The User's Role in the VV&A of New Simulations

RPG Core Document

9/15/06[1]

Table of Contents

VV&A Responsibilities and Challenges 1
- How Does the User Impact VV&A? 1
- How Does VV&A Impact the User? 2
- What Are the User's Responsibilities in VV&A? 2
- What Challenges Does the User Face Relative to VV&A? 3

Role of the User in the Overall Problem Solving Process 4
- Problem Solving Process 4
- M&S Use Process 7
- M&S Development/Preparation Process 10

VV&A Functions of the User Role in New M&S Development 11
- Overview 11
- Refine M&S Requirements Phase 13
- Plan M&S Development Phase 14
- Develop Conceptual Model Phase 18
- Develop Design Phase 20
- Implement and Test Phase 20
- Prepare M&S for Use Phase 21

User's Relationship with Other Roles 22
- Overview 22
- User's Relationship with the M&S Program Manager 22
- User's Relationship with the M&S Developer 23
- User's Relationship with the V&V Agent 23
- User's Relationship with the Accreditation Agent 24
- User's Relationship with Others 24

Documentation Requirements 25
- Status Reports 25
- Archives 25

[1] This document replaces the 5/15/01 version. It contains minor editorial and formatting changes.

This document corresponds to the web version of the VV&A RPG Core Document of the same name and date. It has been modified to make it suitable for printing.

Cost Implications and Resourcing 26
Cost Factors 26
Controlling Costs 29
References 29
RPG References in This Document 29
Appendix A: VV&A Archive Information A-1
Appendix B: Legacy vs. New Simulation B-1
Decision Factors B-1
Evaluating a Legacy Simulation B-2
Preparing a Legacy Simulation B-2

This document corresponds to the web version of the VV&A RPG Core Document of the same name and date. It has been modified to make it suitable for printing.

VV&A Responsibilities and Challenges

The objective of this core document is to discuss the User's role in the verification, validation, and accreditation (VV&A) of a new simulation. As illustrated in the Roles and Responsibilities diagram,[1] the User has many opportunities for involvement.

The User is the driver for the overall application: the one who wants to use the simulation to provide an answer or solve a problem and the one who is concerned that the simulation can provide credible answers. The User defines the objectives and the requirements, scenarios and use cases, and generally serves as the subject matter expert (SME) for issues in the problem and user domains. The purpose of the overall VV&A effort is to provide evidence about the fitness of the simulation for the User's application. Ultimately the User is the one who decides whether the simulation is credible enough to use.

How Does the User Impact VV&A?

Although management of V&V activities is normally not a User responsibility, the User should work with the V&V Agent, Accreditation Agent, and M&S Program Manager (PM) to ensure the V&V effort is sufficient to provide a clear understanding of the simulation's credibility and to identify simulation constraints and limitations with respect to the intended application.

The User is responsible for accreditation. The User designates the Accreditation Agent, approves the accreditation assessment plan and acceptability criteria, ensures funding is available for the accreditation assessment, and makes the accreditation decision. Five accreditation options are possible:

- **Full accreditation** -- the simulation produces results that are sufficiently credible to support the application
- **Limited or conditional accreditation** -- constraints should be placed on how the simulation can be used to support the application
- **Modification of the simulation is needed** -- the simulation's capabilities are insufficient to support either full or conditional accreditation; modifications and subsequent V&V are needed to correct the deficiencies
- **Additional information is needed** -- the information obtained about the simulation is insufficient to support either full or conditional accreditation; supplemental verification, validation and/or testing should be conducted to provide the necessary information before the accreditation decision is made
- **No accreditation** -- the results of the assessment show that the simulation is not fit to support the application

[1] see the Typical Roles and Their Responsibilities diagram and its discussion in the Key Concepts.

How Does VV&A Impact the User?

The User is concerned with the credibility of the outputs of the simulation and needs to know how well the simulation supports, or can be expected to support, the intended use. Because the focus of the overall VV&A effort is to provide information on the simulation's fitness for the intended application and the potential risks associated with its use, the User is directly affected by the quality, completeness, and timeliness of the VV&A effort.

> Example:
>
> Even if the model is a simple algorithm, such as an amortization table from the financial analysis community, the User needs to know that the answers produced (i.e., the payments and interest accrued) are correct.
>
> For more complex simulations, such as an aircrew trainer, a much more rigorous VV&A program would be needed to ensure the simulator provides an environment that leads the aircrew member to desired learning outcomes. Precise 'look' and 'feel', as well as other fidelity issues would be very important aspects of V&V for this class of simulation.

For complex simulations, it is generally considered impossible to prove the accuracy of the answers absolutely, so a rigorous examination of validity is needed to demonstrate the credibility of the answers (i.e., to determine how likely the answers are to be acceptable for the specified purpose).

The User has to decide how to deal with simulation constraints and limitations that are identified during the V&V effort or accreditation assessment and should understand the objectives of the VV&A program, the development process, and how the simulation is to be used in the specified application.

What Are the User's Responsibilities in VV&A?

The User is the motivating force for the VV&A process. At the beginning of the process, the User establishes the objectives, and defines the requirements and serves as the authority for the user domain and problem domain and provides subject matter expertise in these areas for both development and V&V activities. At the end of the process, the User is responsible for making the accreditation decision.

Throughout the process, the User serves as the final decision-maker for all issues that affect the ability of the simulation to address the needs of the application (e.g., changes affecting requirements, objectives, success criteria). The User should plan, direct when appropriate, and participate wherever the User's unique expertise and authority can provide the greatest leverage and benefit. The User should ensure that complete and accurate information is generated by all the VV&A activities so that an informed decision can be made. The User should establish the boundaries of the overall VV&A program, guide the planning and resource allocation of the accreditation process, and monitor its implementation.

Throughout the entire problem solving process, the User participates in a number of tasks that affect the VV&A effort. Typical User responsibilities are shown in the table below.

Typical Tasks	Typical User Responsibilities
Define Problem and Establish Objectives	• provide a problem statement that identifies the issues to be resolved and the objectives that have to be met
Determine M&S Requirements	• provide a complete and concise set of requirements and objectives to define the needs of the application to be addressed using simulation
Develop Scenario	• provide scenarios, use cases, environments, situations, etc. that describe how the simulation entities, behaviors, and interactions should be represented
Select Accreditation Agent	• designate an Accreditation Agent with appropriate experience (e.g., knowledge of problem and user domain; experience with accreditation assessment techniques) to conduct the accreditation assessment
Select SMEs	• select user and problem domain SMEs to assist with problem definition, simulation development, and V&V activities
Define Measures and Acceptability Criteria	• help select appropriate measures and standards and define acceptability criteria for each requirement
Establish V&V Priorities	• determine the order in which requirements should be addressed based on risk
Identify Data Sources	• identify appropriate, authoritative sources for data needed by the simulation
Verify Requirements	• serve as a SME for the user and problem domains
Validate Conceptual Model	• serve as SME for the user and problem domains
Validate Results	• serve as SME for the user and problem domains to prepare appropriate test cases, provide validation data, and participate in the evaluation of results
Review Products	• review user manuals, documentation, etc.
Make Decisions	• make decisions on problems that impact the ability of the simulation to meet the needs of the application
Make Accreditation Decision	• make the accreditation decision based on the evidence provided by the V&V effort and accreditation assessment

What Challenges Does the User Face Relative to VV&A?

