI engineers have developed a probabilistic approach to incorporate expert opinion in a reliability assessment.*



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