Data Verification and Validation (V&V) for Legacy Simulations

RPG Special Topic

9/15/06[1]

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[1] This document replaces the 8/15/01 version. It contains minor editorial and formatting changes.

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

Introduction

Data verification and validation (V&V) activities are performed to ensure that the input data[2] selected and prepared for use in a specific simulation are appropriate for use in a specific application.

- **Data verification** is conducted to ensure that the data selected are the most appropriate for the application and are properly prepared for the model
- **Data validation** is conducted to ensure that the data accurately represent the real world to be simulated

In simulation, it is virtually impossible to separately evaluate the model being executed from the data used because it is the interaction of data and code that produces simulation results, making both responsible for simulation credibility.

This interdependent relationship between a simulation and its associated data dictates that data V&V activities be considered part of the overall M&S verification, validation and accreditation (VV&A) process [VV&C Tiger Team, 1998; IEEE 1278.4, 1997]. However, because of the specialized nature of data V&V, and particularly because of the large varieties of data subject areas, subject matter experts (SMEs),[3] in particular the data producers themselves, are frequently called upon to assist in the data V&V process.

> Example:
>
> A military simulation will typically involve instance data describing the simulated natural environment, man-made obstacles, weather, force structure, system characteristics, system performance, behavior, command and control, etc.

Regardless of who conducts data V&V activities, they should work closely with those modifying and/or preparing the simulation for use and with those performing M&S V&V activities and the data V&V activities should be carefully documented and included in the V&V report.

Data V&V Activities during Legacy Simulation Preparation

A legacy simulation is one that was developed and used before. Using a legacy simulation has challenges, not the least of which is obtaining and preparing the input data. Input data selection and preparation were accomplished as part of the original

[2] See the reference document on M&S Data Concepts and Terms for additional information.
[3] See the special topic on Subject Matter Experts and VV&A for additional information.

simulation development process. Although the categories of input data selected were based on the needs of the application, the specific data elements and the forms they assume were based on the needs of the algorithms built into the code. Unless changes are going to be made to the algorithms involved, the current application will need to use the same kinds of data and organize and prepare them in the same way. A new application may or may not require modifications to the simulation, but changes in the data are practically inevitable. Data may need to be changed for a number of reasons:

- to represent new scenarios
- to represent new objects or behaviors in the simulation
- to correct or update existing data
- to correct or update existing objects or behaviors
- to change the level of security of the simulation
- to accommodate modifications in the code
- to accommodate changes in the algorithms using the data

The ease with which data can be changed or new data can be added depends heavily on how the data are organized and prepared for use in the simulation and how much information about the data is available. Documentation (e.g., conceptual model, user guides, programmer manuals, development artifacts, database structures, VV&A history) should provide information about the data previously used (e.g., source, definition, quality, classification, V&V history) for all input data. New data would have to be able to accommodate the data organization and structures previously used in order to work in the simulation.

Even data previously used in the simulation must normally be re-obtained from the authoritative data sources because the data sets may not be provided with the simulation. This involves understanding what data are needed, identifying the authoritative sources for each different kind (e.g., terrain, weather, lethality, accuracy, system performance, system characteristics), and preparing the requests for data in the forms needed by the simulation. The example below shows one way this effort can be streamlined.

Example:

The TRADOC Analysis Center (TRAC) Data Request System (TRACDRS) allows the users of a number of legacy simulations (e.g., CASTFOREM, Janus, VIC, Eagle, TACWAR) to request data from the authoritative data sources and receive it in a form appropriate for the simulation involved. It is an automated system used by Army study teams to generate Standard Nomenclature Database (SND) compliant systems lists and scenarios. The study team enters the system names to be used in the upcoming simulation and TRACDRS creates a set of ASCII files that is then sent to the TRAC Data Support Division (DSD) for processing. There, functional area experts (FAE) process the requests, which are either forwarded to authoritative data sources (e.g., the Army Materiel Systems Analysis Activity (AMSAA) for lethality data; Ballistics Research Laboratories (BRL) for accuracy data) or handled in-house.[4]

TRACDRS also provides a set of base case scenarios that can be copied and modified. The study team can browse through the various scenarios and select one to copy and modify or can build a new scenario from scratch. Information about the scenario is captured in six functional areas:[5] weather and terrain, direct fire (armor, infantry, helos and air defense); fixed wing, indirect fire (artillery, SSMs, mortars, rocket launchers), mines, IEW (intelligence and electronic warfare, including UAVs and communications). In addition, target assignments to be made and new systems can be added. Once the scenario is completed, the software automatically checks it to ensure that all systems listed are part of the current SND. If the study team wishes to play unknown or unauthorized systems, they must fill out a formal request and provide descriptions). This is done to ensure that TRACDRS remains consistent with the SND. The new (or modified) scenario's data files are then copied to a classified disk and sent to TRAC-DSD for processing.