The User faces several challenges in planning and executing the accreditation decision, including

- **profiling the application** – determining which situations, scenarios, use cases, etc. can best address the application to ensure the correct representations are brought into the simulation
- **analyzing risk and uncertainty** – identifying risks; establishing assessment priorities based on the risks

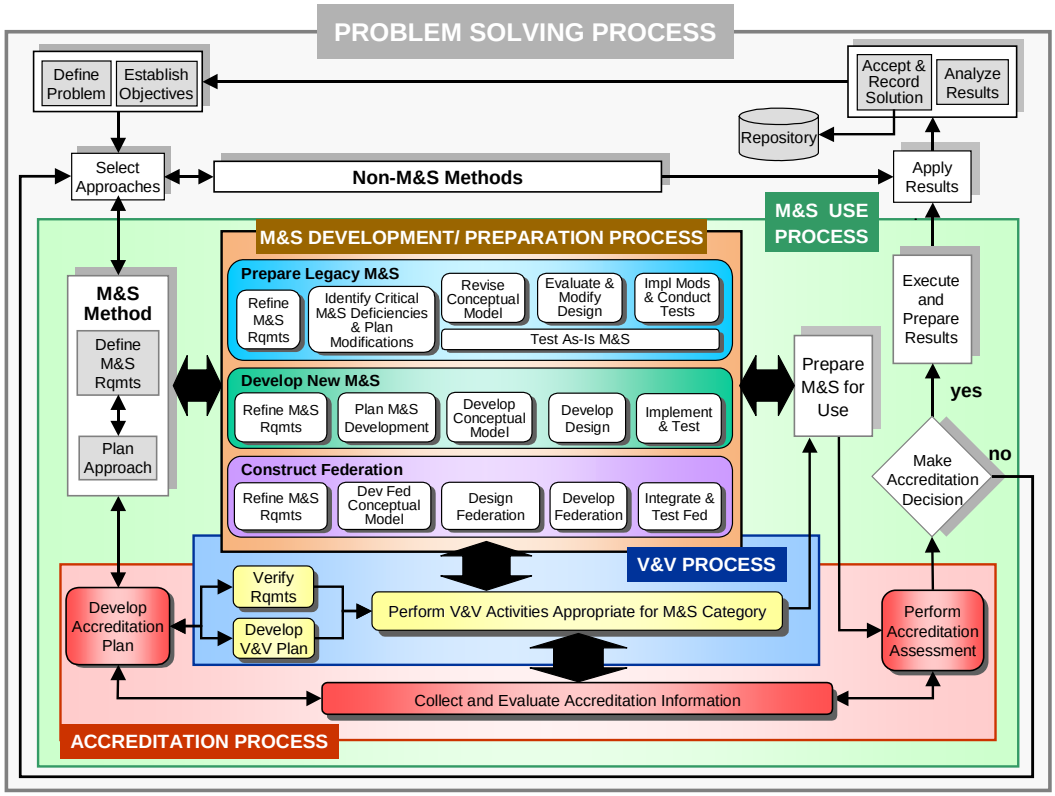
- **tailoring** – finding cost-effective ways to assess the simulation; ensuring the V&V activities are appropriate and adequate to meet the needs of the application
- **measuring success** -- deciding how much evidence is needed to determine credibility.

> Example:
>
> For large projects, the information generated during testing, verification, and validation serves as the basis for the accreditation assessment and decision. However for a small project, such as an amortization model, the resources available for evaluation may be very limited and the User will need to rely more on personal experience and experimentation.

Role of the User in the Overall Problem Solving Process

Problem Solving Process

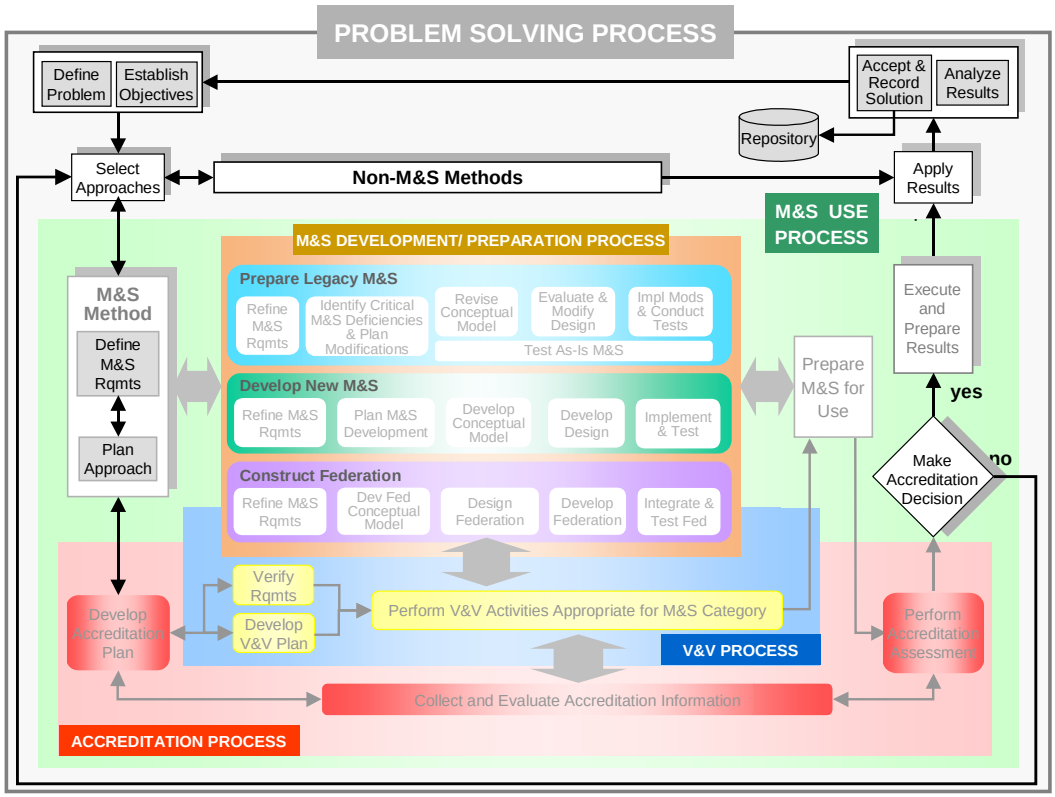
The diagram below shows how the M&S life cycle fits into the overall problem solving process.



The Overall Problem Solving Process

It depicts the relationships among the ***Problem Solving Process, M&S Use Process, M&S Development/Preparation Process, V&V Process,*** **and** ***Accreditation Process*** as a series of nested boxes. Each nested process contains a series of individual boxes that represent the basic individual activities, functions, and subprocesses considered essential to complete that process.

The overall problem solving process is the User's purview. However, as illustrated in the following figure, the User's primary areas of responsibility occur in the outermost box, where the process begins and ends, and at major decision points throughout.



The User's Role in the Problem Solving Process

The User initiates the process by first defining the problem and establishing the objectives and then by selecting the method or methods (e.g., modeling and simulation [M&S], experimentation, statistical analysis, live testing) that will be employed to resolve it. The User completes the process by applying the methods (e.g., making the decision to accredit the simulation for use, running the simulation, accepting the simulation results) and analyzing, accepting, and recording the overall solution. How well these activities are performed, particularly those at the beginning, is critical to the success of the entire process.

Define Problem and Establish Objectives

In defining the problem, the User should first identify the issues involved and establish the objectives that have to be met to solve the problem. This can be done by addressing some basic issues, such as those shown in the table below.

Problem Domain Questions
• What is the basic problem to be solved? What are the objectives? What questions need to be answered?
• What particular aspects of the problem will the simulation be used to help solve? What is the application?
• What is the scope of the problem? What boundaries or mission space apply?
• What decisions will be made based on the simulation results?
• What are the risks that might result from acceptance of erroneous simulation outputs or decisions based on them?

Answers to these questions can provide the information needed by the User to derive M&S requirements,[2] identify appropriate measures and acceptability criteria and establish what constitutes fitness for the given application. The requirements derived from the objectives (i.e., problem domain and user domain requirements) should be defined as clearly and completely as possible, although additional details are expected to be added later. The problem itself should also be articulated clearly enough that decisions can be made about how to solve it. When a complex problem is involved, the User may need to conduct a formal problem analysis. The problem analysis need not be highly detailed but should achieve the following:

- decompose the problem statement and objectives into discrete M&S requirements
- identify the major representations required to address each requirement, including the entities and interactions implied in each
- identify the probable level of precision or detail needed to represent each interaction (i.e., fidelity)
- identify the metrics or types of measures needed to assess the simulation's ability to satisfy the objectives and requirements and the data the simulation needs to address them
- identify the classes or categories of input data needed to support each major representation
- identify and prioritize the representations that appear least likely to meet their requirements (i.e., identify the risks)

[2] See the special topic on Requirements for additional information.

Problem analysis may need to be repeated as more information becomes available to ensure simulation preparation and the V&V and accreditation efforts continue to focus on the priorities and the needs of the application.

