



DEPARTMENT OF THE NAVY
COMMANDER OPERATIONAL TEST AND EVALUATION FORCE
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NORFOLK, VIRGINIA 23505-1498

COMOPTEVFORINST 5000.1A
Code 83

SEP 9 2004

COMOPTEVFOR INSTRUCTION 5000.1A

Subj: USE OF MODELING AND SIMULATION (M&S) IN OPERATIONAL TEST (OT)

Ref: (a) SECNAVINST 5200.40
(b) DODINST 5000.61

Encl: (1) Typical Elements of a Modeling and Simulation Program

1. Purpose. The purpose of this instruction is to provide policy and process for COMOPTEVFOR to increase the potential benefit of M&S through the early planning, organizing, and execution of credible M&S programs to support OT, per reference (a) and (b).

2. Cancellation. COMOPTEVFORINST 5000.1

3. Background. This policy applies to all test assets, test planning aids, and post-test analysis tools that substitute for the time varying characteristics of the system under test, supporting forces, the threat, other forces, or the battlespace environment for an operational test event or a developmental test or other event used to support operational test and evaluation.

a. M&S comprises a subset of the possible test assets available for conducting OT. The line of demarcation between what is and is not a "simulation" is unclear at best. At some level, every test asset we use is a simulation. We do not conduct OT in real environments against real threats operated by hostile forces. Even the idea of a system under test (SUT) being "production representative" is a matter of interpretation and judgment. What is important about all test assets, whether an operations order for an Orange Force unit, a missile seeker being tested, or a virtual electromagnetic environment, is that the appropriate facets of the real-world test assets being replaced are represented well enough to generate the combat interactions that are being monitored for the evaluation of combat effectiveness of the SUT. For M&S to play a role in OT, it must be credible with the tester and stand up to oversight. Because virtual test assets are not as easy

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for the tester to intuitively assess for appropriateness as physical ones are, it is imperative that a well documented, understandable procedure be in place to characterize the use of modeled or simulated data in OT.

b. The accreditation of a model or simulation is the official certification that the results of that model or simulation are appropriate for its intended use. To make this assessment, two primary knowledge bases are required: verity and validity. According to ref (b) verification and validation are defined as:

(1) Verification is the process of determining that a model implementation and its associated data accurately represents the developer's conceptual description and specifications.

(2) Validation is the process of determining the degree to which a model and its associated data is an accurate representation of the real world from the perspective of the intended uses of the model.

c. In short, the primary questions that support accreditation are, "Did I build the right model?" and "Did I build the model right?" In addition to the technical merits of the M&S application, it is essential to ensure that the application will be employed properly. This includes assessing its configuration management, operator manning and training, the availability of required hardware and data resources, and the knowledge base needed to interpret its results.

d. A well defined approach for M&S development facilitates the accreditation process and is in keeping with those policies advocated by the Office of the Secretary of Defense and the Secretary of the Navy. This approach includes the establishment of the use cases for the M&S applications and the accreditation criteria that support those intended uses. Accreditation is supported by the specification of the verity and validity required for the applications to serve as test assets, and the planning necessary to build, configuration manage, characterize, and assess the utility of the applications.

5. Responsibility. This instruction covers all M&S used to supplement OT or to produce DT data that is used as entry to OT criteria. The following responsibilities are assigned:

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a. Commander, Operational Test and Evaluation Force

(1) Provide policy and guidance for the intelligent application of M&S in OT.

(2) Accredit the use of M&S outputs to resolve critical operational issues (COI) during operational evaluation (OPEVAL) or follow-on operational test and evaluation (FOT&E).

b. Assistant Chiefs of Staff, Warfare Divisions (ACOS(W))

(1) Provide an assessment to COMOPTEVFOR of impacts to the test program of using M&S data to resolve COI during OPEVAL or FOT&E.

(2) Accredit the use of M&S data to assess COI used in tests other than OPEVAL and FOT&E.

c. Operational Test Coordinators (OTC)

(1) Assess whether appropriate program resources have been allocated and applied to M&S application development, management, and use to mitigate the risk of using M&S data in the OT program. This risk includes the use of M&S data in DT that supplements OT, or satisfies an entry to OT criterion.

(2) Make recommendations to the ACOS(W) on the program viability of M&S applications for use in OT.

d. Operational Test Directors (OTD)

(1) Manage the use of M&S as a test asset for the conduct of OT.

(2) Make recommendations to the ACOS(W) on the appropriateness of M&S applications to support the resolution and assessment of COI in OT.

e. Modeling and Simulation Manager (MSM)

(1) Manage the use of M&S applications to support OT across the command.

