

A Methodology for Assessing and Prioritizing The Risks Associated with The Level of Verification, Validation and Accreditation Of Models And Simulations

Track 5: Virtual Testing / Modeling and Simulation in the Collaborative
Environment

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Motivation

- ***Modeling & Simulation (M&S) are integral to the Defense Acquisition process in the United States***
- ***For M&S to be useful tools in acquisition, they must be credible and suitable to the specific intended use(s) of interest***
- ***Verification, Validation and Accreditation (VV&A) helps to reduce risk associated with M&S use by establishing:***
 - Whether a particular M&S and its input data are credible and suitable for a particular task
 - Based on objective evidence
- ***DoD, Service and Operational Test Agency (OTA) policy require VV&A for M&S used to support acquisition***
 - DoDI 5000.61, SECNAVINST 5200.40, COTFI 5000.1A
- ***Resources are limited, so you need a logical way to guide your investment in model credibility and VV&A***
 - How much effort to expend establishing credibility and suitability of your M&S toolbox (supporting VV&A)
 - How best to invest resources to get the most return on investment and add the most value



M&S and Risk in Policy

- ***All VV&A implementing policies we're aware of indicate that the magnitude of the effort to support accreditation should be commensurate with risk***
 - DoDI 5000.61, SECNAVINST 5200.40 ...
- ***But --- little practical guidance is given in these high level policies on how to actually do this***
- ***This briefing describes a general approach developed by the Joint Accreditation Support Activity (JASA) to establishing a cost effective risk-based VV&A strategy for acquisition programs:***
 - Consistent with policy
 - Based on experience with successful M&S accreditation efforts
 - Consistent with the Defense Modeling and Simulation Office's VV&A Recommended Practices Guide (RPG)
 - Incorporating industry standards and best practice



Our Approach

- **Flexible and Proven Approach :**
 - **Is consistent with VV&A policy and the Defense Modeling and Simulation Office's VV&A Recommended Practices Guide (RPG)**
 - **Is based on experience with successful M&S accreditation efforts, supporting major acquisition programs (e.g. PMA-261 CH-53K, VH-71, & P-8A Multi-mission Aircraft program)**
 - **Reflects industry standards and best practice**
 - **Incorporates risk-based accreditation methodology developed by Joint Accreditation Support Activity (JASA) over more than a decade**
 - **Builds on structures and practices already in place in DoD acquisition program (program's existing risk management approach, working group/IPT structure, delegation agreements, etc.)**

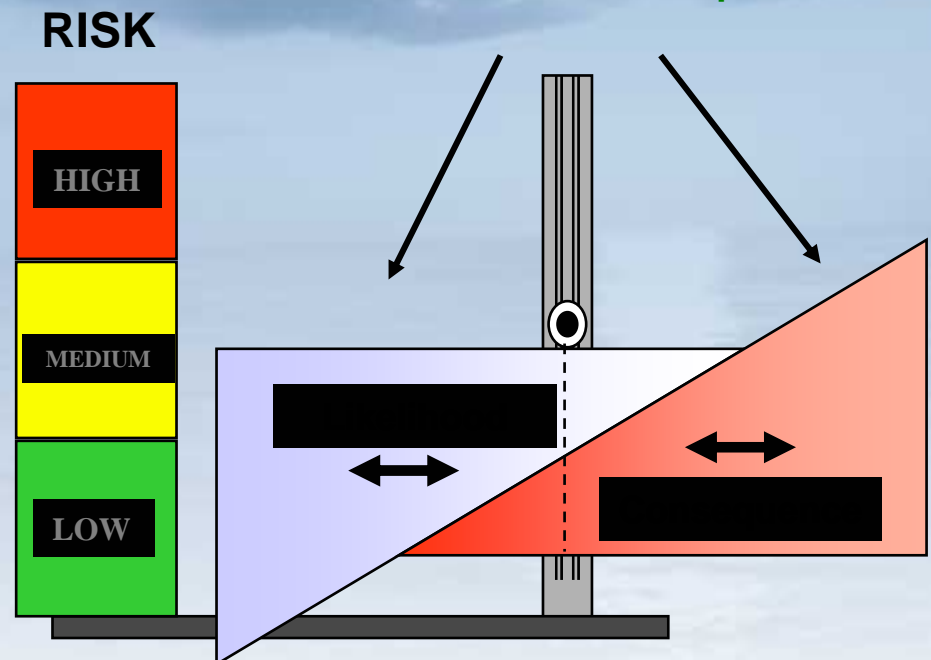


What is Risk?

- ***In the risk management community, risk is generally defined as the likelihood that something (usually bad) will happen times the consequences if it does***
 - Sometimes in casual speech people use the word “risk” to mean likelihood of occurrence
- ***To reduce risk, either reduce the likelihood that something will occur or reduce the severity of the consequence***
 - Risk literature also discusses the idea of exposure, which we’ll come back to shortly

