

A (not necessarily) New Look at V&V Planning

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The Theme



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There is a Dichotomy in Understanding of Verification and Validation Planning:

- *As a formal record of intent.*
- *As a venue for negotiation.*



As a Record of Intent



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V&V plans are often assembled by an individual or small team at the beginning of a design->certification effort

- *Consists of Analyst's assessment of:*
 - *What analyses will be necessary.*
 - *The analysis tools available.*
 - *The fidelity of those tools.*
 - *Input data that is available and that which must be collected.*
 - *How the simulation results will be interpreted – features of interest.*
 - *How uncertainty quantification will be approached.*



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 - *How uncertainty quantification will be approached.*
- *Often constructed as modification of previous V&V plans.*
- *Meeting an institutional requirement.*



How it Works

**How long will it take
you to prepare a
V&V plan for the S5
analysis?**



How it Works

Let's see now: I'll read through the V&V plan for the S4, update the PCMM and PIRT tables, and convert the document from WordStart to MS Word.



How it Works

Give me three weeks.



As a Venue for Negotiation

Causing the right people to discuss
the right topics at the right time.



Decisions to be Aided by Simulation

Yes, we need help assessing whether the devices can stand the Shanghai to Tacoma Sequence (STS). This includes vibration, humidity, temperature, and ...



System Engineer



Analyst



Decisions to be Aided by Simulation



System Engineer



Analyst

We can do a time domain simulation for vibration and a heat transfer analysis for temperature. We shall have to determine if simulation can help with the humidity issue.



Decisions to be Aided by Simulation



System Engineer



Analyst

I should warn you, the vibration analysis can be expensive and a fine resolution might take a few months to set up.

How fine a resolution will you need to be helpful?

Decisions to be Aided by Simulation

The kind of analysis that the System Engineer would find helpful, when it must be available, how much it might cost are all topics of negotiation.



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Analyst

This negotiation is the first element of the V&V plan.



Assess Simulation Capabilities: Predictive Capability Maturity Model (PCMM)

Negotiations involving analysts, code sponsors, subject matter experts, and possibly more



PCMM Negotiations

What do you mean that the CRATER code cannot tell if the brick will penetrate the wing. It is a verified feature in the documentation.

Analyst



PCMM Negotiations

The CRATER code is designed to predict spalling due to small impacts. It cannot address puncture questions.



Code Sponsor

PCMM Negotiations

There is a commercial code, DANTRAN that might be used. It has been used successfully on some similar problems.

**Subject Matter
Expert (SME)**



PCMM Negotiations

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Subject Matter Expert (SME)



SME's should know the science and technology of the problem and that behind the analysis tools.



PCMM Negotiations

I have been able to get very similar results via a momentum balance and some values for fracture strength.

**Another
SME**



PCMM Negotiations

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**Another
SME**



SME's may know other ways to approach the problems.



PCMM Negotiations

We need to work up some affordable validation experiments. Let's invite Dan Gregory to our next meeting. He is a great experimentalist. We may also have to talk with the System Engineer about budget.



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Getting the Right People talking about the Right Problems at the Right Time.



Similarly with PIRT

Negotiation about capabilities specific to this project



V&V Planning is Done Throughout

We have made a few design changes and the transportation vehicle might be different. Can you handle that for me?



System Engineer



Analyst



V&V Planning is Done Throughout



System Engineer



Analyst

Yes, but we shall have to re-examine the appropriateness of our tools for the new problem and we shall have to collect and assess the new load and material data.

V&V Planning is Done Throughout



System Engineer



Analyst

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Uncertainty Quantification

OK, we have nominal stiffness and density for each material from the suppliers. What should we use for the standard deviations?

Analyst



Uncertainty Quantification

I suggest that we do at least 5 laboratory tests for each and then fit Gaussians.

Experimentalist



Uncertainty Quantification

There is really no
reason to expect a
Gaussian distribution
for these properties..

SME



Uncertainty Quantification

Give me a day to figure out what distributions might be justified by the physics.

SME



Uncertainty Quantification

When we have all that,
I'll try a LANL
technique to estimate
margins.

Statistician



Uncertainty Quantification

Let's remember that though the lab experiments did not invalidate our model form, the predictions were not really all that good. Does UQ really make sense here?



V&V Specialist

Uncertainty Quantification

**Maybe we shall have to
express our confidence in a
more qualitative manner.**



V&V Specialist

Uncertainty Quantification

Maybe we shall have to express our confidence in a more qualitative manner.

Every step of the Verification, Validation, and UQ process involves negotiation specific to the problem at hand.



V&V Specialist

The V&V Document



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- Record of the negotiations
 - Traceability – capturing reasoning
 - Map of strengths and weaknesses of analysis process



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- A living document, revised and extended as new issues need to be considered.
- Requires MUCH time and attention.
- Like Strategic Planning, The Journey is More Important than the Destination.





Thank You