Select Approach

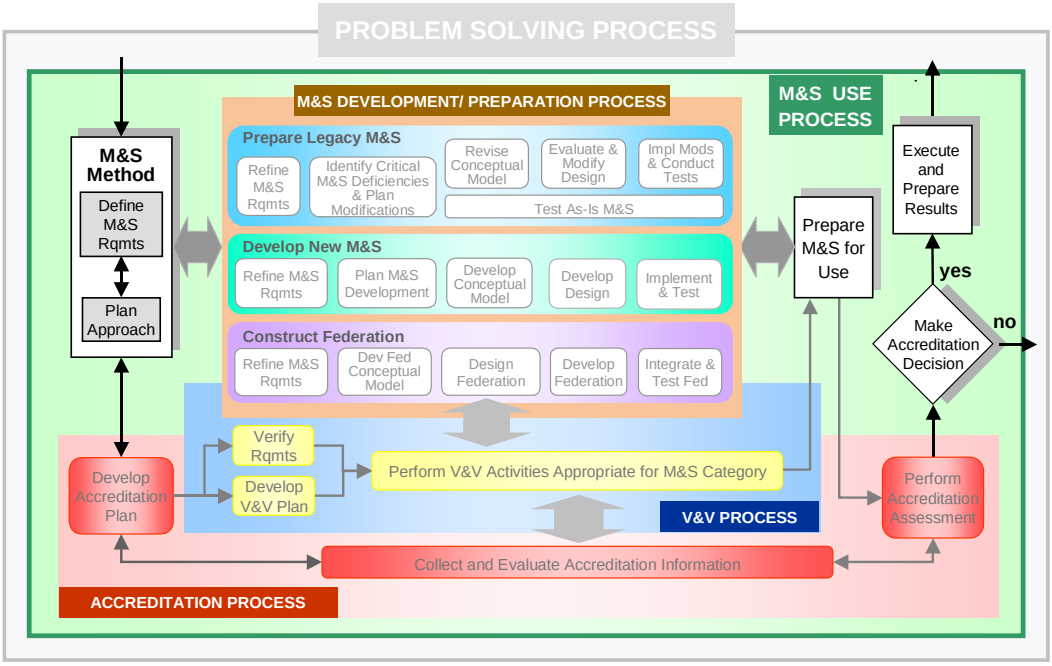
Modeling and simulation (M&S) is but one method that can be used to address the User's problem. Other methods that may be chosen to address all or part of the overall problem are beyond the scope of this document and will not be addressed. The decision to use M&S should not be taken lightly. A preliminary feasibility study should be performed to determine if it is reasonable and appropriate. Typical issues to examine are shown in the table below.

Factors Considered in Determining M&S Feasibility
• Are there issues (e.g., treaty constraints, safety concerns, security problems) that prohibit the use of other methods (e.g., live testing)?
• Can a model or simulation provide credible answers for this particular problem?
• Are there other less costly methods that can provide answers of the same caliber?
• Can an existing model, simulation, or federation meet the need? Are major modifications necessary?
• Do all the necessary component models or algorithms exist, or must some be developed?
• Does all the necessary data exist, or must some be developed?
• Can it all be done in time and under budget?

M&S Use Process

Once M&S has been selected as the method to use, the first nested process in the ***Problem Solving Process,*** the ***M&S Use Process*** (shown below), begins. The first phase of this process, M&S Methods, is perhaps the most critical for successfully meeting the application objectives because the activities performed and decisions made during this phase lay the foundation for a disciplined development process and a tailored and supportive VV&A effort. Two basic activities are performed during this phase, ***Define M&S Requirements*** and ***Plan Approach***. Specific tasks performed by the User during these activities that affect the VV&A effort are listed below and discussed in the following sections.

- Define M&S Requirements
- Plan Approach
  - Determine Simulation Type
  - Designate M&S Program Manager
  - Designate Accreditation Agent
  - Select Subject Matter Experts



M&S Use Process in the Problem Solving Process

User Role in Define M&S Requirements

The User provides the problem objectives and makes all decisions that may involve modifications or adjustments to requirements resulting from the limitations of the simulation. The User defines the M&S requirements from the user and problem domains, focusing on what is needed to solve the problem, and assists the Developer and M&S PM in defining simulation domain requirements that identify what is needed by the simulation to address the problem.[3]

Example:

Problem: Train Air Force (AF) staff in developing Air Tasking Orders (ATOs)

Problem domain requirements: C4I, alternative brigade compositions, theater campaign level

User domain requirements: scenario locations, environmental conditions, AF force structure, AF operations manuals

Simulation domain requirements: computer hardware, coding language, data formats, architecture, interfaces

[3] See the special topic on Requirements for additional information.

The M&S PM and Developer need to have a clear understanding of the requirements and objectives in order to know what to build. Without clearly articulated requirements, every step of the development process is made more difficult and error prone and the resulting simulation is less likely to do what the User needs it to do.

Problem analysis and risk assessment are complementary processes that help identify potential development problems before they become too large and expensive to resolve. Problem analysis helps ensure the right problem is being addressed and appropriate metrics and acceptability criteria are identified. Risk assessment establishes priorities for both the development and V&V efforts and helps ensure simulation results provide correct answers for the problem. [4]

User Role in Plan Approach

Determine Simulation Type

The User must decide whether the circumstances merit using a federation or a stand-alone simulation and then whether to use a legacy simulation or develop a new one. The decision of whether to use a federation or a stand-alone simulation should be determined primarily by the nature of the problem itself. Determining whether to use a legacy simulation, if one exists, or develop a new simulation is a business decision that should be based on a number of different factors affecting the overall costs involved and the level of risk incurred.

If an existing simulation can meet all of the M&S requirements of the current application with little or no modification, then using it may be the best approach. However, if existing simulations cannot address all the M&S requirements, or if extensive modifications are needed to do so, then developing a new simulation may be preferable. The User should carefully examine the risks and costs associated with each option before making a final decision. Additional information on choosing a legacy simulation is available in Appendix B.

Designate M&S Program Manager

Once the decision has been made to develop a new simulation, an M&S PM should be designated to oversee the M&S development program. The User and M&S PM work together to articulate the M&S requirements based on what aspects of the problem are to be addressed by modeling and simulation, determine what type of simulation should be employed, and begin planning the approach. Additional activities that may occur during this phase include selecting the Accreditation Agent and identifying SMEs to participate in development and V&V activities.

[4] See the special topic on Risk and Its Impact on VV&A for additional information.

Designate Accreditation Agent

The User is responsible for the accreditation program. The User coordinates funding for it, designates the Accreditation Agent, and ensures the program develops the information needed to make an informed decision about the ability of the resulting simulation to meet the need. The User relies on the Accreditation Agent to design the accreditation program, produce the accreditation plan, collect and assess the evidence, and provide a report with recommendations for the accreditation decision. The User should select an Accreditation Agent based on experience with the type of simulation involved and knowledge of the problem domain as well as experience in the field of accreditation assessment.

Select Subject Matter Experts

Since neither the Developer nor the V&V Agent is likely have all the necessary expertise to speak for the problem or user domains, the User is counted on to provide expertise in these areas by either acting as an expert or by identifying additional SMEs to participate in both development and V&V activities.[5] Such expertise is particularly critical to the V&V effort, where SMEs are needed to support requirements verification, conceptual model validation, results validation, and other areas where their special expertise can contribute to the accreditation decision. Problem and user domain SMEs are especially important during the development and validation of the conceptual model.