$$\text{RISK} = \text{LIKELIHOOD} \times \text{CONSEQUENCE}$$

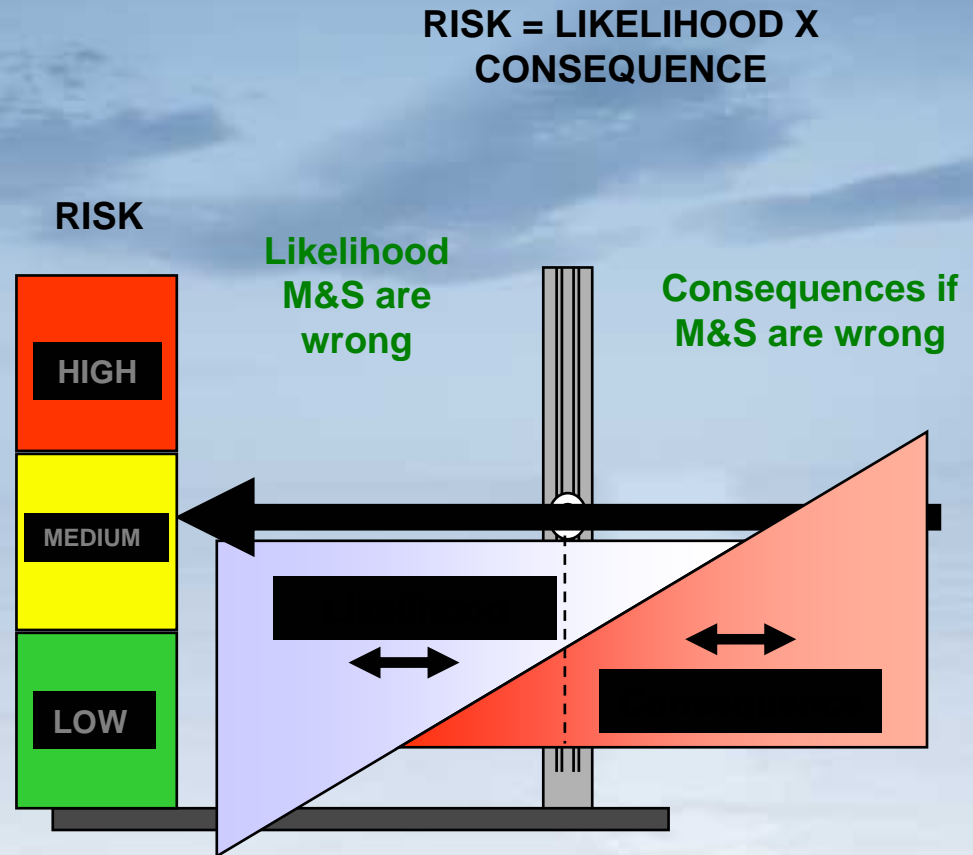
To reduce risk, reduce either likelihood or consequence



Risk Associated with M&S Use

- **Here, the risk of interest is the risk associated with using M&S**
 - M&S includes the models and simulations as well as the necessary input data
- **Likelihood is the odds that the M&S and/or their input data are incorrect or inappropriate to your intended use**
- **Consequence is the impact if the M&S output is wrong but you believe it and act on it**

Note: The risk associated with model development – will it be done on time and within budget—is an important but separate issue. Here we focus on operational risk.



Consequence of a Poor Decision vs. Consequence if Model is Wrong...

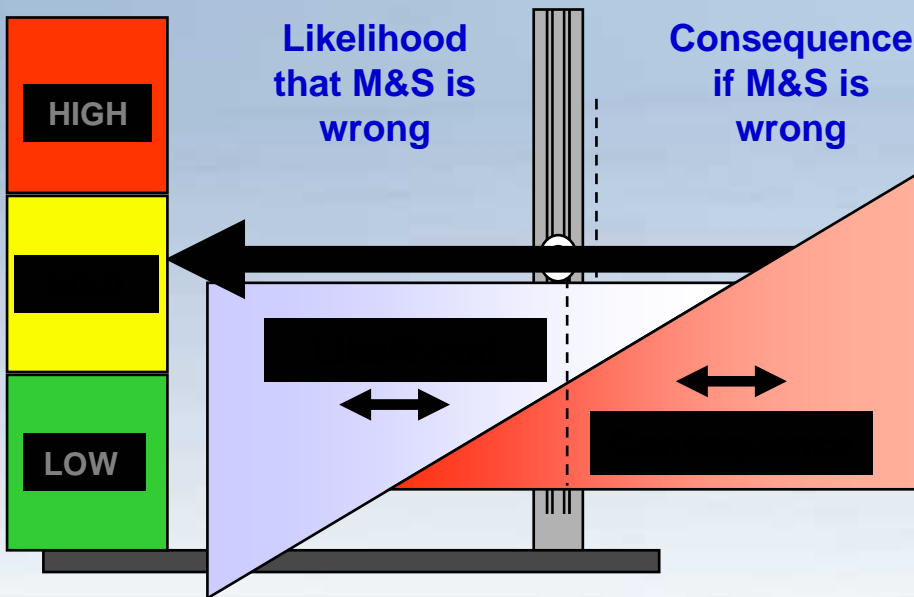
• **Consequence if model is wrong depends on:**

- Role M&S play in the decision-making process
- Consequence of a poor decision

• **Here, the role of M&S in decision making is similar to the concept of exposure in the risk literature**

- Reduce risk by limiting exposure
- One way to reduce the risk associated with M&S use is by limiting the role of M&S in the decision process

RISK



Consequence if model is wrong =
 f (role of M&S in decision
and
 consequence of poor decision)



So Here's the Point ...

