*Invited Article*

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# Defense Science Board Task Force Developmental Test and Evaluation Study Results

**Pete Adolph**
Task Force Chairman
**Christopher DiPetto**
Office of the Under Secretary of Defense for Acquisition,
Technology and Logistics,
Task Force Executive Secretary
**Ernest Seglie, Ph.D.**
Office of the Director,
Operational Test & Evaluation,
Task Force Executive Secretary

*This article summarizes the results of a Defense Science Board (DSB) Task Force study of Developmental Test and Evaluation (DT&E) (Department of Defense, May 2008), which was conducted in 2007 and early 2008. The purpose of the study was to investigate the causal factors for the high percentage of programs entering Initial Operational Test and Evaluation (IOT&E) in recent years which have not been evaluated as both operationally effective and operationally suitable. The following is a summary of the specific issues which the Task Force was asked to assess:*

- *Office of the Secretary of Defense (OSD) organization, roles, and responsibilities for Test and Evaluation (T&E) oversight. Recommend changes that may contribute to improved DT&E oversight, and facilitate integrated T&E;*
- *Changes required to establish statutory authority for OSD DT&E oversight. Recommend changes to Title 10 or other U.S. statutes that may improve OSD authority in DT&E oversight;*
- *Many IOT&E failures have been due to lack of operational suitability. Recommend improvements in DT&E process to discover suitability problems earlier, and thus improve likelihood of operational suitability in IOT&E.*

**Key words:** Acquisition Reform; acquisition workforce; developmental testing; integrated testing; operational reliability; suitability failure.

In recent years, there has been a dramatic increase in the number of systems not meeting suitability requirements during Initial Operational Test and Evaluation (IOT&E). Reliability, availability and maintainability (RAM) deficiencies comprise the primary shortfall areas. Department of Defense Initial Operational Test and Evaluation (DoD IOT&E) results from 2001 to 2006 are summarized in *Figures 1* through *3*. These charts graphically depict the high suitability failure rates during IOT&E resulting from RAM deficiencies.

Early in the Defense Science Board (DSB) study, it became obvious that the high suitability failure rates were the result of systemic changes that had been made to the acquisition process; and that changes in developmental test and evaluation could not remedy poor program formulation. Accordingly, the Task Force study was expanded to address the broader programmatic issues, as well as the above issues identified in the Terms of Reference (TOR).

A number of major changes in the last 15 years have had a significant impact on the acquisition process. First, Congressional direction in Fiscal Year (FY)

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| Program | Service | ACAT | IOT&E Result | | Reason |
|---|---|---|---|---|---|
| *FY 2001* | | | | | |
| F-15 TEWS | USAF | II | Effective | Not Suitable | Reliability, Maintainability, Availability |
| V-22 Osprey | Navy | 1D | Effective | Not Suitable | Reliability, Availability, Maintainability (RAM), Human Factors, BIT |
| Joint Direct Attack Munitions (JDAM) | USAF | 1C | Effective only with legacy fuses | Not Suitable | Integration with delivery platforms |
| M2A3 Bradley Fighting Vehicle | Army | 1D | Effective | Suitable | |
| *FY 2002* | | | | | |
| Joint Primary Aircraft Training System (JPATS) | USAF | 1C | Effective with deficiencies | Not Suitable | RAM, Safety, Human Factors |
| Cooperative Engagement Capability (CEC) | Navy | 1D | Effective | Suitable | |
| Multiple Rocket Launcher System (MLRS) | Army | 1C | Effective | Suitable | |
| MH-60S | Navy | 1C | Effective | Not Suitable | RAM, excessive administrative and logistic repair time impacted RAM |
| *FY 2003* | | | | | |
| B-1B Block E Mission Upgrade Program | USAF | 1D | Effective | Not Suitable | 16% decrease in weapons release rate, reduction in accuracy of Mark 82 low drag weapons, 14% hit rate on moving targets |
| Sea wolf Nuclear Attack Submarine | Navy | 1D | Effective | Suitable | Several requirement thresholds were not met but overall system effective and suitable |