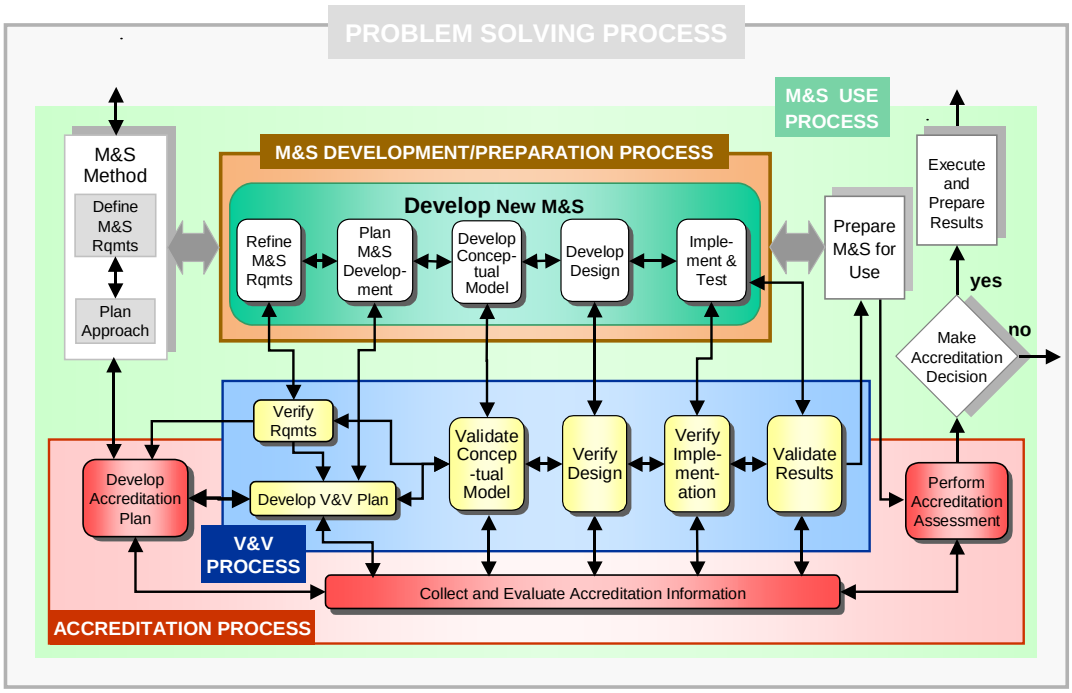
SMEs normally require some level of resourcing. Government employees (e.g., military experts) normally require travel costs at a minimum; experts from the private sector generally require compensation for their time as well. The User should verify that funding for SMEs is included in the M&S PM's budget.

M&S Development/Preparation Process

The next nested process, ***M&S Development/Preparation Process*** begins when the M&S PM designates the Developer. The M&S PM and Developer define the development profile, select the development paradigm, establish the development schedule, and initiate the plan.

The development process for new simulations, ***Develop New M&S Process***, consists of the six basic phases as shown in the figure below. Associated with each development phase is a corresponding V&V activity that examines and tests the progress in that phase, provides timely feedback, and collects evidence of the simulation's capabilities to be used in the accreditation assessment. The User role throughout simulation development involves a number of responsibilities that support the VV&A effort. These responsibilities are discussed in the following section.

[5] See the special topic on SMEs and VV&A for additional information.



M&S Development/Preparation Process for New M&S

VV&A Functions of the User Role in New M&S Development

Overview

As shown in the Roles and Responsibilities diagram[6] and discussed in Key Concepts,[7] the User serves as the major decision-maker and advisor on all aspects of the development that involve the problem or specified application, including those that impact the VV&A effort. Throughout the development process, the User's role focuses on ensuring that the M&S requirements are well-defined and appropriately represented and that sufficient evidence is gathered to be able to make the decision on accreditation. The User serves as the SME for matters that pertain to the problem and user domains and also ensures that appropriate SMEs are available for both the development and V&V processes. Finally, the User serves as the primary decision-maker for all problems that impact the objectives of the application.

Normally the User relies on the V&V Agent and Accreditation Agent to perform the necessary V&V analysis and accreditation assessment, respectively. These agents provide information to and, in the case of the Accreditation Agent, take direction from the User. To establish a close, cooperative working relationship with these agents, the User should participate in the planning sessions, coordination meetings, and information

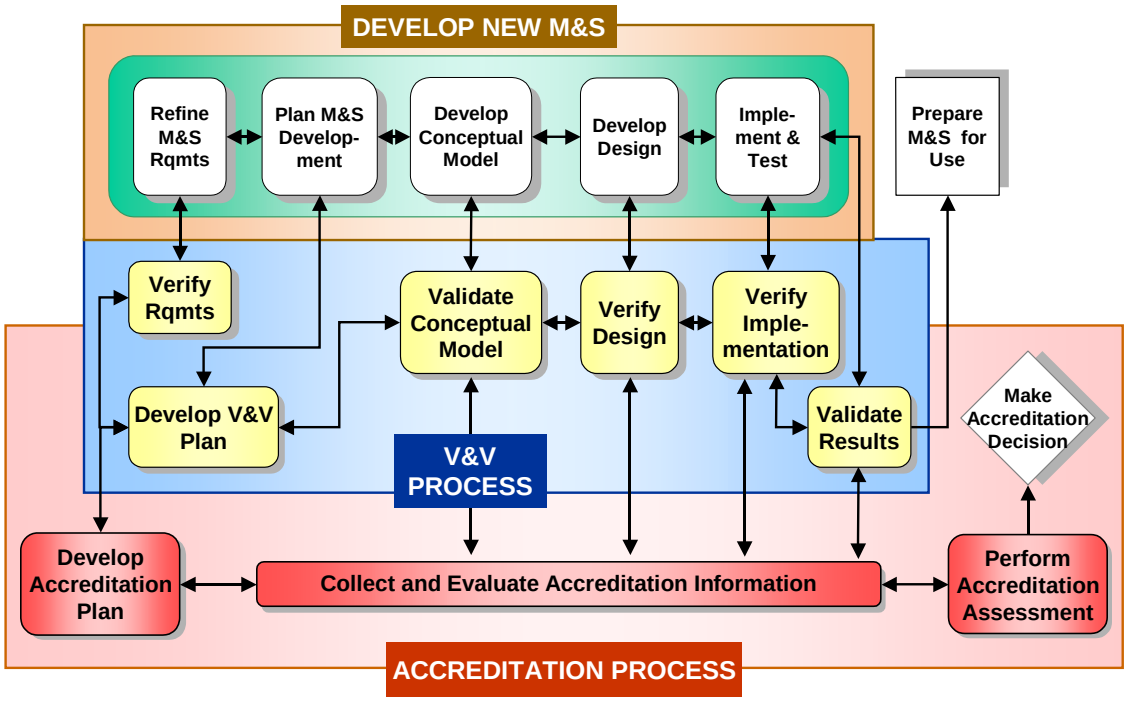
[6] See the diagram on Roles and Responsibilities for additional information.
[7] See the RPG menu item Key Concepts for additional information.

exchange meetings normally conducted by the M&S PM. By maintaining a presence in the development, V&V, and accreditation efforts, the User can ensure that little problems don't develop into big ones and that errors, problems, and oversights are found early enough to prevent them from becoming showstoppers. The User may want to implement a tracking mechanism to ensure continuity of information received from the various agents.

Although most tasks in the V&V process can be preplanned, the implementation of the plan is dynamic. Where and what problems will arise, what their impact will be, or how long they will take to solve cannot be known in advance. The User should continuously coordinate with the V&V Agent to monitor progress and adjust priorities to changing challenges, issues, and problems.

An approach to oversight of the VV&A effort that has worked well in the past is the formation of an Integrated Product Team (IPT), or similar working group. This team normally is made up of the Developer, V&V Agent, Accreditation Agent, and the User and is supported by SMEs as needed. The goal should be to ensure the focus remains on the most critical issues, and the team should act to modify plans and tasks accordingly. The team should conduct regularly scheduled interchange meetings as well as separate, focused problem-solving sessions and produce regular reports.

The new M&S development process, ***Develop New M&S***, consists of six basic phases. Associated with each phase is a corresponding V&V activity, as shown in the figure below.



VV&A in New M&S Development

Within each development phase, the User is involved in a number of activities that impact the V&V effort. Associated with each development phase is a corresponding V&V activity that consists of a number of tasks in which the User can play a role. These are discussed in the following paragraphs.

