

Panel discussion: validation data management

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ANS NUCLEAR GRAND CHALLENGES

- Challenge: accelerate utilization of simulation and experimentation

How: “Integrate experimentation and simulation to enable the development of first principles predictive simulation capabilities that are necessary to transition nuclear energy system design and licensing from reliance on experiments to reliance on modeling and simulation.”

Introduction

- Advanced modeling and simulation (AMS) of reactor systems follows multi-scale, multi-physics approach.
- Increasing stringent requirements are being applied to solution and code verification and validation (V&V), as well as uncertainty quantification (UQ).

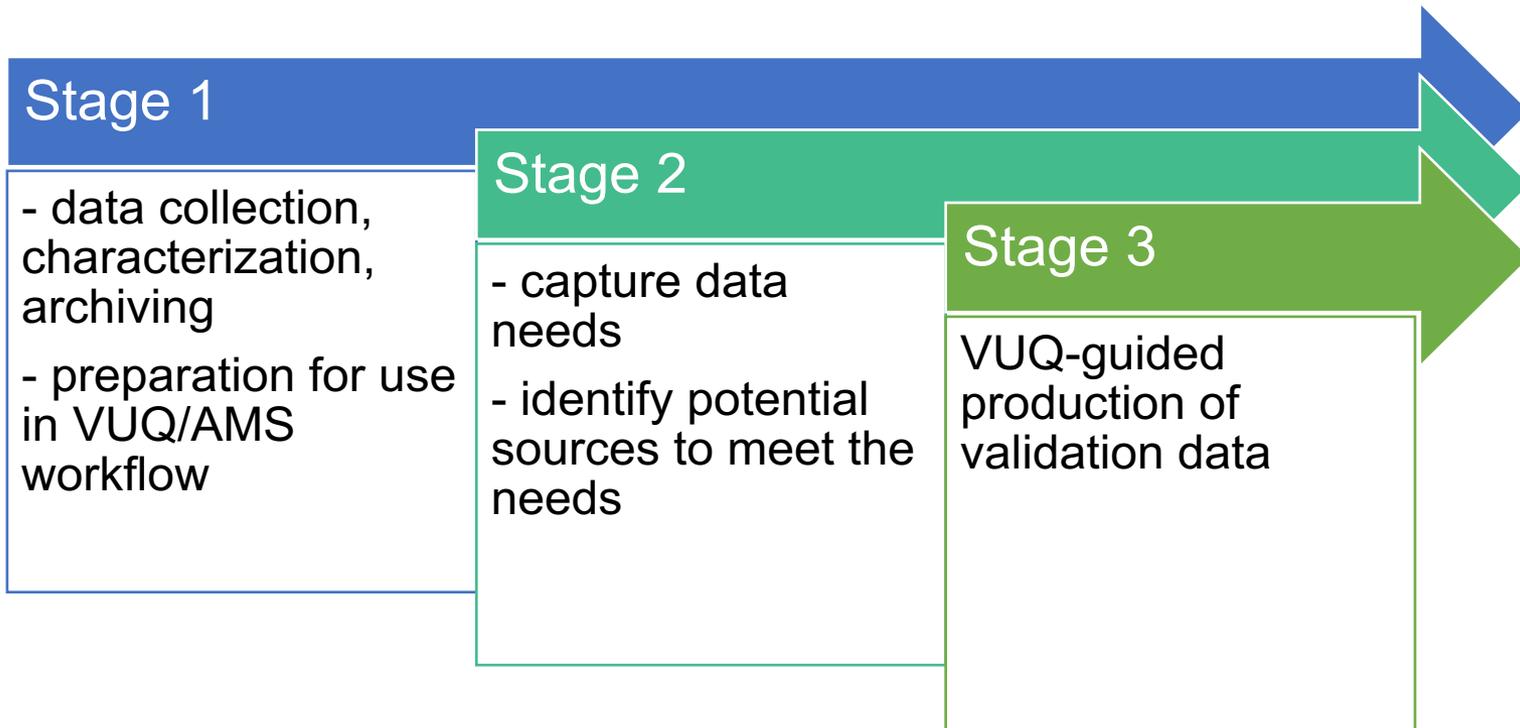
Over past years, significant effort has been made to bring V&V-UQ (VUQ):

- Framework – e.g., Predictive Capability Maturity Model;
- Methods – e.g., sensitivity analysis, hi2lo approach, Bayesian data assimilation; and
- Tool – e.g., DAKOTA, RAVEN

to nuclear energy applications.

- It also substantiated a challenge that any further progress would largely be inhibited by an apparent deficit of experimental / high-fidelity simulation data in both quantity and quality.

Validation data and data management



Validation data management



Data management: how does it fit in our respective researches?

Applications

- Benchmarking
- data quality assessment
- V&V
- UQ
- knowledge accumulation
- information retrieval

Technical areas

- Thermal-hydraulics
- Reactor physics
- Structural mechanics
- Nuclear system chemistry and physical-chemistry
- Fuel performance
- ...

What are the features and functionalities desired for validation data management system?

Data and information management system

- Data file warehouse and semantic storage systems
- Relational digital databases
- Interface and utilities

V&V and UQ methods integration

- V&V and UQ standards, requirements and best practices
- Capture of V&V and UQ methods, processes and workflows
- Web-accessible tools for V&V and UQ activities

M&S integration

- Mapping of M&S data requirements to V&V and UQ processes
- Simulation results processing and linking to data / knowledge bases
- Use of simulation / knowledge / data in the knowledge base: data-driven simulations and other hybrid methods

M&S workflow

- Map every step of M&S workflow to those in V&V workflow
- Help to align V&V activities with M&S tasks

Digitized data storage

- Datasets uploaded into data file warehouse for preservation of their completeness
- Data analyzed and broken down into their lowest meaningful information element levels
- Why is the old fashion data management NOT helpful?

Interfaces

- User interface: simple and easy to use; intelligent search; advanced analytics
- Automated data exchange with modeling and simulation codes
- API to support software-based automated VUQ workflow (DAKOTA, RAVEN, etc.)

What would be our strategy to get infrastructure / capability needed?

- Modular, scalable, improvable
 - Each step of development can meet requirement of a given R&D area (CFD, computational solid mechanics (CSM), nuclear fuel systems, etc.
 - One database component is built a time
 - Better aligned with program funding
- Well defined data structure and database scheme for each R&D domain
 - Collection of electronic documents
 - Maintain interrelationships between data points, documents, and records
 - Collaborations with technical area experts
- Flexible access control and data custodianship
 - Proprietary or sensitive information
- Pilot project

How to engage researchers in building data / knowledge base?

Existing data

- Encourage senior professors / researchers to share data with proper recognition

New data

- For PIs: raw data collection is required as an integral part of deliverables for sponsored projects
- For students: uploading data as a prerequisite for graduation

Rewarding mechanism

- Citation of work
- Supporting repository for journal articles

How to ensure continued and sustained development of such infrastructure?

Interruptions may cause considerable data loss and waste of effort