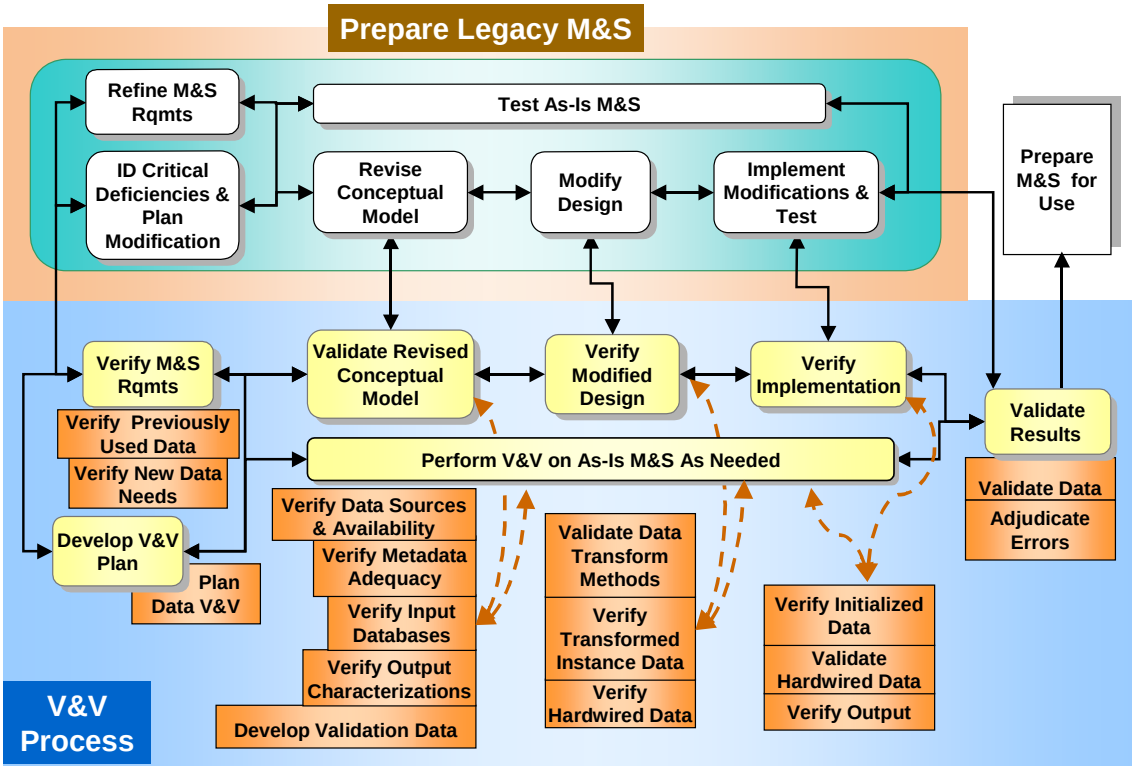
Once the sets of data are obtained, they still need to be reviewed to ensure they are timely, complete, accurate, valid, and appropriate for the current application.

The remainder of this document discusses data-related activities and issues that should be addressed during preparation of a legacy simulation for use in a specific application. The figure below presents a visual depiction of typical data V&V activities overlaid on the V&V process for legacy simulation preparation. Although data-related activities are each shown and discussed in connection with specific legacy preparation phases and V&V activities, these associations merely mark an appropriate opportunity for the data activity to take place.

Because of the sheer magnitude and complexity of the data needed by a simulation, data-related activities should begin as early as possible.[6] In this document, specific data activities are introduced early (i.e., when sufficient information should be available

[4] Direct fire requests are first fed into Direct Fire Pairings Generator (DFPG), which creates a direct fire firer/target matrix. The matrix is then sent through the extraction and surrogation software (TESS) to create the data request for AMSAA.
[5] Additional functional areas are included for specific simulations (e.g., direct fire sensors are needed for Vector in Commander (VIC) and Eagle).
[6] For the TRACDRS discussed in the example, terrain and weather data take the longest to provide and should be requested as early as possible [TRACDRS, 2000].

to begin the activity) rather than tied to specific phases. This approach is taken to emphasize the importance of early action on data V&V.