- Refine M&S Requirements Phase
- Plan M&S Development Phase
- Develop Conceptual Model Phase
- Develop Design Phase
- Implement and Test Phase
- Prepare M&S for Use Phase

Refine M&S Requirements Phase

User Role in Refine M&S Requirements

During this phase, the M&S requirements are examined to ensure they are defined in enough detail to be represented in the simulation. Requirements may be decomposed and additional requirements may be added. Major considerations for the User include:

Requirements Considerations and Rationale

M&S requirements should include requirements from all three domains
If requirements are articulated only from the perspective of the one domain (e.g., problem), then articulation of remaining domain perspectives is left up to the Developer, resulting in inconsistencies and less than satisfactory results.
M&S requirements should be measurable
Measures (e.g., measures of effectiveness [MOEs], measures of performance [MOPs], measures of opportunity [MOOs]) should derive logically from the requirements definitions.
M&S requirements should be traceable
Each requirement and its associated components (e.g., measures, definitions) should be traceable to an objective, as elucidated in the problem statement.
Requirements should be stored to support traceability
Requirements stored in a database should have a unique identifier that can support traceability throughout the various phases of the development process.
Acceptability criteria should describe how the simulation should perform when completed
Acceptability criteria should be fully developed by the end of the conceptual modeling phase and should be continually reviewed throughout the development process to ensure they remain appropriate and sufficient.

User Role in Verify M&S Requirements

The User should provide information on the specific intent of the application and on the accuracy, completeness, and currency of the requirements statements. The User will also serve as the final decision-maker on resolving any inconsistencies.

Because the M&S requirements serve as the foundation for the entire simulation development process, it is essential that they be clearly articulated from the beginning and well understood by all participants. A requirements tracing database or tool should be used to ensure the requirements are correctly carried through into the conceptual model, design, implementation, and test phases of simulation development.

Plan M&S Development Phase

User Role in Planning

The M&S development plan, V&V plan, and accreditation plan should be developed in concert. The User is concerned with a number of factors during this phase that impact all three planning efforts. These are listed below and discussed in the following sections.

- profiling the application
- analyzing risk and uncertainty

- measuring success
- developing scenarios
- tailoring VV&A
- establishing the validation environment

User Role in Profiling the Application

During the planning process, essential planning information, as shown in the table below, is collected and filtered and used to shape the V&V process and accreditation assessment. As the spokesperson for both the problem and user domains, the User can provide much of the necessary information and should help the V&V and Accreditation Agents locate and obtain the rest.

Typical M&S Planning Information
• Warfighting roles, missions, and operational objectives
• Environment, geography, engagement locations, terrain, ocean, space, etc.
• Scenario-driven and general operational capabilities
• Specifications and requirements on the system(s) being modeled
• Schedule for planned use (required accreditation date)
• Resources required (including participants)
• Requirements/expectations for reuse
• Development schedule, including conceptual model, design, implementation, and testing
• Known uncertainties and risks
• Miscellaneous planning information
• History of previous use and V&V and accreditation pedigrees

The scope and character of the VV&A effort take shape as these resources are reviewed and analyzed. This collection of information serves as the basis for formal VV&A planning as shown in the table below:

Typical V&V Planning Information
• Schedule
• Number and location of sites involved
• Requirements of the simulation use
• Generalized scenario and operational constraints
• Acceptability criteria
• V&V event scheduling within the development and test program
• Risk and uncertainty factors
• Information to gather for accreditation assessment
Typical Accreditation Planning Information
• Schedule
• Number and location of sites involved
• Requirements of the application
• Generalized scenario and operational constraints
• Acceptability criteria
• Risk and uncertainty factors
• Information provided by V&V activities
• Additional assessment activities

User Role in Analyzing Risk and Uncertainty

Credibility should be the key driver in determining the acceptability of the simulation for the application. The User's belief that the simulation is credible will depend on how much risk the User is willing to accept. This question is often difficult to answer because risks are seldom specified by the User in concrete, quantifiable terms.

To understand simulation credibility, it is necessary to first identify and quantify the operational risks.[8] The User should begin by addressing the following issues:

Operational Risk Issues
• What risks would result from an incorrect decision based on simulation results?
• What kinds of risks are involved? (e.g., safety, financial, unit effectiveness, program jeopardy, etc.)?
• Who would be affected by these risks and to what extent?
• What visibility will an incorrect decision have?
• What specific issues or concerns associated with the application should be considered as risks?

If the risks associated with the expected decision can be identified, then impacts and probabilities can be bounded using explicit criteria, which can then be used to quantify the level of operational risk involved. The level of operational risk determines how much information is needed to make the accreditation decision. The higher the level of operational risk the greater the information needed by the User. By satisfying this need for information, one can build the User's confidence that the simulation outputs are credible for the intended application and thus mitigate the operational risks associated with the intended use.

Overall risk may be reduced when

- all participants are carefully briefed on the problem and objectives and have a thorough understanding of the requirements
- development plans and V&V plans have been coordinated so events are scheduled to interact appropriately
- SMEs have been identified from appropriate fields of expertise to assist with different phases of the process
- appropriate, authoritative data are available

[8] See special topic on Risk and Its Impact on VV&A for additional information.

User Role in Measuring Success

Once the requirements have been defined, the User and Accreditation Agent should determine how success for each requirement should be measured. This is accomplished by identifying appropriate metrics (e.g., MOEs, MOPs) and acceptability criteria (e.g., standards for success, boundary conditions) for each requirement.

The Accreditation Agent and the User are the primary participants in this process; however, participation by the Developer and V&V Agent is important. The Developer can provide metrics and criteria for simulation domain requirements and the V&V Agent can verify the accuracy and completeness of the data, simulation performance, and behavioral representations.

Although it is generally possible to specify what kinds of verification and validation tasks should be done to demonstrate fitness of the simulation for the application, the amount of verification and validation information required to establish credibility for a particular application ultimately depends on a clear understanding of how program decisions are affected by simulation outputs.

A precise relationship among program objectives, metrics, and the resulting simulation outputs is essential. Acceptability criteria are developed from the M&S requirements and used as the basis of comparison for simulation representations and capabilities. This comparison is an essential aspect of both V&V and accreditation planning because it objectively justifies the selection of specific V&V tasks.

User Role in Developing Scenarios

The User is normally responsible for providing scenarios and use cases that help describe the characteristics and capabilities needed in the simulation. These scenarios and use cases are used during problem and requirements definition to bound the simulation environment for the specific application. The problem statement, by itself, is not sufficient to bound the M&S requirements. Additional information about the problem's "who," "where," "how," "when," and "why" is needed. This detailed information about the problem and M&S usage serves as the foundation of the conceptual model. Later, the scenarios and use cases are used during testing, validation, and accreditation assessment to evaluate the fitness of the simulation for the application.

User Role in Tailoring VV&A

Tailoring is an attempt to provide the most appropriate analysis possible within the constraints of time, resources, and cost. It applies to both the accreditation and V&V processes.

- Tailoring the accreditation process involves using the information obtained during the risk analysis to identify high-risk areas, establish priorities, and

determine the information needed from the V&V effort to best address these areas.

- Tailoring the V&V effort involves the development of a reasonable, balanced (i.e., neither excessive nor insufficient) V&V approach by determining the verification and validation tasks needed to provide the information needed for the accreditation assessment and then by scoping the effort based on resources available.

In most instances, there is a difference between what is desired, what is sufficient and what is possible (i.e., what is affordable). Tradeoffs have to be made. To ensure the V&V effort provides the most evidence possible within the funding available, the User should provide guidance regarding the relative importance of the requirements (based on the results of the problem analysis and risk assessment[9]). A carefully tailored V&V effort, including well-defined program objectives and an audit trail of decisions, can provide information the User needs to understand the limitations, constraints, and risks involved in using the simulation.

User Role in Establishing the Validation Environment

- **Validation Data** -- Frequently, there are no empirical validation data available to compare to simulation results. If this is the case, SMEs from appropriate functional areas should be consulted for their "view of the real world," commonly called the referent. The baseline they provide is used for the comparison. Because the User has in-depth knowledge of the problem and the application, the User or a User representative should participate in this activity as well. [10]
- **Validation Tests** -- Validation tests, developed with guidance from the User and SMEs, should be capable of exercising the needed simulation capabilities. Validation tests should be run against the planned scenario(s) to obtain representative results.