- ***Risk associated with use of M&S is driven by likelihood M&S is wrong and consequence thereof***
- ***VV&A addresses likelihood of M&S error (and thus confidence in model results)***
 - Level of risk you can accept and consequences if model is wrong drive the amount of effort required to establish an acceptable level of confidence
 - Also, likelihood M&S is wrong and consequence if the model is wrong drive risk you accept if you use M&S
- ***If you had a practical method of apply these principles, you could determine how much effort to put into VV&A***
 - What kind and how much evidence is required to establish confidence and reach accreditation decision for particular uses
 - Extent of appropriate review process
 - Level of independence in V&V and review
 - Appropriate level of accreditation authority

} Drive Resources
- ***This briefing offers you one approach to consider and some implementation suggestions***



Considerations/Practical Problems

- ***Problem: You can't always (or even often) come up with actual numbers for either consequence (cost, lives lost, etc.) or likelihood, so how can you multiply what you don't have?***
 - ***Solution:***
 - Usually resort to using estimates within defined bands or levels or bins: High, Medium, Low, etc.
 - Adopt a scheme for combining levels to arrive at a single value (combine likelihood value and consequence value to get risk value)
 - System Safety community has some practical ideas we'll show you
- ***Heads up:***
 - Current DoD and Navy VV&A policy discusses certain circumstances in which formal accreditation of M&S is required (DoD 5000.61, SECNAVINST 5200.40)
 - Updated Navy policy will require ALL M&S in use in the Navy as of the effective date of the instruction to be verified, validated and accredited (proposed SECNAVINST 5200.40A)
 - Your strategy needs to have provisions in case 5200.40A comes into effect during the life of your program



Tools of the Trade

- ***You'll need scales and rules***
 - **Scale and selection criteria for**
 - **Levels of risk associated with M&S use**
 - **Levels of likelihood of error (and an inverse scale for the level of confidence in M&S results)**
 - **Levels of consequence if model is wrong**
 - **Levels for role of M&S in decision making**
 - **Levels of consequence if decision is poor**
 - **Level combining rules**
 - **Combine (role of M&S in decision making) & (level of consequence of a poor decision) to get (Level of consequence if model is wrong)**
 - **Combine (likelihood of model error) & (level of consequence if model is wrong) to get (risk level)**



More Tools

- ***And you'll need Tables***
 - Nature and extent of information necessary to support accreditation as a function of acceptable likelihood of M&S error (or required level of confidence)
 - Method of developing accreditation recommendation given level of consequence of M&S error
 - Approval/signature authority given level of consequence of M&S error
- ***The next few slides give a quick trip through the method (scope VV&A effort) and (estimate risk given a decision to use a model as is) to give you a feel for how the tools are used***
- ***Then we'll look at notional samples of each tool***
- ***Then we'll discuss some examples of how these ideas have been used in successful accreditation efforts***



Goal #1: How much VV&A is necessary to support accreditation?

Key: If you know this, you can figure this out

- 1. Define **intended use** (decision supported by M&S)
- 2. Determine **role of M&S** in the decision process and pick appropriate value from role table
- 3. Assess consequence if the decision is poor and pick the appropriate value from decision consequence table (**Consequence of decision**)
- 4. Determine what level of risk the decision maker is willing to assume for this particular use of M&S (**Acceptable Risk**)
- 5. Use role/decision consequence table to determine a value for consequence if the model is incorrect (Consequence if M&S wrong)
- 6. Use Likelihood of error/decision consequence table to determine the highest likelihood of error value that will result in the acceptable level of risk given the consequence/M&S wrong
- 7. Look at the VV&A evidence table to determine what kind and how much information is necessary to support an accreditation assessment, given the likelihood of error value from step 6.



Goal #1 (continued)

- **8. Look at the Accreditation Recommendation table to determine what approach will be taken to generate an accreditation recommendation, given the consequence-M&S wrong**
- **9. Look at the Decision Authority table to determine the signature authority for VV&A plans and reports as well as the accreditation decision authority.**
- **10. Use answers in 7, 8, and 9 to develop a workable plan to gather/generate required information package, generate an accreditation recommendation, and come to an accreditation decision**



Goal #2: How much risk is associated with M&S use, given the evidence available?

Key: If you know this, you can figure this out

Reality Bites: You have no choice of M&S and you have no time or resources for additional V&V. Here's how to get a handle on the risk associated with model use.

- You'll need to do some research first
- 1. Gather the VV&A related information that is available, look at the likelihood of model error table, and determine roughly which level the nature and amount of information you have equates to—this gives you the likelihood of error value
- Then you'll need to know some key characteristics about the situation under consideration
- 2. Define intended use (decision supported by M&S)
- 3. Determine role of M&S in the decision process and pick appropriate value from role table
- 4. Assess consequence if the decision is poor and pick the appropriate value from decision consequence table (consequence of poor decision)



Goal 2 (continued)

Then determine the level of consequence if the model is wrong

- 5. Use the role of M&S level from Step 3 and the consequence of poor decision level from Step 4 to determine the level of consequence if the M&S is wrong from the role/consequence of model error table.

Then you can back out level of assumed risk

- 6. Use likelihood of error/consequence of decision table to back out the level of risk

- Clearly not the ideal situation, but it happens quite frequently.
 - Even if you're stuck using the (less than ideal) tool you have, the boss needs to have a feel for how much confidence to place in the answers
 - Path 2 gives you a way to estimate risk



Scales, Rules and Tables

- Examples
- Some Tips and Advice



Levels of Risk

- Here's an example of a risk scale with three levels
 - Many programs use a three level high/medium/low risk scale
 - Very conducive to the use of stoplight charts



Give strong consideration to starting with the risk level structure already in use on your program and adapting it for use in your VV&A approach

Risk Level	Definition
High	Unacceptable. Major disruption likely. Different approach required. Priority management attention required
Moderate	Some disruption may occur. Different approach may be required. Additional management attention may be needed
Low	Minimum impact. Minimum oversight needed to ensure risk remains low.