*Figure 1. DoD IOT&E results FY 2001–2003*

1996, 1997, 1998, and 1999 Defense Authorization Acts reduced the acquisition workforce (which includes developmental test and evaluation). Several changes resulted from the implementation of Acquisition Reform in the late 1990s. The use of existing commercial specifications and standards was encouraged, unless there was justification for the use of military specifications. Industry was encouraged to use

| Program | Service | ACAT | IOT&E Result | | Reason |
|---|---|---|---|---|---|
| *FY 2004* | | | | | |
| Evolved Sea sparrow Missile | Navy | II | Effectiveness unresolved | Suitable | Testing was not adequate to determine effectiveness. |
| Stryker | Army | 1D | Effective | Suitable | |
| Advanced SEAL Delivery System (ASDS) | Navy | 1D | Effective with restrictions | Not suitable | Effective for short duration missions; not effective for all missions and profiles. Not suitable due to RAM. |
| Tactical Tomahawk | Navy | 1C | Effective | Suitable | |
| Stryker Mortar Carrier-B (MC-B) | Army | 1D | Effective | Not Suitable | RAM and safety concerns. |
| *FY 2005* | | | | | |
| CH-47F Block I | Army | 1C | Effective | Not Suitable | RAM; communications system less suitable than CH-47D; did not meet Information Exchange Requirements for Block I. |
| F/A-22 | USAF | 1D | Effective | Not Suitable | RAM; needed more maintenance resources and spare parts; BIT |
| Joint Stand-Off Weapon-C | Navy | 1C | Not Effective | | Not effective against moderately hardened targets; mission planning time was excessive. |
| Guided-MLRS | Army | 1C | Effective | Suitable | |
| High Mobility Attack Rocket System (HMARS) | Army | 1C | Effective | Suitable | |
| V-22 Osprey | Navy | 1D | Effective | Suitable | |
| EA-6B (ICAP III) | Navy | II | Effective | Suitable | |

*Figure 2. DoD IOT&E results FY 2004–2005*

| Program | Service | ACAT | IOT&E Result | | Reason |
|---|---|---|---|---|---|
| CY 2006 | | | | | |
| Common Missile Warning System (CMWS) | Army | 1C | Effective | Suitable | Effective and suitable in the OIF/OEF environment but needs further testing outside of the OIF/OEF environment. |
| Deployable Joint Command and Control (DJC2) | Navy | 1AM | Effective | Not Suitable | Operational Test Agency, COTF, reported effective, not suitable. BLRIP not complete. |
| Integrated Defensive Electronic Countermeasures | Navy | II | | | Test suspended due to reliability problems. |
| Surface Electronic Warfare Improvement Program (SEWIP) Block 1A | Navy | II | Not Effective | Not Suitable | Block 1A Upgrade does not make the AN/SLQ-32 EWS operationally effective and suitable but does enhance ability to protect ships |
| C-130J | USAF | 1C | Effective single ship; Not effective in formation | Suitable with shortfalls | Effective single ship; not effective in formation air land / air drop; not effective in non-permissive threat environment. Shortfalls in suitability due to maintainability issues |
| Small Diameter Bomb (SDB) Increment 1 | USAF | 1D | Effective with limitations | Suitable with limitations | Limited effectiveness and suitability due to bomb rack reliability and deficiencies in software used to predict optimum fuzing solutions. Oct 2006 flight operations suspended |

*Figure 3. DoD IOT&E results for 2006*

commercial practices. Numerous military specifications and standards were eliminated in some Service acquisition organizations. The requirement for a reliability growth program during development was also de-emphasized, and in most cases, eliminated. At the same time, systems became more complex, and systems-of-systems integration became more common. Finally, there was a loss of a large number of the most experienced management and technical personnel in government and industry without an adequate replacement pipeline. The loss of personnel was compounded in many cases by the lack of up-to-date standards and handbooks, which had been allowed to atrophy, or in some cases, were eliminated. It should be noted that Acquisition Reform included numerous beneficial initiatives. There have been many programs involving application of poor judgment in the last 15 years that can be attributed to acquisition/test workforce inexperience and funding reductions. It is probable that these problems would have occurred independently of most Acquisition Reform initiatives.

