SAND 2013-3550C

Proposal for FY14 V&V Challenge Workshop

ASME V&V 20 Committee Meeting

30 April, 2013

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Motivation

- V&V field is still developing
- Examples:
  - PSAAP schools just beginning to use V&V
  - 2012 ASME V&V Symposium abstracts
- Goals for a Challenge Workshop
  - Pose a problem that stresses V&V approaches/ strategy, instead of methods
- Vision – series of workshops
  - Alternating topics: Verification, Validation, UQ

  → **Increase awareness, interest, and innovation**

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Current Trend – Challenge Problems

- Challenge problems are in fashion
  - SNL V&V Workshop (2006), UQ workshop (2002)
  - SNL Fracture Challenge (2012)
  - USACM UQ Benchmark (2013)
  - NASA Langley UQ Challenge (2014)
  - X-prize Foundation (1995~)

- UQ field often focuses on comparing methods
- V&V should focus on assumptions, choices, impact
  - "Real world" concerns

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ASME and V&V 20 Committee

- Sandia is developing a challenge problem for V&V
  - Summer 2013 – Present draft problem at conferences
  - Fall 2013 – Finalize problem, formally announce workshop
  - Summer 2014 – Hold workshop (ASME V&V Symposium)

- **Looking for help**:
  - Feedback on the problem
  - Promoting awareness of the workshop
  - Hosting
  - Incentives to participate (publications?)

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Problem Requirements Defined

- Relevant – Multiple levels → V&V hierarchy
- V&V/UQ features – require calibration, solution verification, validation, aggregation
- Pose an 'end-to-end' problem
  - Data and models → prediction, uncertainty, credibility → model informed decision
- "Realistic", intuitive, and interesting story
  - No physics expertise required
- Physics based models
  - Computationally affordable, easy to distribute, unclassified, unlimited release

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Progress Report – Problem Development

- The Challenge Problem story

  A performance problem is found

  → Experimental Investigation & CompSim analysis

  → Decision

- CompSim predictions based on a series of models
  - Parametric, numerical, model form uncertainties
  - Uncertainty from extrapolation from validation domain
- Add data → Calibration and Validation
- Requires ***aggregation of uncertainty***

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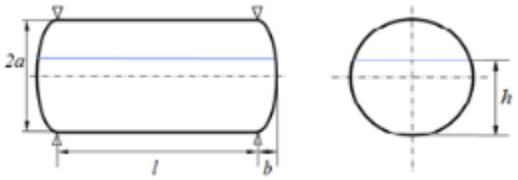
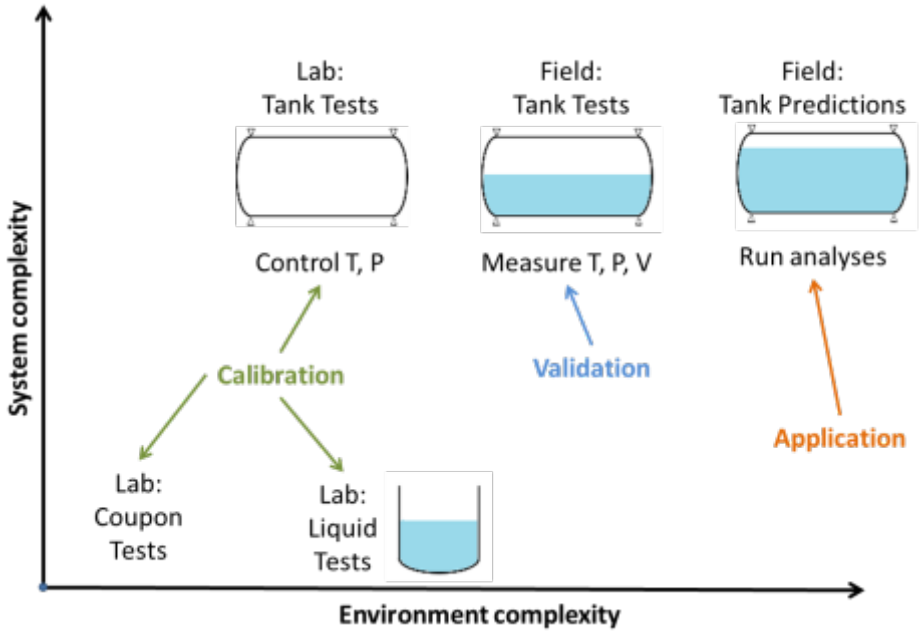
The Problem