(2) Provide direct support to the ACOS(W), OTC, and OTD in executing the policy, responsibilities, and processes relating to the use of M&S in OT.

(3) Review M&S program data requested from PM for rigor and relevance to the application's intended use within OPTEVFOR.

(4) Make recommendations to the ACOS(W) on the technical soundness of M&S applications with respect to programmatics and appropriateness for use to support OT.

(5) Maintain the corporate knowledge on the use of M&S to support OT and apply that knowledge to improving the policies and processes at OPTEVFOR.

(6) Work with the command's Staff Editor to maintain and update formats for M&S process documentation in the command's OT&E Reference Library directory, OT&E Formats folder and to update and maintain detailed instructions for completing the formats in the Modeling and Simulation folder.

6. Policy

a. Accreditation approval by COMOPTEVFOR will be obtained a minimum of 120 days prior to commencement of the phase of OT it is intended to support unless otherwise specified in the Test and Evaluation Master Plan (TEMP).

b. OPTEVFOR does not lead the M&S effort, but will participate by generating OT acceptability requirements and providing operational insight at both technical and management review meetings. OPTEVFOR will establish and assess accreditation criteria for all use of M&S in OT. OPTEVFOR may assist the program office in the development of other accreditation criteria for the M&S for the purposes of coordinating the overall verification, validation, and accreditation effort. This coordination shall include OPTEVFOR's scrutiny of DT and other data used as entry to OT criteria or otherwise in support of OT.

c. Use of M&S as a test asset will be identified in test and evaluation strategies (TES), TEMPs, and test plans. OPTEVFOR OTCs, OTDs, and analysts shall provide specific accreditation criteria for the use of M&S test assets in OT to the Program Manager (PM). This will support proper planning to

fund work completion for testing in a timely manner. The COMOPTEVFOR M&S accreditation decision shall be scheduled sufficiently ahead of the test event to allow alternative approaches to test to be implemented in case of nonaccreditation. In order to meet this requirement, the PM must provide sufficient verification and validation (V&V) information in time to support the accreditation. PMs are encouraged to submit V&V information incrementally as adequate data becomes available to answer individual accreditation criteria.

d. As early as possible within the acquisition process, the PM and COMOPTEVFOR should cooperatively determine the sufficiency of assets and resources for test. Early involvement, proper identification of simulation requirements (including programmatic, operational, and performance requirements), and close coordination with the program office are essential to the development of a functional model for OT&E uses. M&S intended uses should be included in the test and evaluation management process as soon as possible. Establishing the high level requirements and working toward more detailed descriptions as details of the program unfold should be the norm.

7. Process

a. Where M&S is to be used as a test asset, the OTD shall describe the scenario by creating a capability model as described below to explicitly describe the interactions among SUT, the threat, and the Environment. This model will be used to allocate test assets including M&S for the event. The relevant interactions to be tested will be identified and used to drive the establishment of accreditation criteria. The elements of the capability model are:

(1) Combat Interactions. The interactions that occur between the SUT and the threat in the combat environment drive the scenario, and consequently drive the use of M&S to support OT. COIs are the top level view of the combat interactions, with measures of effectiveness (MOE) characterizing SUT to threat interactions and SUT internal interactions. Subordinate to the MOE will be the data elements necessary to evaluate the MOE. The OTD must produce a hierarchical description relating COI to data.

(2) SUT. The system, as a whole, must be identified and the relevant component parts of the system specified. For every MOE there should be at least one SUT element identified. The distinction between Blue Force elements that are part of the SUT and those that are part of the supporting environment for the SUT has a significant impact on the standards to which they must be represented in the test.

(3) Threat. The threat, for the purposes of the capability model, includes all elements of the combat problem that inhibit the capability of the SUT to carry out its mission. Neutral entities may be considered part of the threat, not inasmuch as they are hostile or belligerent, but from the standpoint that SUT or Blue Force supporting effort must be focused on their protection.

(4) Environment. The environment encompasses the rest of the battle problem that is relevant to the SUT or threat. The elements of the environment are those that directly interface with the elements of the SUT and threat, or affect the combat interactions. Elements of the environment must be explicitly associated with the interactions that they affect.

(a) Physical. The physical elements of the battlespace are all of the factors not belonging to either force that influence the combat interactions. These typically include specifics on location, force geometry, geography, hydrography, and weather.

(b) Cognitive. Cognitive elements include SUT and threat doctrine, operations, training, and human performance factors for all forces. The support elements for either force (such as logistics or intelligence) that are not directly involved in the combat interactions are considered part of the cognitive environment.

b. When M&S is desired to represent an element of test, as identified above, the capability model forms the basis for establishing accreditation criteria. Using the formal description of the test event as a reference, the MSM will assist the OTD in developing the accreditation criteria for the M&S application as described below:

(1) Identify which elements of test are being represented by the M&S application. This may necessitate

dividing SUT, threat, or environment elements into subcomponents and specifying/allocating interactions to the subcomponents. These elements form the functional system description for the M&S application.