All Service acquisition and test organizations experienced significant personnel cuts, the magnitude varying from organization to organization. Over time, in-house DoD offices of subject matter experts (who specialized in multiple areas, such as promoting the use of proven reliability development methods) were drastically reduced, and in some cases, disestablished. A summary of reductions in developmental test personnel follows. The U.S. Army essentially eliminated their military developmental testing (DT) component and declared the conduct of DT by the government to be discretionary in each program. The U.S. Navy reduced their DT workforce by 10 percent but no shift of "hands-on" government DT to industry DT occurred. The trend within the U.S. Air Force gave DT conduct and control to the contractor. Air Force test personnel have been reduced by approximately 15 percent and engineering personnel supporting program offices have been reduced by as much as 60 percent in some organizations. The reduction of DT personnel in the Services occurred during a time when programs have become increasingly complex (e.g., significant increases in software lines of code, off-board sensor data integration, and systems of systems testing).

## Principal findings and recommendations

### *RAM*

As a result of industry recommendations in the early 1970s, the Services began a concerted effort to implement reliability growth testing as an integral part of the development process. This implementation consisted of a reliability growth process wherein a system is continually tested from the beginning of development, reliability problems are uncovered, and

corrective actions are taken as soon as possible. The Services captured this practice in their reliability regulations, and the DoD issued a new military standard on reliability, which included reliability growth and development testing as a best practice task. The goal of this process from 1980 until the mid-1990s was to achieve good reliability by focusing on reliability fundamentals during design and manufacturing rather than merely setting numerical requirements and testing for compliance towards the end of development.

The general practice of reliability growth was discontinued in the mid to late 1990s, concurrent with the implementation of Acquisition Reform. This discontinuance may not be a direct result of Acquisition Reform, but may be related instead to the loss of key personnel and experience, as well as shortsighted attempts to save acquisition funds at the expense of increased life cycle costs. With the current DoD policy, most development contracts do not include a robust reliability growth program. The lack of failure prevention during design, and the resulting low initial Mean Time Between Failure (MTBF) and low growth potential are the most significant reasons that systems are failing to meet their operational reliability requirements.

*Findings:*

Acquisition personnel reductions combined with acquisition system changes in the last 15 years had a detrimental impact on RAM practices:

- With some exceptions, the practice of reliability growth methodologies was discontinued during system design and development (SDD);
- Relevant military specifications, standards, and other guidance were not used;
- Suitability criteria, including RAM, were de-emphasized.

- Improved RAM decreases life cycle costs and reduces demand on the logistics system.
- The deficiency report can be a valuable tool for early identification of RAM-related suitability problems, when used in conjunction with an adequately resourced deficiency correction system.

*Recommendations:*

The single most important step necessary to correct high suitability failure rates is to ensure programs are formulated to execute a viable systems engineering strategy from the beginning, including a robust RAM program, as an integral part of design and development. No amount of testing will compensate for deficiencies in RAM program formulation. To this end, the following RAM-related actions are required as a minimum:

- Identify and define RAM requirements during the Joint Capabilities Integration Development System (JCIDS) process, and incorporate them in the Request for Proposal (RFP) as a mandatory contractual requirement.
- During source selection, evaluate the bidders' approaches to satisfying RAM requirements:
  - Ensure flow-down of RAM requirements to subcontractors,
  - Require development of leading indicators to ensure RAM requirements are met.
- Make RAM, to include a robust reliability growth program, a mandatory contractual requirement and document progress as part of every major program review.
- Ensure that a credible reliability assessment is conducted during the various stages of the technical review process and that reliability criteria are achievable in an operational environment.
- Strengthen program manager accountability for RAM-related achievements.
- Develop a military standard for RAM development and testing that can be readily referenced in future DoD contracts.
- Ensure an adequate cadre of experienced RAM personnel are part of the Service acquisition and engineering office staffs.

### *Roles and responsibilities of government test and evaluation organizations*

The traditional role of the government during the DT planning phase included the identification of the test resource requirements and government test facilities, the development of the test strategy and detailed test and evaluation plans, as well as the actual conduct of T&E. When a program moved from the planning phase to the test execution phase, the government traditionally participated in test conduct and analysis; performing an evaluation of the test results for the program office. With some exceptions, this is no longer the case. Until recently, it was recognized that there should be some level of government involvement and oversight even when the contractor has the primary responsibility regarding planning and execution of the DT program.