- Liquid storage tank – fails from tensile overload
- Based on test data and models determine the probability of failure
- **Decide whether to retire all tanks**
- "Physics Level"
  - →Calibrate liquid property
  - →Calibrate failure threshold
  - →Calibrate material model
- "System Level"
  - – Validate @ Mild conditions
  - – Predict @ Extreme conditions





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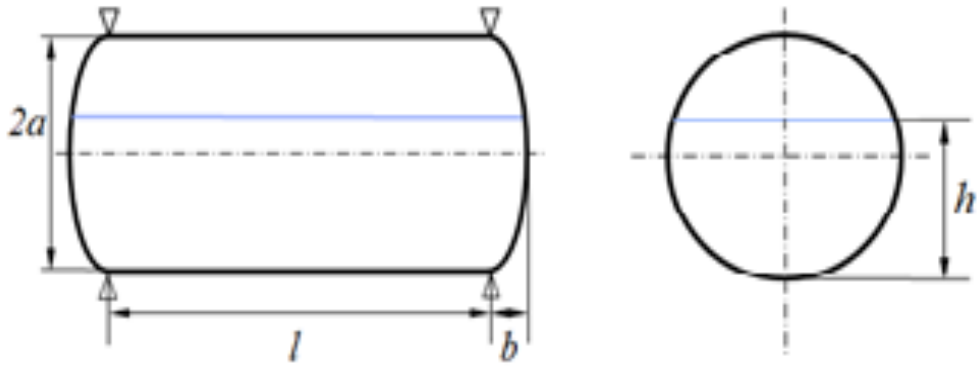
Main System Model

- Runs quickly – series solution
  - Not limited by methods
- Non-ideal convergence behavior
  - Interesting **solution verification** problem
- Many parameters, nonlinear responses
  - Non-trivial **UQ** problem
- Modeling limitations
  - Calibration of parameters w/ known **model form error**
- Physically intuitive
  - Pressurized vessel
  - Liquid load

  → Displacement & stress



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V&V problem

- Multiple “levels” of complexity
- Physics level
  - Temperature dependent liquid properties
  - Multiple models → **Model form uncertainty**
  - Measurement limitations, Variation in materials
    - **Epistemic, parametric uncertainty**
    - **Aleatoric, parametric uncertainty**
- System level (Full tank)
  - Combine all sources of uncertainty → **Aggregation**
  - Extrapolation out of calibration & validation domains
    - Is the model still valid? Still useful?
    - **“Rollup”**

Remaining Work - Problem Development

- Code verification, testing of models
- Generate data
- **Finalize Scope – feedback requested**
  - Problem could become unreasonably large
- Significant “problem preparation” and review
  - Ensure that the problem will allow for many approaches
  - Pose difficult analysis choices, force participants to consider aggregation of uncertainty
- Package the problem for distribution

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Remaining Work - Organiziation

- Promote at two conferences this summer
- **Identify potential participants**
  - Target industry and academia
- Work with V&V Symposium organizers
  - **Hosting**
  - Funding
  - **Publication**

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Goal of this workshop

- Pose a problem with many concepts
- Give participants choices
  - Analyze some vs. all of the pieces
  - How to model uncertainty
  - How to combine uncertainty
  - Make a final decision, informed by model predictions
- What is the impact of UQ/V&V choices?
- Provide a different perspective from UQ community
- **Increase awareness, interest, innovation in V&V**

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