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Data V&V for Legacy M&S

Refine M&S Requirements

The User, Developer, and M&S PM (when available)[7] establish the M&S environment by identifying constraints based on the simulation re-use, such as resource availability, timelines, etc. and refining the M&S requirements.[8] Part of the refinement process should be identification and definition of the data needs (both input data needs and output data needs) for the given application. Data subject matter experts (SMEs)[9] may be needed to help identify and define these data needs.

[7] In legacy simulation reuse, the presence or absence of a formal Developer and M&S PM depend on the magnitude of the modifications involved. When there are few or no modifications anticipated, the responsibilities of a Developer or M&S PM may be handled informally by the User.
[8] See the special topic on Requirements for additional information.
[9] See the special topic on Subject Matter Experts and VV&A for additional information.

Example:

One method used to capture data needs of the simulation is to prepare a characteristics and performance (C&P) specification. The C&P Specification is a technical document that provides a complete description of needed data, including a set of sample instance data, and can be used for validation of the conceptual model.

Once the input data needs of the application have been identified and defined, the User should begin locating appropriate authoritative sources and collecting candidate data and metadata [VV&C Tiger Team, 1998; IEEE 1278.4, 1997]. For legacy simulations, many of the input data needs should be the same or similar to those of the original simulation. These needs should be articulated in the existing conceptual model. Once it is known which of the previously used input data can be used in the current application, the input data needs are reviewed to determine if new data may also be needed. Like the M&S requirements, data needs are subject to refinement and change as plans are finalized and the conceptual model is reviewed and revised.

Verify M&S Requirements

Verify M&S Requirements: Verify Previously Used Data

When a legacy simulation is involved, it is necessary to determine if previously used data are acceptable to use. If the data sets are available, they can be examined; otherwise, the documentation has to be reviewed. User guides and programmer manuals should provide information about where the data are from and how they are organized and prepared. Additionally, development artifacts (e.g., conceptual model, design documents) should provide information on what specific data are needed and how they are to be used in the simulation. Data V&V histories should indicate whether there were problems with any of the data or if any constraints had been placed on their use. Some issues to address include:

- Are there changes reflected in the current application that may affect how the data are handled in the simulation?
- Do the data characteristics (defined in the metadata) match the characteristics needed for the application? Do they have the correct level of precision and resolution for the application?
- Is the security classification of the data appropriate for the current application?
- Are the data sources authoritative for the current application?

As soon as the data sets are available, they should be reviewed to ensure they are complete and the data are current.

Verify M&S Requirements: Verify New Data Needs

New Input Data Needs

New input data may be required if

- the M&S requirements of the application include new objects, entities, functions, or behaviors that need to be represented
- descriptions of the objects, entities, functions, or behaviors present in the simulation need revision
- the modifications to be made involve changing algorithms that require different data (e.g., converting from a nearest-square line-of-sight (LOS) algorithm to an interpolative solid surface LOS algorithm)
- the current application requires a different level of security than the original (e.g., a simulation previously used in a classified environment is being used in an unclassified training exercise)
- the previously used data or sources are not appropriate for the current application

The V&V Agent and appropriate SMEs should carefully review the specifications of the new data needs to ensure they are sufficient to support the application and are suitable for use in the simulation. The review should determine if the specifications completely characterize the data needed, including data definition, precision, accuracy, resolution, security classification, form, etc.[10] Input data needs are defined not only by what the data should be but what they are expected to do in the simulation. Once the data specifications are shown to be complete, they should be verified to ensure they are consistent and appropriate as defined for the application.

Simulation algorithms should be reviewed to ensure compatibility with the new input data. The simulation's methods of storing and preparing input data should be reviewed to ensure formats are correctly specified for the new data needs.

Output Data Needs

The output data needs of the application are verified to ensure they can be obtained from the simulation. If the output desired cannot be obtained then the User and Developer need to resolve the problem early.