Levels of Confidence / Likelihood of M&S Error

- Here's one suggestion based upon JASA's experience and guidelines in DMSO VV&A RPG



Include one level for either low or unknown level of confidence so that your approach has a minimal effort option to cover emergency or low consequence situations

Likelihood of Error	Confidence Level	Description
1	4	Very high confidence based upon extensive documented V&V relevant to intended use
2	3	High confidence based on face validation by SMEs
3	2	Moderate confidence based upon previous usage history
4 (High)	1	Low or unknown level of confidence. M&S appears to have the functionality required but credibility is unknown.



Levels of Consequence

- Here's an extremely simple example of consequence levels with four broadly defined levels



Whatever scheme you choose, you should make provisions to consider consequences of varying natures including cost, schedule, personnel safety, political, operational

- Also be sure you take into consideration all of the ways the model output could be wrong (e.g. M&S could erroneously over- or under-estimate performance of a military system, and the consequences might be different for each case)

Consequence Level	Definition
High	Major disruption to program. Different approach required. Priority management attention and resource allocation required immediately.
Moderately High	Significant disruption to program. Different approach required. Priority management attention required.
Moderate	Noticeable disruption. Different approach may be required. Additional management attention may be needed.
Low	Minimum impact. Minimum oversight needed to ensure risk remains low.



Levels of Consequences if Decision is Poor

Level	Technical Performance	Schedule	Cost
5	Severe degradation in technical performance; cannot meet KPP or key technical/supportability threshold; will jeopardize program success; no workarounds	Cannot meet key program milestones Slip > __ months	Exceed APBA threshold > (10% of budget)
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success; workarounds may not be available or may have negative consequences	Program critical path affected, all schedule float associated with key milestone exhausted Slip < __ months	Budget increase or unit production cost increases <(10% of budget)
3	Moderate reduction in technical performance or supportability with limited impact on program objectives; workarounds available	Minor schedule slip, no impact to key milestones Slip < month(s) of critical path Sub-system slip > __ months(s)	Budget increase or unit production cost increases < (5% of budget)
2	Minor reduction in technical performance or supportability, can be tolerated with little or no impact on program; same approach retained	Additional activities required, able to meet key dates Slip < __ months (s)	Budget increase or unit production costs increases <(1% of budget)
1	Minimal or no impact	Minimal or no impact	Minimal or no impact



Here's a Complicated Scheme for "Quantifying" Consequence (Impact) of Poor Decision

From MIL-STD 882C/D on System Safety

Impact Categories	Impact Level: Catastrophic	Impact Level: Critical	Impact Level: Marginal	Impact Level: Negligible
Personnel Safety	Death	Severe Injury	Minor Injury	< Minor Injury
Equipment Safety	Major Equip Loss' Broad Scale Major Damage	Small Scale Major Damage	Broad Scale Minor Damage	Small Scale Minor Damage
Environmental Damage	Severe (Chernobyl)	Major (Love Canal)	Minor	Some Trivial
Occupational Illness	Severe & Broad	Severe or Broad	Minor and Small Scale	Minor or Small Scale
Cost	Loss or Program Funds; 100% Cost Growth	Funds Reduction; 50% to 100% Cost Growth	20% to 50% Cost Growth	<20% Cost Growth
Schedule	Slip Reduces DoD Capabilities	Slip Causes Cost Impact	Slip Causes Internal Turmoil	Republish Schedules
Political	Nat'l or Internat'l (Watergate)	Significant (Tailhook)	Embarrassment (\$200 Hammer)	Local
Operational	Widespread Add'l Combat Deaths	Limited Add'l Combat Deaths	Moderate Add'l Casualties	Minimal Add'l Casualties



Role of M&S in Decision Making

- Here's an example scheme

Role Level	Definition
4	M&S will be the <u>only method</u> employed to make a decision
3	M&S will be the <u>primary method</u> , employed with other non-M&S methods
2	M&S will be a <u>secondary method</u> , employed with other non-M&S methods, and will <u>provide significant data unavailable through other means</u>
1	M&S will be a <u>supplemental method</u> , employed with other non-M&S methods, and will <u>provide supplemental data already available through other means</u>



Combination Schemes



Risk Management Guide for DoD Acquisition

Fifth Edition V2.0 June 2003 Figure B-2

Level	What is the Likelihood the Risk Event will Happen?
E (High)	Near Certainty
D	Highly Likely
C	Likely
B	Unlikely
A	Remote

Likelihood	E	M	M	H	H	H
	D	L	M	M	H	H
	C	L	L	M	M	H
	B	L	L	L	M	M
	A	L	L	L	L	M
		A	B	C	D	E

Consequence

Assigned Risk Level	
R	High – Unacceptable. Major disruption likely. Different approach reqd. Priority mgmt attention reqd.
Y	Moderate – Some disruption. Different approach may be reqd. Addl mgmt attention may be needed
G	Low – Minimum impact. Minimum oversight needed to ensure risk remains low.