(2) Identify the MOE associated with elements of test to be represented as well as the COI under which they fall. Evaluating these test elements is the intended use of the M&S application.

(3) Identify the data elements of the functional system description that are necessary to evaluate the MOE and COI listed in the intended use. These elements form the M&S observables, a subset of the M&S outputs. Identify the interactions associated with elements of the functional system description other than the intended use. The data required to characterize these interactions forms M&S *constraints*. Together, the M&S observables and the M&S constraints form the *validation* data set.

(4) Consider each pairing of an observable and a constraint. Determine where a behavior of the element in the functional system description relates an observable to a constraint. This set of behaviors forms the conceptual model that must be verified for the M&S application.

(5) The elements of the validation data set and the conceptual model behaviors comprise the *accreditation criteria*. Each criterion must be assigned a threshold that will describe the expected values of the M&S outputs and characterize the acceptable deviation from those expected values. In setting the thresholds, consider each criterion within the context of the COI that it supports. The COI must be considered in the context of the Navy management decisions that it will support. The threshold for a criterion must be set sufficiently high so that when Navy leadership considers the evaluation of its COI, appropriate decisions can be made. The threshold should not be set so high that work will be conducted by the developers, operators, and analysts for the M&S application that will not contribute to the quality of the decision made by Navy leadership.

c. M&S Accreditation Letters. M&S accreditation letters are issued by the accreditation authority and may include an M&S

accreditation assessment report. The M&S accreditation decision letter confirms that the M&S is adequate and credible for the intended use.

(1) OPTEVFOR will report on the adequacy of the M&S to support each MOE and COI specified in the accreditation criteria. OPTEVFOR will address the impact on the test strategy of each failure to support the evaluation of an MOE or COI.

(2) Accreditation is not an end state; thus, the accreditation letter must address any continuing requirements for the use of the M&S application including, but not limited to, configuration control of the application, manning and operating requirements for the application, analytical requirements for using the data generated by the application, additional V&V requirements, and post-use regression testing requirements.

(3) The MSM will receive the PM V&V data and provide an assessment of the technical soundness of the package to the OTC and OTD. The OTC will provide the ACOS(W) with an assessment of the programmatic capability to support the M&S for use in OT. The OTD will provide an assessment of the appropriateness of the M&S application for use as a test asset for the OT event. The ACOS(W) will accredit the simulation or provide an accreditation recommendation to COMOPTEVFOR, as appropriate.

d. Demonstration. The degree to which the performance of the simulation must be demonstrated to support accreditation is fundamentally different than the standard of performance that is to be demonstrated. With the shift from characterizing the relevance of the simulation to OT to characterizing the quality of the simulation comes a shift in responsibility from the OTD and OTC to the MSM. The MSM will determine the level of demonstration that is acceptable for the accreditation criteria and communicate it to the PM. During the development of the V&V plan, OPTEVFOR will establish the minimum fidelity requirements for the V&V data that can support accreditation for OT. These requirements include acceptance of the V&V techniques to be used, their method of application, and the degree of observation required to build confidence in the V&V results to be assessed for accreditation.

e. Model/Simulation Development Resources. These resources to support DT and OT uses must be identified as early as

possible to enable the program to budget appropriately. Resources should reflect the financial and material requirements for accreditation as well as the technical expertise required to develop, manage, operate, and apply the results of the M&S application. The OTC will ensure that adequate responsibilities are identified in the TES and adequate resources are allocated in the TEMP to ensure that M&S applications produce credible data for use in OT and DT events that support OT. The MSM will provide assessments of the technical soundness of the program's approach to satisfying these requirements. Common concerns to consider are:

(1) Compliance with high level architecture requirements or resources to obtain waiver as required.

(2) Other proprietary programs (not free) generating and supplying interfacing data as input to the M&S (such as environmental, threat simulations, and models embedded within larger models).

(3) Computer equipment, to include network bandwidth and paths.

(4) Facilities and ranges.

(5) Computer/simulation run time.

(6) Laboratory/other tests that support model validation.

(7) Contractor and/or government model development Personnel.

(8) Configuration management.

(9) Supervisory personnel.

(10) Documentation (plans/reports/correspondence, etc.).

(11) Time and travel expenses for members, including OPTEVFOR representatives, of M&S application management teams.