> Example:
>
> The User of a legacy simulation needed to accumulate results from a series of battles. A number of excursions were run and the output data analyzed; however, the results were inconsistent. Further examination revealed that the simulation accumulated data by time step and so the output did not reflect the battle results.

[10] See the Data Quality Templates for additional information on characterizing data.

Identify Critical Deficiencies and Plan Modification

During this task, the Developer, supported by the User, M&S PM, V&V Agent, Accreditation Agent, and SMEs as appropriate, compares the application's refined and verified M&S requirements with the existing design and capabilities of the legacy simulation. Inconsistencies and incompatibilities are ranked according to their importance to the application and decisions are made on how to resolve each (e.g., work-arounds, modification of the M&S requirements, modification of the code, data changes). Questions concerning the data should be handled as described in Review New Data Needs (p. 5).

Develop V&V Plan

Develop V&V Plan: Plan Data V&V

Data V&V activities should be carefully planned to complement the different M&S modification phases and M&S V&V activities. Early detection of data problems (e.g., non-availability, inappropriate fidelity) can have a large impact on the modification design. The V&V Agent should work closely with the Accreditation Agent to identify data-related accreditation information needs and appropriate acceptability criteria. Data V&V tasks that are best suited for providing evidence to support the accreditation decision should be selected. The data V&V plan should ensure that any changes to input data, both hard-wired and instance, and to output data are thoroughly investigated.

Test As-Is M&S

Even if no modifications are needed in the code or hardware, there may still be data issues to resolve. Ideally, data previously used in the legacy simulation can be used because the simulation is already set up to accept them and they have a proven record. However, these data still have to be obtained and evaluated to ensure they are appropriate for use in the intended application (see the section on Verify Previously Used Data [p. 5]). If new data are needed, the User should locate authoritative sources (see the section on Verify New Data Needs [p. 5]). Once acceptable data are obtained, the Developer prepares them for use in the simulation. The existing data structure may need to be modified to accommodate new data or new data sets; similarly, transformation algorithms may need to be devised to convert the data into usable formats for the simulation.

Once the data have been prepared, the simulation should be tested to ensure correct operation. Particularly when new data are involved, regression testing should be conducted to ensure the inclusion of the new data does not have a negative impact on the performance of the simulation.

Perform V&V on As-Is M&S as Needed

Because many existing simulations have little or no V&V documentation, it is often necessary to perform supplemental V&V to satisfy the accreditation information needs. This activity also includes the data V&V activities needed to ensure the data are authoritative, accurate, and appropriate for the application. The specific tasks performed depend on the data issues to be resolved, the availability of data information and data V&V history, and the data changes involved (e.g., different classification, new data).

When data changes are involved, the data sources (p. 9) should be verified and the metadata (p. 9) should be reviewed to ensure they fully characterize the data. Once the data are obtained they should be added to the appropriate data sets (p. 9) and reviewed. The data transformation methods (p. 12) used and all transformed data (p. 13) should be checked for accuracy. Additional data V&V tasks should be performed as needed.

Revise Conceptual Model

The conceptual model of a legacy simulation, when one exists, is a collection of information that describes the original Developer's concept of what capabilities and representations the simulation needs in order to address the M&S requirements and meet the needs of the original application. It is that Developer's perception of what the original User needed. This information includes descriptions of entities, objects, algorithms, relationships (i.e., architecture), and data as well as assumptions and limitations. Many data needs are identified and data selection decisions are made during conceptual model development. When modifications are to be made to the legacy simulation, the conceptual model also needs to be revised. During conceptual model revision, the Developer charged with making the modification should check the status of the associated data by addressing the following issues.

Data Issues During Conceptual Model Revision
• What changes need to be made to input instance data to support specific individual algorithms, functions, and behaviors?
• What changes will be necessary for hard-wired data?
• Do any changes or additions to data affect the desired levels of fidelity for the application?
• Are there any changes in the output data that need to be collected to support the application?

Once candidate data sources for input instance data and hard-wired data have been identified, their data descriptions should be included in the revised conceptual model.

Validate Revised Conceptual Model

The revised conceptual model[11] is validated to ensure that it adequately specifies both physical and behavioral aspects of the problem domain and appropriately traces operational requirements in the emerging design. Data availability and data appropriateness are key considerations during this phase because of their impact on model design. Several data-related tasks that can be done during this phase are described in the following paragraphs.