Develop the Conceptual Model Phase

User Role in Develop Conceptual Model

The conceptual model[11] serves as a vehicle to move from the requirements to design and code. It functions as a blueprint by which the Developer and others can understand precisely what needs to be built. The User supports the Developer by articulating the appropriate level of abstraction of the real world to be modeled and providing the requirements, scenarios, use cases, and constraints that drive the conceptual model design.

---

[9] See the special topic on Risk and Its Impact on VV&A for additional information.
[10] See the special topic on Data V&V for New Simulations for additional information.
[11] See the special topic on Conceptual Model Development and Validation for additional information.

User Role in Validate Conceptual Model

The User can participate in conceptual model validation[12] by helping to ensure the requirements are considered correctly and by selecting SMEs to participate in the validation process. Conceptual model validation assesses the degree to which the conceptual model accurately describes the real-world entities and processes that are candidates for representation. The entity attributes and cause-and-effect relationships governing behaviors should be defined as accurately as needed by the application. A comprehensive validated conceptual model is necessary before an appropriate design can be developed because it serves as the basis for the design. The validated conceptual model also serves as the referent against which simulation representations are compared during results validation.

User Role in Data Acquisition and Data V&V

The lengthy process of acquiring and preparing data[13] should begin during conceptual model development. The earlier this process is begun, the more likely quality data[14] will be available for the application. Once the model is designed and code is built, changes to resolve data problems become much more costly and time-consuming. The Developer identifies the data needs (including the level of fidelity) of the simulation, frequently without regard to whether or not such data actually exist. As the representative of the problem and user domains, the User should help identify potential data sources (e.g., authoritative data sources, data producers, functional descriptions of the mission space [FDMS][15]) and SMEs. Once appropriate data are obtained, they need to be prepared for use (e.g., manipulated, transformed, aggregated). Because of the wide variety of data types used in a simulation, multiple SMEs may be needed to support both data preparation and data V&V.

Data V&V[16] activities are performed in concert with model V&V activities, beginning in the conceptual model phase and extending through testing and validation, to ensure that data are appropriate for use in a particular simulation for a specific application. SMEs, in particular, data producers, are frequently called upon to assist with data verification and validation activities. The User helps identify the SMEs to support individual tasks and monitors the overall process. If data or data source problems are discovered that impact the simulation's ability to satisfy the M&S requirements, it's the User's responsibility to decide whether to modify requirements; revise acceptability criteria; use available data that are not totally appropriate (i.e., accept the risk of reduced credibility); modify the simulation (which may reduce the simulation's fitness for purpose); or, undertake a data production effort, which increases program costs and can result in program delays.

---

[12] See the special topic on Conceptual Model Development and Validation for additional information.
[13] See the reference document on M&S Data Concepts and Terms for additional information.
[14] See the Data Quality Templates for additional information.
[15] Designated as the Conceptual Model of the Mission Space (CMMS) in DoD 5000.59-P, the *DoD M&S Master Plan*. The term CMMS is in the process of officially being changed to FDMS.
[16] See the special topic on Data V&V for New Simulations for additional information.

Develop Design Phase

The User does not play a direct role in developing the design; however, because decisions may be required to resolve design issues, the User should monitor these events to ensure the information being provided for the accreditation decision is complete and accurate. The User also counts on V&V information as a risk mitigation tool. By reviewing V&V results and products as they are produced, the User can use them as the basis for trade-off decisions.

User Role in Verify Design

The User should ensure this effort addresses essential issues of design integrity, performance, behavior, and credibility.

Implement and Test Phase

The User does not play a direct role in the Implement and Test Design phase; however, because decisions may be required to resolve coding issues, the User should monitor these events to ensure the information being provided for the accreditation decision is complete and accurate. Again, the User should count on V&V information to help mitigate risk. By reviewing V&V results and products as they are produced, the User can use them as the basis for trade-off decisions.

User Role in Verify Implementation

The User should ensure this effort addresses essential issues of code integrity, performance, behavior, and credibility.

User Role in Validate Results

Results validation is conducted to determine the extent to which the simulation addresses the needs of the particular application. Because the data are inextricably intertwined with the simulation (i.e., if the data are not valid, then the validity of the models and algorithms that use the data cannot be demonstrated and vice versa), data validation and simulation validation are conducted together.

The validity of the simulation has to be demonstrated and measured through comprehensive retesting and analysis. In one view, validation can be perceived as calibration, where simulation performance is observed, quantified (where possible), and adjusted within the range of data values under which it is intended to operate. The validation process continues until the User is satisfied that the acceptability criteria have been met and the simulation is stable and operating as expected.

Prepare M&S for Use Phase

Once the User has accepted the results of the validation effort, the Developer can begin to prepare it for use in the actual application. However, before the simulation is used, the User needs to make the accreditation decision.

User Role in Accreditation

Accreditation is the official certification that a simulation and its associated data are acceptable for use in the specified application. Although accreditation is often perceived as occurring at the end of a development process, the actual assessment process should begin as early as possible. This will help ensure that the results of V&V and testing activities will provide appropriate and sufficient information to support the accreditation decision. The User provides information regarding the problem objectives and M&S requirements and identifies SMEs who can be used in the assessment process.

The Accreditation Agent assesses the fitness of the simulation based on the evidence collected during the V&V effort and accreditation assessment process and prepares an accreditation report for the User. This report should include the results of the assessment, with detailed explanations of the risks associated with using the simulation as intended and any constraints, limitations, and permissible ranges of use, and an accreditation recommendation.

The User, as the accreditation authority, evaluates the information provided and makes the accreditation determination. If the results of the V&V effort indicate the simulation meets the acceptability criteria, and the User concurs with the findings of the accreditation assessment, the accreditation decision should follow easily. However, when the accreditation assessment shows that actual simulation performance falls short of the needs of the application, the User must first understand the risks involved and then decide among the following alternatives:

- **full accreditation –** using the simulation as is (accepting the risks)
- **limited accreditation –** constraining the application to minimize the risks
- **modification of the simulation is needed –** corrections can be made that can reduce the risk but they also increase costs and cause delays
- **additional information is needed –** more information is needed to understand the risks involved and instill confidence in the simulation's fitness
- **no accreditation –** determining that the risks involved in using the simulation and the costs involved in fixing it are both too great

If the User chooses limited accreditation, then the constraints and limitations should be clearly identified and the ranges of permissible usage clearly defined.

User Role in Verify Documentation

The quality and usability of instructional material and user manuals have a direct impact on the successful operation of the simulation. All manuals and materials delivered with the simulation should be reviewed for completeness, appropriateness, utility, and currency. If this activity is not included in the V&V plan, the User should lead this effort. When documentation verification is conducted as part of the V&V effort, the User should provide subject matter expertise.

User's Relationship with Other Roles

Overview

The User is the authority on the application (i.e., problem, use) and serves as the final decision-maker on all issues that impact the application. As such, the User is responsible for providing information shown in the table below to all participants:

Information the User Provides
• problem domain requirements
• user domain requirements
• authoritative data sources
• subject matter experts (SMEs)
• planned scenarios and use cases
• general information about the simulation usage including locations, facilities, organizations, etc.
• other critical usage needs which may drive accreditation criteria

User's Relationship with the M&S Program Manager

In addition to the information listed above, the User provides the M&S PM with clear and complete problem statements and requirement definitions, detailed information (i.e., expertise) about the user and problem domains (e.g., what is to be represented; how the simulation will be used), and decisions regarding potential changes and problem resolution.

The User looks to the M&S PM to provide appropriate funding and support for the V&V effort, frequent updates on the status of the development and the V&V effort, and support in resolving issues and in keeping both efforts on track. The User is the ultimate decision-maker regarding all changes affecting the ability of the simulation to meet the needs of the application and as such should be called upon to decide between

cost overruns and schedule delays, modification of requirements, or limitations in simulation capability.

User's Relationship with the M&S Developer

The Developer relies on the User to

- define the problem and requirements
- locate authoritative data sources and SMEs
- help define acceptability criteria
- serve as a domain expert for the user and problem domains
- make decisions regarding potential changes.

The User should work closely with the Developer to ensure the requirements are faithfully converted through the conceptual model to the design and finally into the code.

