SAND2015-2290D

The 2014 Sandia V&V Challenge Workshop

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What is V&V?

Part of the engineering process

Systems engineering

Verification & Validation

Modeling
Experiments

Collection of methods, disciplines, concepts

SQE decision theory expert judgment
statistics PCMM confidence
uncertainty quantification
probability PIRT credibility
metrics risk sensitivity analysis
extrapolation calibration uncertainty

V&V is a key piece of decision support!

The Current State of V&V

- V&V/UQ methods are developed and maturing
- The concepts & principles are known i.e. Validati hierarchy, PIRT, PCMM, SQE
- Community is growing – ASME , AIAA, USACM, FAA, FDA, SEMS…
- Need to connect methods to decisions
- **We lack vexperience assessing and communicating credibility**

The 3rd V&V Workshop – May 2014

- **Goals: Highlight V&V issues that impact Sandia**
  - Demonstrate state of the art V&V and UQ methods
  - Engage and lead the community – partner with ASME
- Challenge problem released to V&V community
- Participants presented at the 2014 ASME V&V Symposium
- Seven responses – diversity of methods, approaches, results
- **Significant differences in predicted probability of failure**

The Current State of V&V

- Increased awareness of gap between V&V methods and decisions
- **Diversity of methods and predictions illustrates difficulty of V&V**
  - Are there lessons for how Sandia should use V&V results?
- **Role of V&V in the decision process needs to be explored**
  - Challenge problems can help, more project experience needed
- Community, notably ASME, has recognized value and opportunity
  - Additional challenge problems are underway or in preparation
- Solutions and discussion papers to be published in the ASME Journal of Verification, Validation, and Uncertainty Quantification

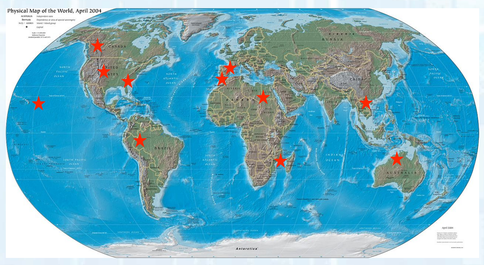
Good decisions require credible evidence (i.e. predictions or data). This requires V&V.

A Case Study in V&V and Decision Support:

The Story of the Mystery Liquid Company

Back story

Storage tanks are used to store Mystery Liquid under pressure



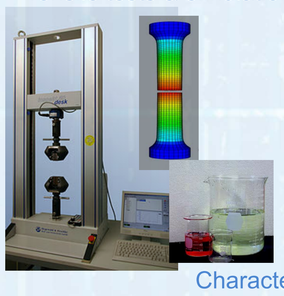
During standard safety testing, **one tank's** measurements has exceeded a safety specification

How should the company respond?

- Are the tanks at risk of failure?
- Must they be replaced?

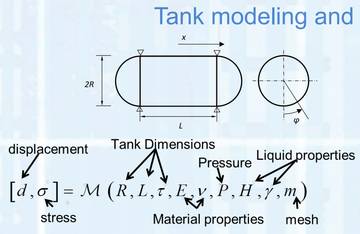
Experimental and modeling efforts are begun at material and full tank levels

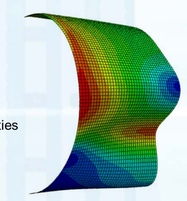
Tensile tests & simulations



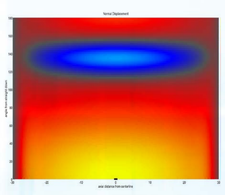
Characterize Mystery Liquid

Tank modeling and simulation





Quarter view



Side view

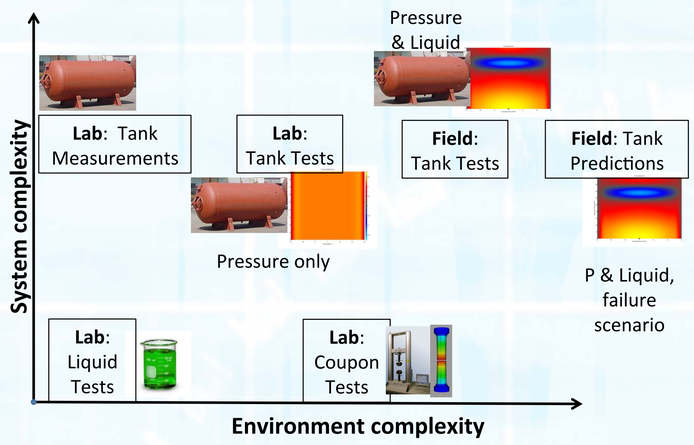
Data, models, code, and problem statement provided (open source)

Participants should:

1) Develop a strategy to use experimental data and models
2) Predict failure probability at max load and account for uncertainty
3) Assess the credibility of the prediction

Is the prediction credible?

The hierarchy is a way to visualize the available information



The true challenge:
How will the evidence from experiments and simulations be integrated and used to support the final decision?

Which methods should be applied? How do the methods support the claim that the prediction is credible? What other tools/ concepts are required?

Probability of failure predictions varied by orders of magnitude.
Participants split between: replace/ don't replace/ no decision.

PREDICTIVE ENGINEERING SCIENCE PANEL

U.S. DEPARTMENT OF ENERGY
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