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Enhancing Operational Realism in Test & Evaluation

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The Test & Evaluation (T&E) community likes to talk about realistic operational testing. Today, weapons systems are being rushed overseas to face the real test in real — not realistic — operations. Our nation is at war and T&E must do all it can in support. Rapid acquisition is a worthy response, and finding failure modes early is an obvious way to avoid delay when problems are discovered, avoid costly rework for the fix, or preclude fielding systems with problems. There are examples:

- The Stryker Mobile Gun System's coaxially mounted 7.62-mm machine gun. In predeployment testing, the system appeared to function satisfactorily. Yet, when handed off to troops and fired in new equipment training, the machine gun's bore-sight failed.
- Two air weapons systems: Small Diameter Bomb, and Joint Air-to-Surface Standoff Missile. Both deployed systems were grounded. The weapons systems were under-designed, not tested for realistic operational tempo, and experienced unacceptable reliability and related operational performance failures.
- The MH-60S Armed Helicopter Weapons System. Hellfire missiles hanging from external launchers — forward of and level with the open cabin doors — created a hazard for the helicopter's GAU 21 gunner. In a post OT training incident, blast from a Hellfire broke pins securing the gun and forced the gun barrel around, causing it to pierce the fuselage. If the gunner had been in contact with the weapon, results could have been catastrophic.

In the above examples, more realistic test environments and operations would have enabled discovery of the problems. The need to find problems earlier is recognized inside and outside the Department of Defense (DoD). DoD promulgated T&E policy changes in a December 22, 2007, memorandum (reprinted in the appendix following this article and available at https://akss.dau.mil/Documents/Policy/TE-Policy-Memo-Dec-2007.pdf). The goal of this policy is "early identification of technical, operational, and system deficiencies, so that appropriate and timely corrective actions can be developed prior to fielding the system." The leverage of finding problems early in system design is obvious, but unfortunately we often discover problems late, even after production commitments have been made. In this issue Darlene Mosser–Kerner explains the new policy and its impact on revitalizing T&E.

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The need to find problems earlier is recognized outside the Department of Defense. The basis for the new T&E policy is a DoD Report which cites recommendations by the Government Accountability Office, Defense Acquisition Performance Assessment, and National Research Council. The report recommended that DoD: lessen dependence on testing late in development; consolidate Developmental Testing (DT) and Operational Testing (OT); and, require DT to have an operational perspective. In all instances, the implied goal is early identification of operational failure modes and system deficiencies.

At the same time, Dr. Charles McQueary, Director for Operational Test and Evaluation (DOT&E), established a priority: "Enhance operational realism in early tests, including DT." ITEA should be praised for selecting this theme for *The ITEA Journal*.

The DOT&E desired end-state is, "Sufficient operational insights gained prior to design reviews and acquisition decision points to influence system design and reduce surprises in operational test." As Dr. McQueary stated in his guest editorial in the September 2007, ITEA Journal: "OT&E should be a time of confirmation, not discovery." The focus of employing operational realism in early tests is on designing the system to operate effectively in the environment (with threat conditions) and with the system operators and maintainers anticipated when the system is deployed.

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Operational realism may be easiest to imagine when thinking about system level tests — when the system or a prototype is available. But operational realism has a role very much earlier during design, when components, subsystems, and operational procedures are chosen.

What does it mean to include operational realism in testing early? Enhanced operational realism should be part of demonstrating technology readiness. Often, systems enter design and development at Milestone B (MS B) with insufficient technology maturity. Public law (PL 109–163, Section 801) now requires the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) to certify technology has been demonstrated in a relevant environment. This certification could add discipline to acquisition guidance calling for demonstrating Technology Readiness Level 6 prior to MS B, i.e., demonstrating the technology in an operationally relevant environment before MS B. Testers should be involved in the technology demonstration, and influence the characterization of the "relevant environment" so that it is both operationally relevant and consistent with subsequent testing.

Operational realism in early testing should mean that components are tested in a relevant environment. For example, the vibrational environment on the center pylon of the F-15 necessitated major redesign of the original AMRAAM missile because no one characterized that acoustic environment and tested the components and system in those conditions. Typically, designers assume the systems with which they interface are characterized by the design specifications of the item in development. Often the truth in the field is different. For example, electrical power is often "dirtier" (noisier) than specified. Testing system components in a realistic environment — under realistic stress — can save substantial system development time. Dr. Cliff Duncan, the second Director for OT&E, once told me that with avionics he found the first places to look for trouble were in the behavior of the power supply and the connector. Shouldn't that be the first place we test components too?

