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UNCERTAINTY TREATMENT: SANDIA'S PERSPECTIVE

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Sandia has acknowledged and advocated the importance of uncertainty treatment for several decades

Sandia has been involved in two large nuclear waste repository performance assessments. We are therefore **strongly supportive of any collaboration** in this field and will be happy to participate in such an effort

Currently, we would like to focus our effort in three areas

1. Presenting current conceptual and computational approach for uncertainty treatment

Promoting sampling-based methodology to incorporate **aleatory** and **epistemic** uncertainty into analyses for complex systems

Two special issues of RESS have been published to present such approach

- *WIPP: "The 1996 Performance Assessment for the Waste Isolation Pilot Plant"* ***Reliability Engineering and System Safety*** *Vol. 69, Numbers 1-3 (2000)*
- *YMP: "Performance Assessment for the proposed High-Level Radioactive Waste Repository at Yucca Mountain, Nevada "* ***RESS*** *Vol. 122 (2014)*

We would like to **share our expertise** via short courses, peer review publications and conference participation and presentations

We are also eager to **learn in return** from exchange and comments as well as comparison with approaches used by our counterparts in other countries

2. Promoting the use of UA and SA in complex systems analyses

We are strong advocates of promoting uncertainty analysis (UA) and sensitivity analysis (SA), not only within the radioactive waste management community, but **in any research and application field dealing with complex systems.** This promotion can be supported by the following three axes.

- **development of special issues** which has had greater impact than single articles in the past. RESS Editors in Chief have always been supportive of such initiatives
- **articles published in other fields** dealing with complex systems involving uncertainty (nuclear power plant, petroleum engineering…) are important to broaden the perspective.
- **train future generations** is crucial, especially considering that many university programs do not have a strong emphasis on uncertainty characterization and analysis in real world situations. Therefore, we fully support development and **teaching of courses at university levels, as well as giving short courses and workshops** (such as the SAMO summer school)

3. Sharing and testing new uncertainty and sensitivity techniques

As the interest in Uncertainty and Sensitivity analysis grows among the scientific community, more sophisticated and promising techniques will be developed

We are regularly working on developing, learning and testing new techniques and would like to continue efforts in that direction

Among the new techniques, we are particularly interested in the following:

Non-parametric regressions techniques using response surfaces and complete variance decomposition.

We would be interested in testing the methods presented by D. A. Becker at the 3rd US-German workshop on Salt such as the **change of variables**.

We thought also that some **technical exchanges** to exchange idea and **define benchmark testing** would be beneficial to all parties.

The Yucca Mountain Special issue in *Reliability Engineering and System Safety* (vol. 122 – 2014) could be a good starting point to set up benchmark

Description of several techniques to **handle both aleatory and epistemic** uncertainty in a computationally efficient way: each scenario (nominal, early failure, seismic, igneous) offered different perspective in treating aleatory uncertainty

Uncertainty and Sensitivity Analyses have been applied on an extensive set of data . Stepwise linear regression was not always successful in explaining the variance in the output of interest. Other regression techniques could be applied and their efficiency assessed.

SUMMARY OF SANDIA'S EXPERTISE AND INTEREST

- **High Level characterization of complex system:** Separation of aleatory and epistemic uncertainty.
- **Uncertainty characterization:** probabilistic approach, evidence theory (Dempster-Shafer), …
  - **Distribution construction:** construction via expert elicitation, frequentist approach, Bayesian updating
- **Sampling techniques:** Simple Random Sampling, Latin Hypercube Sampling, Importance Sampling, Reliability Methods (DAKOTA package)
- **Uncertainty Analysis:** estimate of output uncertainty and characterization via statistics over time or at selected time-step/condition.
- **Sensitivity analysis:** correlation and regression (parametric and nonparametric) techniques at selected time-steps or over time

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