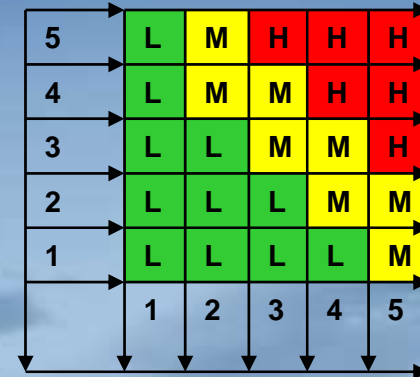
Level	Technical Performance	And/or	Schedule	And/or	Cost	And/or	Impact on Other Teams
A	Minimal or no impact		Minimal or no impact		Minimal or no impact		None
B	Acceptable, some reduction in margin		Additional resources reqd; able to meet need dates		<5%		Some impact
C	Acceptable; significant reduction in margin		Minor slip in key milestones; not able to meet need date		5 – 7%		Moderate impact
D	Acceptable; no remaining margin		Major slip in key milestones or critical path impacted		7-10%		Major impact
E (High)	Unacceptable		Can't achieve key team or major program milestones		>10%		Unacceptable



Program Risk Reporting

Likelihood

Level	Likelihood the Event Will Happen?	Probability of Occurrence
5 (High)	Near Certainty	~90%
4	Highly Likely	~70%
3	Likely	~50%
2	Low Likelihood	~30%
1	Not Likely	~10%



Level of Risk:
High, Med, or Low

Level	Technical Performance	Schedule	Cost
5 (High)	Severe degradation in technical performance; cannot meet KPP or key technical/supportability threshold; will jeopardize program success; no workarounds available	Cannot meet key program milestones Slip > __ months	Exceed APBA threshold > (10% of budget)
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success; workarounds may not be available or may have negative consequences	Program critical path affected, all schedule float associated with key milestone exhausted Slip < __ months	Budget increase or unit production cost increases < (10% of budget)
3	Moderate reduction in technical performance or supportability with limited impact on program objectives; workarounds available	Minor schedule slip, no impact to key milestones Slip < month(s) of critical path Sub-system slip > __ months(s)	Budget increase or unit production cost increases < (5% of budget)
2	Minor reduction in technical performance or supportability, can be tolerated with little or no impact on program; same approach retained	Additional activities required, able to meet key dates Slip < __ months (s)	Budget increase or unit production costs increases < (1% of budget)
1	Minimal or no consequence to technical performance	Minimal or no impact	Minimal or no impact



Sample Method of Generating
Consequence / Evidence
Required to Support Accreditation



Method of Generating Accreditation Recommendation/Consequence if M&S is Wrong

- This table identifies, for each level of consequence if the M&S is wrong, the method that will be used to come to an accreditation recommendation
- Generally, higher levels of consequence merit review and concurrence by major stakeholders (Program Office, DOT&E, OTA, contractor) with support from appropriate technical SMEs
 - The higher the consequence, generally the more appearance of some independent review becomes important
 - Give strong consideration for a level requiring only the judgment of a qualified analyst or engineer with minimal (but some) documentation requirements



Consequence Level	Method of Generating Accreditation Recommendation
4 (highest)	Formal Review of Accreditation Case by specially convened Accreditation Review Board resulting in recommendation documented in formal accreditation package
3	Review of accreditation case by M&S IPT resulting in recommendation documented in detailed briefing or report
2	Review of accreditation case by recognized SME resulting in recommendation documented in briefing or report format
1	Review of accreditation case by responsible engineer documented in Memo for the Record



Example Scheme for “Quantifying” Likelihood

An Example Scheme for “Quantifying” Likelihood

**The number of items should be specified

Likelihood Description	Likelihood of Occurrence over Lifetime of an Item	Likelihood of Occurrence Per Number of Items**
Frequent	Likely to Occur Frequently	Widely Experienced
Probable	Will Occur Several Times in Life of Item	Will Occur Frequently
Occasional	Likely to Occur Some Time in Life of Item	Will Occur Several Times
Remote	Unlikely but Possible to Occur in Life of Item	Unlikely but can Reasonably be Expected to Occur
Improbable	So Unlikely, it can be Assumed Occurrence May Not Be Experienced	Unlikely to Occur but Possible



Evidence Required to Support Accreditation/Likelihood of Error

- *For each level of likelihood of error and confidence level, the table summarizes the information necessary to support an accreditation assessment*
 - More rigorous verification, validation, configuration management, discipline in model development, and oversight and review are required to drive down likelihood of error
 - As likelihood of error goes down, confidence in model results goes up

Likelihood of Error	Confidence Level	Evidence Required to Support Accreditation Assessment
1	4	Level 3 + extensive body of documented verification and validation + evidence of disciplined M&S development including history of technical and managerial review over time
2	3	Level 2 + SME face validation relevant to current intended use + evidence of effective configuration management
3	2	Level 1 + usage history + known V&V history
4 (High)	1	Comparison of M&S requirement derived from intended use with capabilities and limitations of candidate simulation

This is based on JASA's rules of thumb adopted by the DMSO VV&A RPG. See "Role of Accreditation Agent in VV&A of Legacy Simulations" for more details. www.vva.dmsomil



Decision Authority/ Consequence if the Model is Wrong

- *This table identifies, for each consequence (M&S wrong) level, the signature authority for VV&A plans and reports as well as the accreditation decision authority*
- *Generally, delegating the signature and decision authority as low as seems reasonable is the most efficient use of resources*
 - DoD and Service policy give OTAs accreditation authority for use of M&S in OT&E; PM for SUT must submit accreditation package and make recommendation
 - Current practice is for PM to be AA for uses of M&S within the purview of the program office (e.g. DT&E including demonstration of spec compliance, LFT&E)