Validate Revised Conceptual Model: Verify Data Sources and Availability

The existing data sources being considered for reuse should be verified as authoritative (see *Verify Previously Used Data* [p. 5]). As soon as new data source candidates are identified, data source metadata should be reviewed to ensure the sources are authoritative, appropriate for the application, and able to provide the required data in a timely manner.

> Examples:
>
> The authoritative source for helicopter data may be different depending on whether the simulation will be used by the Army or the Navy.
>
> The authoritative source for tank data may be different depending on whether the simulation is to be used in an unclassified training exercise or in a classified, force-on-force combat analysis.

Validate Revised Conceptual Model: Verify Adequacy of Metadata

Once a data source has been verified (i.e., shown to be appropriate and available), the metadata should be reviewed to ensure that they provide the information needed to satisfactorily characterize the data for the given application (e.g., they should be reviewed for data currency and availability, quality assessment history, usage in similar applications, fidelity, and other quality characteristics).

Validate Revised Conceptual Model: Verify Input Databases

If the input databases (i.e., aggregated sets of all the input instance data) are modified, they should be reviewed to ensure that they are adequate and complete and mapped to the algorithms, models, or simulation components in which they are to be used to confirm that they are appropriate for the application.

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[11] See the special topic on Conceptual Model Development and Validation for additional information.

> Example:
>
> For a legacy combat simulation, the input databases should be checked to make sure that attrition data are available for all possible weapon system/target combinations possible in the current application, that terrain maps include all features specified in the application, that systems characteristics are available for all systems, etc.

If new data are involved, a sample input database might be generated to prove that the data producer can provide appropriate data in the proper formats and within the required timeline of the application.

If data or data source problems are discovered, the User may need to decide whether to modify requirements (and revise the conceptual model, etc.), use available data that are not totally appropriate (i.e., accept the risk of reduced credibility), or undertake a data production effort to fill the void. The earlier such a decision is made the better. Once the simulation is designed and built, changes to resolve data problems become much more costly and time-consuming.

Validate Revised Conceptual Model: Verify Output Data Characterizations

The algorithms and models identified for use in the simulation should be examined to ensure they can provide output data to support the needs of the application. This review should include data characterization (e.g., fidelity, format, completeness) as well as methods of collection and preparation.

> Example:
>
> For an application concerned with missile lethality, the missile fly-out model selected for use in the simulation should be able to produce outputs for probability of kill (Pk) values as well as the probabilities of detection, track, engage, and closest point of approach.

Validate Revised Conceptual Model: Develop Validation Data

Even when a legacy simulation is being used as is, the results need to be validated for the current application. Because results validation normally involves comparison of the results of a simulation to a referent (a codified body of knowledge about the thing being simulated based on M&S requirements), validation data describing the referent should be identified and collected or developed. These validation data are compared to the actual simulation output data during results validation.

Ideally, the referent and validation data used in the original validation effort will be part of the V&V history and can be used as a starting point. The original validation data should be reviewed to determine if they are sufficient for the current application. However, in most cases, some changes will have to be made. Any modification to the

code or change to input data may result in changes to simulation output so the corresponding validation data must be reviewed to ensure they are still valid.

Validation data can be obtained a number of ways. Real-world empirical data are best (e.g., physical measurements, test range results, historical records) when available. However, when real-world data are not available, appropriate test scenarios should be developed and SMEs asked to provide reasonable, expected outcomes for the scenarios or use cases to be executed in the simulation [Rothenberg et al., 1997]. One possibility is regression testing. The scenarios or use cases can be executed in the original simulation (before any changes have been made) to establish a baseline. This could limit the need to obtain new validation data to those associated with new M&S requirements or modified areas of the simulation. For more information on referents and results validation, see the special topic Validation.[12]

Modify Design

During the design phase of a legacy modification, the Developer incorporates the necessary modifications into the design artifacts. The design modifications should be based on the information and relationships articulated in the revised conceptual model and address all the code and hardware modifications designated in the modification plan. The preliminary design is modified to assign the new M&S requirements derived from the conceptual model to hardware and software configuration items. The detailed design should be modified to allocate requirements to software components, the identification of the specific data sets and elements to be used, and the definition of interfaces among components and external systems.

Although data identification and selection processes should be initiated as early in the modification process as possible (e.g., during conceptual model development), they can continue throughout this phase. Additional considerations focus on how to prepare the selected data for use.