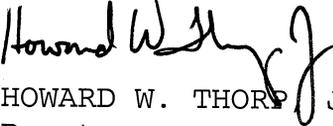
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(12) Contractors/lab time for assisting accreditation authorities in collecting and developing necessary information and documentation for formulating an accreditation decision prior to the use of M&S.

(13) Cost for government to obtain ownership rights to the simulation(s) or licensing fees.

(14) M&S accreditation support agents.

f. Lessons Learned. OTDs and OTCs are directed, and PMs are invited, to submit M&S lessons learned after each use of M&S as a test asset. The MSM will maintain and integrate improvements gleaned from lessons learned during application into COMOPTEVFOR process and policy.


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Distribution: (COMOPTEVFORINST 5216.2Q)
List I, II

Typical Elements of an M&S Program

The following information illustrates many of the important elements of well-structured M&S application development programs.

1. Modeling and Simulation Support Plan (MSSP). The MSSP is the overarching M&S document and is singularly most responsible for ensuring that the model development is a controlled process. It should document the procedures for development, implementation, changes, and V&V, as well as specifying any independent V&V required. The typical elements found in a comprehensive MSSP include application owners and customers, intended uses, constraints of use, embedded model descriptions, schedules, design standards, test planning, documentation development, and expertise requirements for operation. The MSSP should address model development from managerial and technical perspectives. The MSSP should ensure that a disciplined change control process and review is in place to continue validation of the model or simulation as additional data are collected.

2. Configuration Management Plan (CMP). The CMP should address the scheduled delivery of and functional dependencies between hardware, source and object code, documentation, and interfaces with other models/simulations for all versions of the M&S application. Typical CMP items include:

- a. software status accounting procedures
- b. handling of changes to requirements
- c. managing requirements changes
- d. control points and reviews within the process

3. V&V Reports. M&S V&V reports are the foundation for M&S accreditation. Early model development discipline and periodic formal review should help ensure that relevant information about the performance of the simulation is demonstrated, captured, and documented in an efficient manner.

4. Simulation Management Board (SMB). The SMB is the principal entity for the development of simulation management policy and its implementation. Depending on the projected scope of the M&S, one or more SMBs may be required to support the overall effort. The SMB must be responsible as the PM's and user's agent for dealing with activities outside of the program that are involved in M&S component development or integration. Typical duties include:

- a. Develop the MSSP and accreditation plan.
- b. Establish and charter a simulation control panel (SCP) of technical experts.
- c. Maintain program-wide oversight, provide recommendations, and take appropriate actions to ensure proper execution of simulation management objectives and policies as defined by the M&S users.
- d. Coordinate, resolve, and disseminate resolution of technical issues affecting authorized simulations.
- e. Serve as the user representatives in discussions of model or simulation content and methodology for all program-related M&S.
- f. Maintain the M&S archive (PMS and Navy modeling and simulation offices per reference (a)) and ensure retention of documentation.
- g. Update the M&S database (if one is maintained by the program).

5. Simulation Control Panel. SCPs are responsible for providing technical support to the SMB and for reviewing and recommending to the SMB simulation products for certification (certifies ready for DT and/or OT accreditation). Ideally, the SCP is a group of independent technical experts scrutinizing the operating details of the model or simulation in conjunction with

internal program experts. The SCP should periodically review the model for accuracy of the approach, use of algorithms, applicability of data in use, software development (as applicable), hardware in use (as applicable), etc. Typically, the SCPs are responsible for:

a. Providing a recognized channel for technical review and technical approval of simulations and supporting documentation.

b. Reviewing simulation products and processes.

c. Recommending to the SMB, as appropriate, simulation certification with attached specific applicability of use for which the model or simulation is valid.

d. Providing periodic model status, plans, schedules, and other reports as required to the SMB.

e. The selection, review, and distribution of program or National Institute of Standards and Technology certified reference simulations, models, databases, and check cases, as required.

f. Maintaining specific certification requirements for simulations within their purview.

g. Providing V&V plan and report guidelines to the M&S developer (contractor or government laboratory).

h. Developing and forwarding a V&V assessment report to the SMB for review and approval.

6. M&S Proponent and M&S Developer. The M&S proponent is ultimately responsible for model development and gathering the information necessary to support an accreditation decision and submitting that information to COMOPTEVFOR. The M&S developer is usually contracted (funded) by the M&S proponent to develop plans, code the models, and provide other support for the users - typically contractors, government laboratories, or other

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research organizations. Typical responsibilities of the M&S developer are:

- a. Develop a CMP.
- b. Update M&S according to latest M&S requirements.
- c. Develop and execute the V&V plan.
- d. Develop the V&V reports for DT, OT, and other intended uses.