Consequence Level	Signature Authority VV&A Plans & Rpts	Decision Authority M&S Accreditation
4 (highest)	Acquisition Program Manager (For use of M&S in OT&E, PM is signature authority with OTA's concurrence)	Acquisition Program Manager (For use of M&S in OT&E, OTA is decision authority with recommendation from PM)
3	Chief Engineer	Chief Engineer
2	Chair, M&S IPT	Chair, M&S IPT
1	Responsible Engineer or Analyst	Responsible Engineer or Analyst



Criticality Analysis: Importance of Decisions

- *Descriptions of Level of Importance of Decision*

Level	Description
4	Intended use addresses <u>multiple areas</u> of significant program risk, key program reviews and test events, key system performance analysis, primary test objectives and test article design, system requirements definition, and/or high software criticality, used to make a technical or managerial decision
3	Intended use addresses an <u>area of significant program risk</u> ...
2	Intended use addresses <u>medium or low program risk</u> , other program reviews and test events, secondary test objectives and test article design, other system requirements and system performance analysis, and medium or low S/W criticality used to make technical or managerial decisions
1	1 = Intended use addresses <u>program objectives or analysis that is not a significant factor</u> in the technical or managerial decision making process



Criticality Analysis: Role of M&S

- *Here's an example scheme*

Role Level	Definition
4	M&S will be the <u>only method</u> employed to make a decision
3	M&S will be the <u>primary method</u> , employed with other non-M&S methods
2	M&S will be a <u>secondary method</u> , employed with other non-M&S methods, and will <u>provide significant data unavailable through other means</u>
1	M&S will be a <u>supplemental method</u> , employed with other non-M&S methods, and will <u>provide supplemental data already available through other means</u>

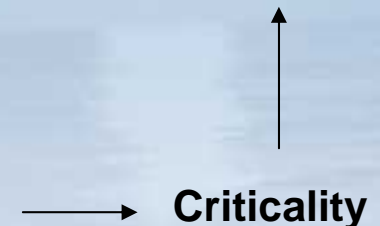


Criticality Measure

- **Criticality Measure is determined from level of reliance on M&S and importance of the decision**
- **Criticality Measure drives nature and amount of information and effort applied to VV&A of this model**

Importance of Decisions	Level of Reliance on M&S			
	4	3	2	1
4	4	4 or 3	3 or 2	2
3	3	3	2	2 or 1
2	2	2	2	1
1	1	1	1	1

Resources Applied to VV&A



Source: DD(X) Verification, Validation and Accreditation Overview by Charles Hays of Northrup Grumman Corporation. Presented at NMSO VV&A TWG, Salt Lake City UT on 16 Feb 2005



Benefit of the risk-based VV&A strategy

- ***Helps you develop a standard operating procedure for scoping and carrying out VV&A efforts on your program so that day to day implementation is consistent, effective, efficient, and straightforward***
 - Upper management can dictate deviations at their discretion so long as the deviations and the rationale are documented
 - Helps you devise a mechanism for elevating particular M&S uses to “command interest” status for funding and risk mitigation
- ***In the early stages of your program, our VV&A approach will help you scope and plan your VV&A strategy over the life of the program***
 - Get VV&A related activities in contracts, schedules, budgets, resource planning
- ***As the program progresses, an established strategy gives you a way to quickly scope the effort necessary to determine the credibility of M&S for unanticipated uses as the program evolves***

You can work out a thoughtful VV&A strategy early on, or duke it out on a case by case basis each time the issue of accreditation or credibility comes up.

Why not think hard early on in the program, and then get on with it?



Applying Resources Intelligently

- ***Other Acquisition programs have used the practical methods:***
 - To determine how much effort to put into VV&A and
 - To get the most return on their investment
- ***This method offers you an approach for figuring out:***
 - What kind and how much evidence is required to establish a particular level of confidence
 - What kind and how much evidence is required to reach accreditation decision for particular uses
 - The appropriate level of review to generate an accreditation recommendation
 - The appropriate level of independence in V&V and review
 - The appropriate level of signature authority for VV&A plans and reports
 - The appropriate level for accreditation authority

All of
these
factors
drive
resources



Some Practical Help with Risk Assessment

- ***System Safety community within DoD and foreign defense establishments have grappled with risk assessment***
 - Defining qualitative levels of impact in many areas (financial loss, political embarrassment, material loss, personnel loss, etc.)
 - Defining qualitative levels of risk given likelihood and consequence
 - See MIL STD 882D for examples
- ***JASA and many other groups have a strong interest in VV&A as risk reduction and have contributed to the literature***
 - JASA's Risk Assessment Example, based upon work we've done for a major acquisition program, is an extreme example, but may also give you some food for thought on doing risk assessment related to model use
 - See the DMSO VV&A RPG's core document "Accreditation Agent Role in VV&A of Legacy Models" for JASA's rules of thumb for what kind of and how much information is appropriate to support accreditation assessments given varying levels of acceptable risk
 - Download from DMSO's VV&A site: www.vva.dmsomil



Questions?