Enhanced operational realism should be part of determining whether commercial-off-the-shelf (COTS) technology, software, or system components will actually perform as needed when in real operations. COTS functionality can be highly desirable but a key question is: does COTS performance hold up in operations? Obviously, the military environment can be more demanding. System designers should step up to the challenge of assessing COTS in the operational environment. Testers are obligated to identify COTS risks by testing it, early, in the proper environment.

Enhanced operational realism means we need to employ real operators to operate the system. We have had cases where equipment that was effective when used by other nations, was not so effective when our forces used it. Part of the reason was that another country could man the system with highly educated soldiers who understood much of the basic chemistry that impacts system operation. You may have heard stories of systems failing because the operator used them inappropriately. The first operational test of the SINCGARS radio had to be stopped. Soldiers when ordered to move the radio grabbed it by the antenna — which broke — leading to a mission failure. The radio did not have a handle. The point is, include those operators early so we will understand differences between the systems operated by system developers and warfighter operators.

Enhanced operational realism also means that all the interactions and interfaces that have to work for a mission to be successful are checked before the design is finalized. More general than connectors and power supplies, the age of net-centric operations and service oriented architectures requires sharing data and coordinating activity of separately developed services. If "n" services must work for mission success, and each service has a probability of success "x," then — to a first approximation — the mission will have a probability of success of only x^n. For example, if you have six services that have to work, and you only want 0.8 chance of success, then each service has to exceed 0.96 probability of success! That does not consider the case when the services are correlated, but they will be. Service oriented architectures will require more unit level testing, much more regression testing, and lots of end-to-end testing. It will be essential in testing a new service that simulated inputs from other services be realistic.

So, it is important for testers to enhance operational realism in T&E in every way they can imagine. Operational realism in early T&E can improve the chances of success in rapid fielding and in OT. It is a way we can better support our deployed forces. ❑

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MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Test and Evaluation Policy Revisions

The fundamental purpose of test and evaluation is to provide knowledge to assist in managing the risks involved in developing, producing, operating, and sustaining systems and capabilities.

T&E measures progress in both system and capability development. T&E provides knowledge of system capabilities and limitations to the acquisition community for use in improving the system performance, and the user community for optimizing system use in operations. T&E expertise must be brought to bear at the beginning of the system life cycle to provide earlier learning about the strengths and weaknesses of the system under development. The goal is early identification of technical, operational, and system deficiencies, so that appropriate and timely corrective actions can be developed prior to fielding the system. Consequently, to achieve this goal we have decided to immediately implement the following policies:

- Developmental and operational test activities shall be integrated and seamless throughout the system life cycle. As technology, software, and threats change, follow-on T&E should be used to assess current mission performance and inform operational users' during the development of new capability requirements.

- Evaluations shall include a comparison with current mission capabilities using existing data, so that measurable improvements can be determined. If such evaluation is considered cost prohibitive the Service Component shall propose an alternative evaluation strategy.

- T&E should assess improvements to mission capability and operational support based on user needs and should be reported in terms of operational significance to the user. Consequently, evaluations shall be conducted in the mission context expected at time of fielding, as described in the user's capability document, and consider any new validated threat environments that will alter operational effectiveness.

- To maximize the efficiency of the T&E process and more effectively integrate developmental and operational T&E, evaluations shall take into account all available and relevant data and information from contractor and government sources.

- Operational evaluators will continue to fulfill their statutory roles in providing assessments of operational effectiveness, operational suitability, and survivability to the MDA. In addition, program managers shall report the results of completed developmental testing to the milestone decision authority at milestones B and C. The report shall identify strengths and weaknesses in meeting the warfighters' documented needs based on developmental evaluations. The operational evaluators assessment will be provided to the MDA at the full rate production review.

- To realize the benefits of modeling and simulation, T&E will be conducted in a continuum of live, virtual, and constructive system and operational environments.

These policies will be incorporated in the next revision to DoDI 5000.2.

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