The Developer also plays a major role in the V&V effort. A development effort that adheres to good software engineering practices will produce formal products that can be instrumental to the V&V effort. Additionally, tools used during the development effort should also support the V&V effort (e.g., a built-in code verifier can provide signification information). In most instances, the V&V Agent works closely with the Developer to obtain information; however, under some circumstances (e.g., low budget, low need for detailed representations, uncomplicated simulation), the Developer may conduct the entire V&V effort.[17] Most important to the User is the generation of development, test, and V&V products so the requirements can be traced through the design and the design can be verified. In addition, the User counts on the Developer to generate other system products, such as operations and maintenance manuals for employment of the simulation.

User's Relationship with the V&V Agent

The V&V Agent relies on the User to provide expertise regarding user and problem domain requirements and the intended application, and to resolve issues arising during the V&V process. The User relies on the V&V Agent to provide evidence of the simulation's credibility and risks associated with using it in the intended application and to provide timely reports and recommendations concerning problems throughout the development process.

---

[17] The main danger in having the Developer responsible for the entire V&V effort is difficulty in maintaining independent viewpoints. A Developer's primary concern is to ensure the code does what it is supposed to; the V&V effort is expected to go beyond this and evaluate if the simulation provides results that are sufficiently credible to be used in the application.

When problems are uncovered during V&V activities, the V&V Agent typically reports directly to the M&S PM who, in turn, consults the User for decisions about cost, schedule, and performance issues.

User's Relationship with the Accreditation Agent

Because the User is not normally able to personally gather and evaluate all the information needed for the accreditation decision, an Accreditation Agent is designated to conduct the assessment. The Accreditation Agent works directly for and with the User to ensure the accreditation assessment process can provide sufficient information to support an accreditation decision.

The Accreditation Agent supports the User in developing acceptability criteria based on the requirements of the application. Additionally, the Accreditation Agent produces the overall accreditation plan and provides resource and cost estimates for the conduct of the accreditation program. The User should assist in the development of acceptability criteria and provide subject matter expertise and information regarding the problem and user domain requirements as needed. The Accreditation Agent assesses the information gathered and provides a report and recommendations to the User for the accreditation decision based on documentation of any previous and current V&V efforts and personal knowledge of the requirements the simulation will support.

User's Relationship with Others

The User's concern about the simulation's fitness for the specified application can result in relationships with additional organizations and agencies that can provide important information.

Testing

To leverage efforts that can provide information and reduce costs, the User should encourage cooperation and collaboration between the V&V effort and testing efforts (e.g., developmental testing, operational testing, and Test and Evaluation (T&E)[18] when the simulation itself is an acquisition product (e.g., JWARS, JSIMS)). Combining tests, sharing data, and comparing results can help reduce overall cost and improve the comprehensiveness of the information collected. Involving outside organizations in reviews and spot testing can provide additional evidence regarding the fitness and credibility of the simulation.

Subject Matter Experts

[18] See the reference document on T&E and V&V Integration for additional information.

SMEs[19] are relied on to provide information on a variety of topics (e.g., operational doctrine, tactics, and procedures; software languages; data; physical and natural laws and relationships; hardware).

- During the development process, SMEs are often called upon during requirements definition, scenario development, and conceptual model development
- During the V&V effort, SMEs help establish the validation environment by providing validation data in the absence of empirical data and participate in verification, conceptual model validation, data validation, and results validation
- During the accreditation assessment, SMEs may serve as members of the assessment team.

The User is normally expected to identify, select, or approve SMEs with expertise in the problem and user domains.

Documentation Requirements

Information about the V&V and accreditation efforts should be collected, documented, and archived throughout the VV&A effort. Documentation should be approached realistically. Careful planning can result in products that serve both current and future Users, Developers, V&V Agents, and Accreditation Agents.

Status Reports

The User should receive status reports summarizing V&V and accreditation activities and costs on a regular basis from the V&V Agent through the M&S PM and Accreditation Agent respectively. Although some variance between actual and planned performance and events is acceptable, the User should take immediate action in concert with the M&S PM if the reports show an adverse trend.

Archives

Only the documentation pertaining to the problem statement (e.g., objectives and requirements) and the accreditation decision is generated by the User. However, the User should recognize the importance of maintaining a complete pedigree of VV&A information and work to ensure that an accurate, comprehensive record of all VV&A activities is kept. VV&A information to be archived should include, at a minimum:

VV&A Information

[19] See the special topic on Subject Matter Experts and VV&A for additional information

VV&A Information
• Problem statement
• M&S approach statement
• M&S Requirements statement
• Acceptability criteria and metrics
• Conceptual model description
• V&V plan
• Accreditation plan
• Requirements Verification report
• Conceptual Model Validation report
• Design Verification report
• Implementation Verification report
• Validation report
• Accreditation Assessment report
• Accreditation decision statement

Additional information about VV&A archive documentation is available at Appendix A.

The VV&A archive should be specific enough to demonstrate the rigor of the V&V and accreditation activities and comprehensive enough to fully describe the overall VV&A process that was executed. Two major reasons for maintaining this information are

- **Accountability --** A well-documented VV&A effort provides a record of how and why decisions were made in the application process. This information can serve to increase confidence in the simulation by providing the rationale behind its development. A well-recorded VV&A history is invaluable when challenges are raised regarding its capabilities and limitations.
- **Model reuse --** By keeping an archive of VV&A activities during simulation development and application, its fitness for reuse in new applications should be much easier to assess.

Cost Implications and Resourcing

Cost Factors

The V&V costs that the User is directly concerned with are those associated with the accreditation effort. These costs depend on a variety of factors.

Application-Related Factors

The credibility demanded by the User for the application shapes the V&V and accreditation efforts. Credibility is directly related to operational risk. If the operational risk is great, the User will demand proof that the simulation is fit for use (credible). In general, the greater the operational risk, the greater the need to accumulate evidence to prove the simulation's fitness for use.

The complexity of the application (use) impacts the complexity of the development which, in turn, impacts the number and types of activities, the number and variety of SMEs involved in the V&V effort, and the amount of evidence needed for the accreditation assessment. In general, greater complexity implies greater risk and requires more evidence be accumulated.

The quality of the problem definition, requirements identification, and planning has a direct impact on development of the simulation. This, in turn, impacts the amount of verification and validation needed to ensure sufficient evidence is available for the accreditation assessment. Ambiguous objectives, inconsistent requirements, and incomplete planning result in development delays and additional verification and validation tasks that increase costs and reduce the amount of time available for the accreditation assessment.

Simulation-Related Factors

The type of simulation involved (e.g., new, legacy, federation, constructive, human in the loop [HITL], virtual) helps determine what V&V tasks are needed to provide the evidence used the accreditation assessment. In general, it costs more to collect the necessary information for a new simulation development than for a legacy simulation that has an extensive history.

> Example:
>
> Key to minimizing costs with legacy simulations is the completeness and accessibility of its history. If the simulation's history is readily available (e.g., under configuration management and recorded in the M&S Resource Repository (MSRR) on the World Wide Web), then necessary information can be obtained for relatively little cost. However, if extensive research is needed to obtain the past VV&A history, the cost may be greatly increased.

Accreditation-Related Factors

The amount of time available for the accreditation assessment impacts the amount of manpower and resources required. If there is a short suspense, additional manpower may be needed to complete the assessment (e.g., additional technical personnel to conduct tests and gather results; SMEs and analysts to assist with the assessment; administrative personnel to prepare reports).

The experience of the people involved, i.e., their knowledge, skills, and capabilities, relative to the tasks involved, determines how much time and training they need to perform those tasks.

> Example:
>
> Selection of participants in the accreditation effort can have major cost impacts. Participants who do not have the right experience or background or who cannot provide the time to prepare for and participate in assessment activities can lead to unnecessary work by others, last-minute workarounds, disruptions, delays, and compromised assessments.

Tools

Tools and technology also impact costs. Tools should be carefully selected so the savings involved in using them are greater than the cost of purchasing them, training people to use them, and maintaining them. Special consideration should be given to ensure tools are useful for both development and V&V activities. Knowledge acquisition (KA) products, e.g., functional descriptions of the battle space, can be the single most expensive part of the development and the assessment. If an archive of validated functional descriptions pertaining to the problem space is available, KA costs can be reduced. Good documentation of the functional descriptions can also reduce the level of effort needed for V&V activities.