- For **hard-wired data**, considerations include selecting an appropriate format (e.g., floating or integer) and degree of accuracy (e.g., should (pi) be represented by 3.14, 3.1416 or 3.141592?) to meet the needs of the simulation and then documenting the rationale.
- For **input instance data**, a major concern is determining what form the data are available in, what form the model needs the data to be in, and the best way to make the transformations. In most situations, instance data will have to be transformed from their original state. Appropriate transformation techniques should be selected (or developed) and validated.

[12] See the special topic on Validation for additional information.

Examples:

Converting all rates of speed to kilometers per hour, all ranges to kilometers

Converting the probabilities of acquisition, shot, hit, and kill into a single-shot kill probability

Aggregating kills of individual classes of targets by individual classes of weapon systems over time into a overall kill probability

- For **output instance data**, a major concern is ensuring the design (i.e., algorithms, code, interfaces) can produce, collect, and store the desired output data. In many situations, output data have to be transformed (e.g., aggregated, combined) to produce usable results. Whether data collection occurs external to the model or not, appropriate transformation techniques should be selected (or developed) and validated during design to make sure that proper collection is possible.

Verify Modified Design

The focus of design verification is to ensure that all features, functions, behaviors, and interactions defined in the revised design can be traced back to the requirements expressed in the revised conceptual model and that all requirements expressed in the conceptual model are articulated in the design. The primary data-related V&V activities associated with design verification are described in the paragraphs below.

Verify Modified Design: Validate Data Transformation Methods

The techniques used to prepare data for use in the simulation and those used to collect output data are examined to ensure they maintain their accuracy, fidelity, and integrity throughout the transformation. Input data are seldom provided in the format needed by a simulation and they normally have to undergo some form of transformation to be used (e.g., conversion of units, change of precision, interpolation, aggregation). Raw output data are normally collected based on the needs of the application (e.g., system kills by weapon system per event; system losses by time step) and stored in output databases. When changes have occurred to either the data or the transformation techniques,

- algorithms and techniques used to prepare each input instance database should be assessed to ensure that the transformation occurs correctly and is appropriate for the simulation
- methods used to collect and prepare output instance data, whether internal to the model or not, should be assessed to ensure that they can collect and transform data properly for the application

Existing techniques used to prepare previously used data should need little attention if the data V&V histories are adequate and nothing has changed either the data or the data uses; however, any techniques (existing or new) used to transform and prepare

new data should be tested. Output data collection methods should be checked to ensure they do collect and prepare output data as needed for the current application.

Regression testing is one technique that can be used in this task[13]. Generally, this activity does not investigate the validity of the output instance data; rather, it focuses on the validity of what has been done to the data.

Verify Modified Design: Verify Transformed Input Instance Data

This activity assures that transformed input instance data correspond to the original intent and are in appropriate form for use in the simulation. The producers of the original input instance data may serve as SMEs during this activity. Transformed output instance data should be traced to their origins to ensure they have been properly collected. Their characterizations should be verified to ensure that they provide appropriate, usable results. Again, previously used data undergoing the original transformations with no changes to either should need little attention as long as their V&V histories are satisfactory.

Verify Modified Design: Verify Hard-wired Data

Hard-wired data are considered separately because typically they are independent, single instances of data or fixed constants to be used in specific algorithms. They should be verified in conjunction with the algorithms in which they are placed. Specific tasks include

- ensuring that the data have been obtained from an authoritative source
- verifying that the data, when transformed into the form required for use in the simulation, are appropriate for their intended purpose
- ensuring that any deviations from the required data are corrected or at least documented

Hard-wired data values are specific values selected for the original application. They should be verified to ensure that their specific values are still appropriate for the current application.

Implement and Test Modifications

During this phase, the modified legacy design is realized in code using actual hardware and data. The components or modules are built, tested, and integrated. The actual input instance data sets are initialized and tested.

[13] See the reference document on V&V Techniques for more information.

Verify Implementation

Requirements are traced to the implemented software components, individual algorithms and components are tested to ensure that they perform as designed, and data/code relationships are reviewed for appropriate operation.

Verify Implementation: Verify Initialized Data

The initialized data sets (i.e., the aggregated sets of transformed input instance data, in their initialized or start-up state) are checked to ensure that the transformed data continue to correspond to their in their originating forms, have been transformed as intended, and have maintained the accuracy, fidelity, and integrity required for the intended use.