Backup Material



Another Twist

- ***What if the question is which tools to place emphasis on over the life of the program?***
- ***Criticality measure is one idea***
 - Takes into account role of M&S in making decisions and
 - Number and importance of decisions that M&S is expected to support over the life of the program
 - Focus your efforts on those M&S that will be used most often for the highest profile/highest consequence decisions



Criticality Analysis

- *An aid for tackling how to best allocate VV&A resources over the life of an acquisition program*
- *Offered by the Northrop Grumman team working with the DD(X) program: M&S criticality analysis*
 - **Criticality is a function of the dependence on M&S in making decisions over the life of the program, and the nature and importance of those decisions**
 - **The scales used by the NG team are shown on the next two slides**
- *The idea is that the criticality score for a particular model can help determine whether formal VV&A is required and how much effort will be put into supporting accreditation*
- *Interesting idea that is intuitively appealing*
- *One practical implementation issue is the fact that the role of M&S may differ in various phases of the program and in different decisions, so you might need a weighted average or something*



Implementation Suggestions

- ***Consider appointing someone to work out a straw man based upon the structure and processes in place in your program***
 - VV&A person working in conjunction with program person works well
- ***Present straw man to M&S WG for feedback – rework incorporating feedback then present to MSWG for concurrence***
- ***Once you have concurrence of MSWG, staff it up the chain for management approval***
- ***Get going with implementation once you've got a solid draft or you'll spend the entire program arguing about the nitnoids***



VV&A is Risk Reduction

Reduce Likelihood of Error \Rightarrow Reduce Risk

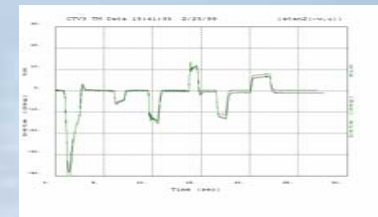
- **VERIFICATION**

- Reduces the likelihood that the software you build (or use) has undetected errors that are fatal to your intended use
- Reduces the likelihood that the data are inappropriate for the intended application or improperly prepared



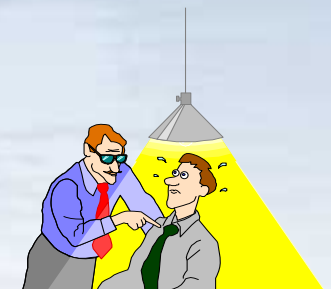
- **VALIDATION**

- Reduces the likelihood that simulation outputs won't match the "real world" well enough for you to use them credibly as part of the solution to your problem
- Reduces the likelihood that the data don't represent the real world with sufficient accuracy for the application



- **ACCREDITATION**

- Reduces the likelihood that an inappropriate or unsuitable simulation is selected for use in solving your problem



What's a JASA Accreditation Support Package (ASP)?

- ***A JASA ASP (as in A-S-P, not the name of the snake) is an organized way to document and relay the information about a model or simulation and its input data that is typically used to support an accreditation assessment***
 - Contents are based on the model-related information elements that DoD and Service level policies either require or recommend to support accreditation decisions and 13 years of experience doing accreditation support for DoD acquisition programs
- ***It has a single volume format organized around the three pillars of M&S credibility conceived by JASA and adopted by the Defense Modeling and Simulation Office (DMSO)***
 - **Capability:** Does the simulation do what you want it to?
 - **Accuracy:** How much confidence can be placed in the accuracy of model results?
 - **Usability:** Is there enough information/help available to enable proper, consistent use of the model and correct interpretation of results?



JASA Accreditation Support Package (ASP) Structure 2004 Specification

1.0 Introduction

Overview of Accreditation Process
Information Needed for Accreditation
 Capability
 Accuracy
 Usability

2.0 Capability

Model Description
Functional Capabilities
Development History
Summary of Assumptions and Limitations
Implications for Model Use

*See Accreditation Support Package (ASP)
Specification, Joint Accreditation Support Activity,
September 2004, Rev B May 2005, JASPO-03-M-002B*

3.0 Accuracy

Software Accuracy
 S/W Verification Results
 S/W Development and CM Environment
 S/W Quality Assessment
Data Accuracy
 Simulation Data including Pedigree
 Data Transformations
Output Accuracy
 Sensitivity Analysis
 Benchmarking
 Face Validation
 Results Validation
Implications for Model Use

4.0 Usability

Documentation
User Support
Usage History
Implications for Model Use



JASA's Evolution

- ***Predecessor was the OSD-sponsored Susceptibility Model Assessment and Range Test (SMART) Program***
 - Five years (FY92-96, OSD-funded, Tri-Service Steering Group)
 - Developed and documented cost effective VV&A process for survivability M&S including Accreditation Support Package (ASP) specification
 - Exercised process on 5 survivability models
 - Documented processes and lessons learned
- ***JASA was created in FY96 to provide M&S accreditation support services to the larger acquisition community***
 - Concepts and processes broadly applicable to M&S used in the larger acquisition community, not only for survivability
 - Initially under the auspices of the Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS), who provided some infrastructure funding from FY96-98 to assist in transition
 - FY99 to present almost entirely customer funded with some specific tasking for JTCG/AS (now JASPO)
 - 2006 JASA became part of the Battlespace Simulation & Test Dept (5.4) NAVAIR



Terminology: Industry Standards vs. M&S VV&A Policy

Question	SE/SysE/CMMI/ISO 9000 Terminology	M&S VV&A Terminology
Does the product <u>meet the requirements/specs</u> ?	Product Verification	M&S Verification and Validation <i>M&S Validation deals with <u>accuracy</u> requirements</i>
Is the <u>product fit for purpose in the customer's intended environment</u> ?	Product Validation	M&S Accreditation <i>Accreditation is a government decision</i>
What is the desired end state?	<ul style="list-style-type: none"> •Acceptance by customer and payment for services •Launch of quality product or service 	Use of M&S by decision maker with an acceptable level of risk

