

Perspective Change: A (hopefully) clearer understanding of Verification, Validation, and Uncertainty Quantification (VVUQ)

Joshua Kaizer, PhD Nuclear Methods and Fuels Analysis Nuclear Regulatory Commission

October 3, 2024

Disclaimer

While I'm appearing on behalf of the U.S. Nuclear Regulatory Commission, some of my comments may reflect my own views, and not necessarily those of the U.S. NRC.



Main Goal

To be able to say that I gave a seminar, and all the students agreed it was not the worst seminar they saw during their time at Penn State.



Who Am I?

Background

- Penn State ME/NucE BS
- Penn State NucE MS
- Univ of M PhD ME

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- 18 years reviewing modeling and simulation for nuclear power plant safety
- Active Uncert
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What am I currently working on?

• Is the computational model credible?

• Data driven (ML) model to predict a specific phenomenon

• Is the UQ method credible?

- Data Validation and Reconciliation
- Statistical methods

• Requirements for CFD?

• Developing CFD "minimum requirements"





History of Computer Simulation



Protecting People and the Environment

Why AI is such a big deal...





What is VVUQ?

The collection of activities we perform to determine if we can trust the model and/or simulation.

What is credibility?

Binary determination – do you trust the results of the model / simulation for its intended use or not?



One way to think of Modeling & Simulation...





Content on a Slide Then, it won't matter how bad your slide is!

- Some people don't want to put too much content on a slide.
- They think that your audience can get lost in it all.
- However, I don't think its the amount of content that is the problem.
- But the fact that most people put the content up all at once and the slide gets...





United States Nuclear Regulatory Commission Protecting People and the Environment

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U.S.NRC United States Nuclear Regulatory Commission Protecting People and the Environment





What about Uncertainty Quantification?

uncertainty

stuff you do not know

quantification

stuff you know so well you can assign a number to it

uncertainty quantification

stuff you do not know, but that you know so well you can assign a number to it



What are all the uncertainties in Modeling and Simulation?



Uncertainties

- 1. Model Qualification
- 2. Verification
- 3. Validation
- 4. Scaling
- 5. Simulation of the Real-World



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VERIFICATION, VALIDATION, AND UNCERTAINTY QUANTIFICATION

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Post





The rebranding of linear algebra as "artificial intelligence" may be the most successful marketing campaign of all time.



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I can mathematically guarantee this by just giving 2 seminars...





The best lecture I had in 11 years of college.

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"Life in Industry"

L.E. Hochreiter

Professor of Nuclear and Mechanical Engineering

Worked at Westinghouse Electric Corporation for nearly 26 years in the Nuclear Energy Systems Division.

- Thermal-Hydrauliuc, Reactor Safety area
- Performed model/code development
- Designed safety related and other experiments, reduced and analyzed data, developed models

for safety codes.

- Represented Westinghouse designs/codes/models to Nuclear Regulatory Commission (NRC), Advisory Committee on Reactor Safeguards (ACRS), DOE, and customers.
- Had technical lead on several projects
- Was encouraged to publish papers, attend meetings, participate in national societies (ASME, ANS Fellow)
- When I left, Westinghouse had changed

- Study the more senior people and decide what your career path should be and how much effort you want to put into your job.
- You can NOT work only 40 hrs/week and expect to be highly successful.
 - See if there is a Technical promotion path, and what the requirements are,
 - You should decide if you want to go into management.



- Or, you should decide if you will be satisfied being a competent engineer within the organization. If so you need to realize.
- Salaries plateau in industry, raises are usually by merit only.
- There are limits on how much "Engineers" get paid in a company.

- You need to be VERY pro-active in your career development, no one will do it for you.
- Once you decide on the path, you can enlist the help of your local manager.
- He/She can help you get assignments that are career building.

- Once given, you must succeed or both you and your manager will look bad.
- When an assignment is given, it is your responsibility, and yours alone, to get it done, regardless of circumstances.
- Cost and Schedule are the key drivers in industry.

- Technology, while necessary, is not viewed as important as meeting cost/schedule deadlines.
- If you see that you may not meet either cost or schedule, you MUST tell your management immediately, don't wait and hope for the best. Anticipate problems.

- If told early, they can help provide additional resources or at least they will notify their management.
- You must have a VERY GOOD reason for missing a date or higher cost (Act of God).
- Missing schedules and incurring higher cost will NEGATIVLEY impact your career and future with a company.

- Companies look at the present, not the past and not necessarily the future.
- Your performance is mostly based on "what you did for me lately", not last year or next year.
- In well run companies, you will meet with your manager and set goals, objectives, milestones, etc for the next year.

- You will usually have input into the schedules, milestones, work load etc.
- If you see problems you MUST identify them up front so your management is not surprised.
- When given an assignment, "grind it to dust" and do absolutely the best job possible.

- This will usually require more than 40 hrs/week, or 8 hours/day it is YOUR responsibility to get the job done, period.
- Management DOES remember who did the best job as well as who didn't.
 - -Management must have confidence in your ability to complete good technical work within cost and schedule.

- Good, hard working people get promoted and rewarded.
- If you find they don't, move on to a different company.
- When I started at Westinghouse, a first-level group usually had 10 Engineers, 5 Technicians, and a secretary.

- The Engineer would do the calculations or analysis, the technical would plot up the results and the secretary would type the memo, letter, or report. There was ample support personal like technical editors, draftsman, computer support etc.
- When I left, there were typically 20 to 30 engineers,
 2 or 3 technicians, and one secretary and not support functions.

- The engineer had to perform the calculations, prepare the plots, write the letter and reports, write the calculation note and submit the final reports, calculations, and associated design documentation.
- Today, the Engineer must be "vertically" orientated and be multi-task oriented to fulfill his and other functions that were normally performed by others.
- This is expected.

- In my area, I found that technology was primarily developed by industry, not national laboratories, universities, or other government institutions.
- I found that I had great pride in the products (Nuclear Power Plants) that Westinghouse produced, these were real!

- I also had great pride in being a technical spokesman for a Fortune 500 Company, and the leader in my field.
- For the most part, I felt that I had a very good position at Westinghouse.
- I also believe that working in the industry better prepares one for the University, particularly for engineering.