Verify Implementation: Validate Hard-Wired Data

Hard-wired data are evaluated separately because they typically consist of individual fixed constants used in specific algorithms or formulas. They should be validated along with the algorithms into which they are placed. Hard-wired data can be checked by executing the associated individual algorithms to ensure that they execute properly and provide appropriate output when compared with validation data (p. 10) (i.e., the expected performance). In legacy simulation, regression testing may be used to establish a baseline. Any deviations should be assessed to determine the cause (i.e., statement or execution of the algorithm, hard-wired data, or validation data) and recommendations made to resolve the problem.

Hard-wired data values are specific values selected for the original application. In legacy simulation, validation of the original hard-wired data is particularly important to ensure that their specific values are still appropriate for the current application.

Verify Implementation: Verify Output Data

The code implementing individual algorithms and models should be examined to ensure that these algorithms and models provide output data to support the needs of the application. This review should include data characterization (e.g., fidelity, format, completeness) as well as methods of collection and preparation.

> Example:
>
> For an application concerned with missile lethality, the missile fly-out model used in the simulation should be executed and the output examined to ensure that it includes the necessary data categories (Pk, closest point of approach, etc.) and that the values produced for each category are accurate and usable.

Validate Results

Results validation is conducted to determine the extent to which the simulation addresses the requirements of the application. Because the data and the simulation are inextricably intertwined (i.e., if one is not valid, then the validity of the other cannot be demonstrated), their validations are usually conducted in concert. It is perhaps better to think of the simulation as being calibrated - its performance observed, known, and understood within the range of data values under which it is intended to operate.

This activity examines the extent to which the simulation, driven by valid input instance data, can provide appropriate responses when exercised in the context of the application. Individual components or modules are executed to ensure appropriate performance and output. Additional testing is done as the components are integrated. Ultimately, the complete simulation is executed and the resulting data are compared to the validation data (p. 10) to determine if the simulation is producing credible, appropriate answers.

Validate Results: Validate Data

Concurrent with testing and validation tasks, the impact of the input data on the performance of individual components and on the integrated simulation is assessed. For each validation test, key data elements should be tracked to ensure appropriate output. Sensitivity excursions can be run to test boundary conditions on key data elements to assess the impact of data ranges on model output. Regression testing can be conducted to identify improper inconsistencies with the baseline. Data validation can also be conducted incrementally. For example, the terrain database for a battle simulation can be validated before battle entities and objects are added.

Data validation is performed to ensure that input data are appropriate for use in a particular simulation for a specific application. All data used to drive a model are subject to validation; however, the sheer quantity of data may make this impractical given cost and schedule constraints. Careful planning is needed to identify and prioritize key data components -- those data that most directly impact the performance of the model for the application.

Validate Results: Adjudicate Errors

Discrepancies between simulation outputs and the validation data are examined to determine probable cause. Errors can result from problems with the code, input data, output data, validation data, or a combination of any of these factors, and it is important to determine the cause. The divergent output should be retraced through the code, key algorithms, and input data. Sensitivity excursions may be needed to isolate the error. When the culprit has been identified, the information is recorded and recommendations made to eliminate the problem.

Prepare M&S for Use

When all errors identified during testing and validation are adjudicated and/or eliminated, the User accredits the simulation. At this point, the integrated model is ready for its intended use.

References

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IEEE 1278.4: Recommended Practice for Distributed Interactive Simulation -- Verification, Validation, and Accreditation, Annex C, "Data Verification, Validation, and Certification," 1997.

Rothenberg, Jeff; Walter Stanley; George Hanna; Mark Ralston, Rand Project Memorandum PM-710-DMSO, August 1997. This report offers an outstanding theoretical foundation for data verification and validation. It includes a data VV&C (verification, validation and certification; i.e., data V&V) process model and lists considerations for structuring individual data V&V efforts with different kinds of data. It also provides a guide for planning both producer and user V&V activities.

U.S. Army Modeling and Simulation Standard Algorithms For Terrain and Dynamic Environment, TRADOC Analysis Center – Fort Leavenworth (TRAC-FLVN), 30 September 1997.

TRAC Data Request System Version 2.3 User's Manual, TRADOC Analysis Center – Fort Leavenworth (TRAC-FLVN), Data Support Division (DSD), February, 2000.

RPG References in this Document:

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

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