Cost Estimation

Cost estimation for both V&V and accreditation is complex and varies depending on the type of simulation involved and the nature of the evidence to be collected and assessed. The V&V and Accreditation Agents should prepare cost estimates and provide them to the User for review. The User does not need to be an expert on cost estimating but should become familiar with the cost estimating tools and processes used to ensure the resulting plans will provide the information needed to support the accreditation decision.

Cost estimation focuses on those factors that most directly impact the risk or uncertainty of the project. Additional factors should be considered as well:

- specialized V&V tools[20]
- use of SMEs[21] for particular tasks
- travel and temporary duty (TDY)
- specialized training
- special computers or devices
- communications and networking equipment

[20] See the reference document on V&V Tools for additional information.
[21] See the special topic on Subject Matter Experts and VV&A for additional information.

- maintenance contracts, licenses, etc.

The costs associated with these factors should be added to the cost matrix after adjustments and calculations have been made since they are not affected by risk or uncertainty of the project itself.

Controlling Costs

Working with the Accreditation Agent and V&V Agent, the User can take a number of steps to control costs:

- plan the accreditation effort based on clearly defined application and credibility needs
- conduct a risk assessment to determine the minimum essential V&V evidence needed to justify an accreditation decision based on the level of output errors that can be tolerated
- plan an efficient V&V effort designed to reduce development cost and risk (A well-planned V&V effort can be expected to more than pay for itself by reducing errors and rework in development.)
- analyze objects and behaviors identified in the requirements to determine which are most critical (i.e., have the greatest impact on the simulation outputs)
- encourage the V&V effort to focus on the most critical objects and behaviors
- determine an appropriate level of error tolerance for the critical objects and their behaviors

Documentation standards can benefit both initial and future Users. They can reduce preparation time, help ensure that appropriate, complete information is provided, and reduce the time needed for reviews and editing. Documentation standards also allow future users to rapidly find the particular information elements they need.

References

Doyle, John, "Virtual Engineering: Toward a Theory for Modeling and Simulation of Complex Systems," *Appendix B of Volume 9 Modeling and Simulation, Technology for the United States Navy and Marine Corps 2000-2035: Becoming a 21st-Century Force*, Panel on Modeling and Simulation, Committee on Technology for Future Naval Forces, Naval Studies Board, Commission on Physical Sciences, Mathematics, and Applications, National Research Council, published by National Academy Press, Washington, D. C., 1997, pp. 158-159.

RPG References in This Document

select menu*: RPG Diagrams*, select item: “Typical Roles and Their Responsibilities”

select menu*: RPG menu*, select item: “Key Concepts”

select menu*: RPG Reference Documents*, select item: "M&S Data Concepts and Terms"

select menu*: RPG Reference Documents*, select item: "T&E and V&V Integration"

select menu*: RPG Reference Documents*, select item: "V&V Tools"

select menu*: RPG Special Topics*, select item: "Conceptual Model Development and Validation"

select menu*: RPG Special Topics*, select item: "Data V&V for New Simulations"

select menu*: RPG Special Topics*, select item: "Measures"

select menu*: RPG Special Topics*, select item: "Paradigms for M&S Development"

select menu*: RPG Special Topics*, select item: "Requirements"

select menu*: RPG Special Topics*, select item: "Risk and Its Impact on VV&A"

select menu*: RPG Special Topics*, select item: "Subject Matter Experts and VV&A"

select menu*: RPG Templates*, select item: "Data Quality Templates"

In the web-based version of this document, the appendix below appears as a hot link in the Documentation Requirements section.

Appendix A: VV&A Archive Information

The following table lists some of the major artifacts and products to be archived for future VV&A efforts.

Information to Consider Archiving for VV&A	
	Products and Information
M&S Requirements	• definitions • metrics, measures, and acceptability criteria • requirement trail through the conceptual model and design to code • relationships to specific entities, processes, behaviors, events, or outputs • modifications/revisions required and accomplished
Planning	• problem definition and objectives • M&S development plan • V&V plan • accreditation plan • modifications/revisions required and accomplished
Conceptual Model	• validated annotated conceptual model • behaviors and interactions and associated data • sources of real world knowledge, data • verification techniques and results (e.g., data sources, interactions) • validation process and results (e.g., behaviors, conceptual model) • modifications/revisions required and accomplished
M&S Design	• annotated simulation design, preliminary and detailed • design entities (e.g., objects, attributes, parameters) mapping to conceptual model elements, objectives, requirements • verification techniques and results (e.g., functionality) • modifications/revisions required and accomplished
Implement and Test	• verified code • verification techniques and results (e.g., data, code) • testing techniques, data, scenarios (use cases), and results • data flow analysis • validation techniques, data, algorithms, scenarios (use cases), and results • modifications/revisions required and accomplished
Prepare for Use	• accreditation information needs • accreditation assessment process, results, and recommendations • accreditation report • modifications/revisions required and accomplished • constraints, limitations, assumptions associated with the application • results of execution

In the web-based version of this document, the appendix below appears as a hot link in the M&S Use Process: Determine Simulation Type section.

Appendix B: Legacy vs. New Simulation

Decision Factors

Determining whether to use a legacy model or simulation, if one exists, or develop a new one is a business decision that should be based on factors like those shown in the table below.

Legacy vs. New M&S Considerations
• Viability of the technology of the candidate legacy simulations -- hardware and software supportability, efficiency, etc.
• Capability of the candidate legacy simulations to support the requirements
• Adequacy of documentation and information sources (e.g., simulation, past applications, VV&A histories) – configuration management
• Amount and complexity of modification required
• Policies governing the modification
• Relative costs in money, resources, and time of developing a new simulation vs. using a legacy simulation

This decision should be made by the User in cooperation with the M&S PM who will be responsible for resourcing and overseeing the development or modification effort.

Evaluating a Legacy Simulation

One of the most useful tools for legacy evaluation is a well-documented pedigree. In-depth knowledge of what the candidate simulations are capable of doing and what they were intended to be able to do as well as information regarding their history of usage can help determine a candidate's fitness for the current application. A concise statement by each previous User about the specific application that includes the constraints and limitations involved can help a new User determine whether the current intended use is within the capabilities of the simulation. Some of the key information to review is listed in the table below:

Legacy Pedigree Information	
• prior usage	• requirements addressed
• conceptual model	• VV&A history
• data requirements	• detailed design

Legacy Pedigree Information	
• results, limitations, constraints	• hardware, software specifications

Additional factors to consider before selecting a legacy simulation include:

- extent of modification necessary – the amount of time and resources (e.g., personnel and equipment) needed to prepare the legacy for the intended use
- availability of the source code
- availability of appropriate data
- equipment needed
- training and/or specialized personnel needed

Preparing a Legacy Simulation

When a legacy simulation is selected for use, the amount of modification involved will determine how the preparation is handled. In general, when there are no extraneous factors to consider, the "30% rule" is followed:

- If more than 30% of the code has to be changed or more than 30% additional code has to be written, then the modification effort should be handled like a new development, complete with a formal development process, an M&S PM to manage the development, a Developer to make the changes, and a large budget
- If less than 30% of the code has to be written or modified, then the modification effort can normally be handled in a less formal manner (e.g., preparation and modifications are managed in-house) with a lower budget

When the legacy simulation requires major modification, there may be some advantages to involving the "original" Developer of the simulation. The original Developer would have access to

- the technical experts that designed and coded the simulation and have knowledge of the assumptions and trade-offs that were made
- details about the development itself, tests and analysis performed, verification activities, results, and recommendations
- development tools, equipment, documentation libraries (including configuration management information), software libraries, and the code itself

Using the same tools and experts can be particularly helpful when evaluating the impact of the modified code on the remaining simulation. In addition, the User can use the original tests and analyses to obtain additional information to support the final accreditation decision.

However, this is not always possible. When a new Developer is selected or modifications are done in-house, time should be allocated for information acquisition and training. Greater emphasis should be placed on the VV&A effort in this instance because the pedigree information needed for the assessment may be unavailable, incomplete, or unreliable and a greater V&V effort will be required to compensate for this lack of information.

§ § § § § § §