•Note: CMMI and ISO 9000 emphasize effective process rather than product, but use of terms is consistent with that of the Software Engineering (SE) and Systems Engineering (SysE) communities



MORE ADVANCED COMBINATION SCHEMES

- **Useful when Different Schemes Result In Different Risk Level Ratings**

METHODOLOGY: (see next 4 slides)

1. Use Chart #1 in the “Standard Risk Chart” to determine appropriate color: G1, Y1 or R1
 2. Use Chart #2 in the “Standard Risk Chart” to determine appropriate color: G2, Y2 or R2
 3. Use COMBINED RISK CHART to determine appropriate color: Green, Yellow or Red.
- **NOTE:** If you are a decision maker who is more interested in very low risk (i.e. a Risk Averse Decision-maker), use the **COMBINED RISK AVERSE CHART** instead of the **COMBINED RISK CHART**



SAMPLE IMPACT TABLE

IMPACT MATRIX

IMPACT	LEVEL OF RELIANCE		
	3 ←	2	1
CATASTROPHIC	5	4	3
CRITICAL	4	3	2
MARGINAL	3	2	1



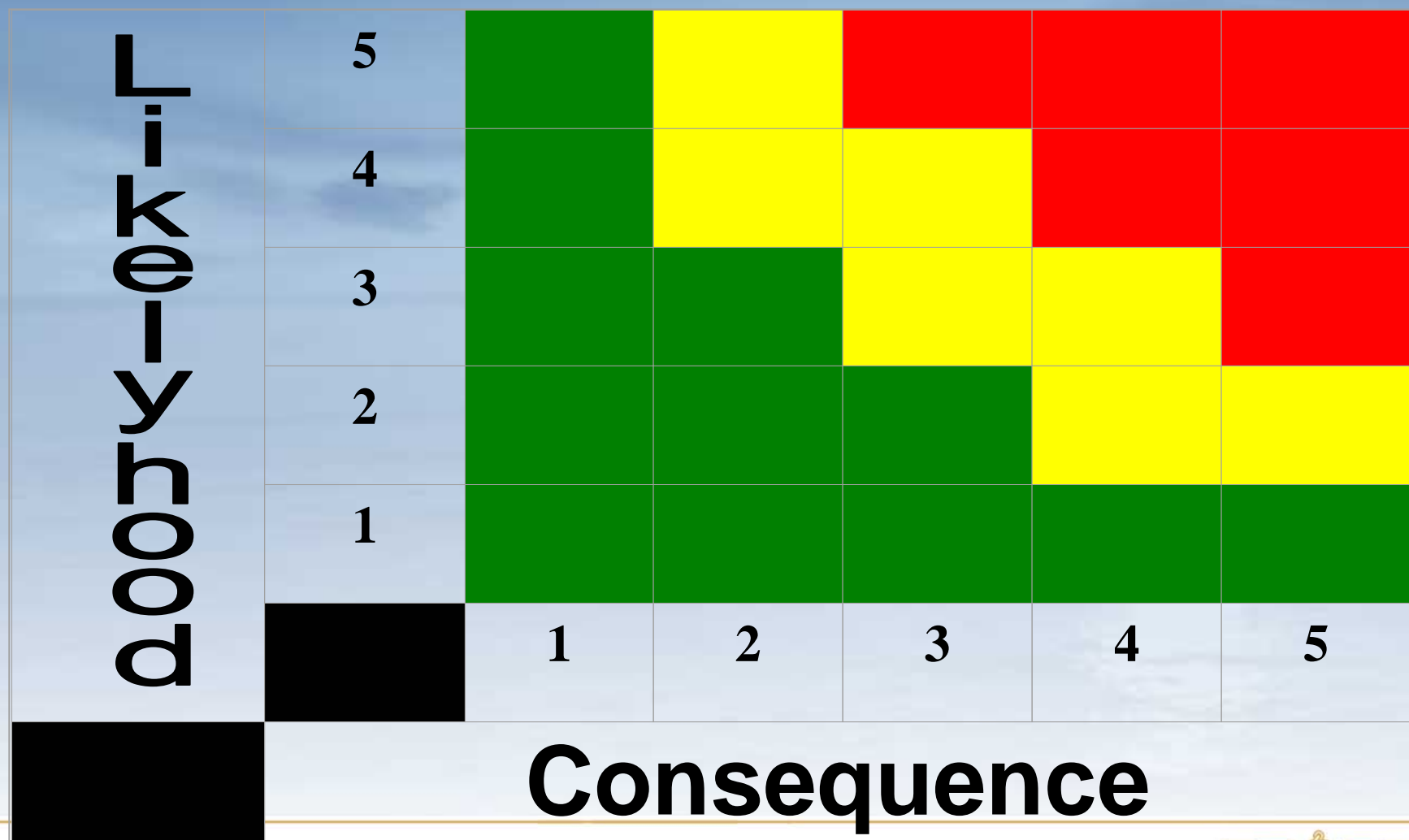
SAMPLE CONSEQUENCE TABLE

Consequence Matrix

Importance of Decision	Level of Reliance		
	3	2	1
3	5	4	3
2	4	3	2
1	3	2	1



STANDARD RISK CHART



COMBINED RISK CHARTS

RISK AVERSE MATRIX

I M P A C T	R2			
	Y2			
	G2			
		G1	Y1	R1
CONSEQUENCE				

NORMAL RISK MATRIX

I M P A C T	R 2			
	Y 2			
	G 2			
		G 1	Y 1	R 1
CONSEQUENCE				