*Findings:*

The changes in the last 15 years, when aggregated, have had a significant negative impact on DoD's ability to successfully execute increasingly complex acquisition programs. Major contributors include massive workforce reductions in acquisition and test personnel, a lack of up-to-date process guidance in some acquisition

organizations, acquisition process changes, as well as the high retirement rate of the most experienced technical and managerial personnel in government and industry without an adequate replacement pipeline.

- Major personnel reductions have strained the pool of experienced government test personnel.
- A significant amount of developmental testing is currently performed without a needed degree of government involvement or oversight and in some cases, with limited government access to contractor data.

*Recommendations:*

- As a minimum, government test organizations should develop and retain a cadre of experienced T&E personnel to perform the following functions:
  - Participate in the translation of operational requirements into contract specifications, and in the source selection process, including RFP preparation;
  - Participate in Developmental Test and Evaluation (DT&E) planning including Test and Evaluation Master Plan (TEMP) preparation and approval;
  - Participate in technical review processes;
  - Participate in test conduct, data analysis, and evaluation and reporting; with emphasis on analysis and reporting.
- Utilize red teams, where appropriate, to compensate for shortages in skilled, experienced T&E domain and process experts.
- Develop programs to attract and retain government personnel in T&E career fields so that the government can properly perform its role as a contract administrator and as a "smart buyer".

### Integrated test and evaluation

Integrated testing is not a new concept within the Department of Defense, but its importance in recent years has been highlighted, due in part to the growth of asymmetric threats and the adoption of net-centric warfare. The December 2007 Office of the Secretary of Defense (OSD) Test and Evaluation Policy Revisions memorandum reinforces the need for integrated testing. Implementation of integrated test concepts has been allowed to evolve on an *ad hoc* basis. The time has come to pursue more consistency in integrated test planning and execution.

Collaboration between developmental and operational testers to build a robust integrated test program will increase the amount of operationally relevant data that can be used by both communities. DT and Operational Test (OT) planning is separate and this inhibits efforts by the Services to streamline test schedules, thereby increasing the acquisition timeline and program test costs.

DoD policy should mandate integrated test planning and execution on all programs to the extent possible. To accomplish this, programs must establish a team made up of all relevant organizations (including contractors, developmental and operational test and evaluation communities) to create and manage the approach to incorporate integrated testing into the T&E Strategy and the TEMP.

*Findings:*

- Service acquisition programs are incorporating integrated testing to a limited degree through varying approaches.
- Additional emphasis on integrated testing will result in greater T&E process efficiency and program cost reductions.

*Recommendations:*

- Implement OSD and Service policy mandating integrated DT&E/OT&E planning and execution throughout the program:
  - Require sharing and access to all appropriate system-level and selected component-level test and model data by government DT and OT organizations, as well as the prime contractor, where appropriate;
  - Integrate test events, where practical, to satisfy OT and DT requirements.

### Operational test readiness review (OTRR)

Each Service has an operational test readiness review (OTRR) process. Although it varies from Service to Service, the process generally results in in-depth reviews of readiness to undergo an IOT&E event.

*Findings:*

- Shortcomings in system performance, suitability, and RAM are usually identified during the OTRR.
- In most cases, the operational test readiness certifying authority is well aware of the risk of not meeting OT criteria when major shortcomings exist.
- Because of funding constraints, the low priority given to sustainment, as well as the urgency in recent years to get new capabilities to the warfighter, major suitability shortcomings have rarely delayed the commencement of dedicated IOT&E.

*Recommendations:*

- Conduct periodic operational assessments to evaluate progress and the potential for achieving

predetermined entrance criteria for operational test events.
- Conduct an independent assessment of operational test readiness (AOTR) prior to the OTRR.
- Include a detailed RAM template in preparation for the OTRR.
- Require the Command Acquisition Executive (CAE) to submit a report to OSD that provides the rationale for the readiness decision.

### *OSD test and evaluation organization*

The Task Force was asked to assess OSD roles and responsibilities for T&E oversight. T&E has been a visible part of OSD since the early 1970s, reporting to the Research and Engineering command section when it was in charge of acquisition oversight and subsequently to the Under Secretary of Defense for Acquisition (now AT&L). The early T&E office was responsible for all T&E, ranges, resources oversight, and policy. In 1983, Congress established an independent Director, Operational Test and Evaluation (DOT&E) organization, reporting directly to the Secretary of Defense (SECDEF), responsible for operational test and evaluation policy, budget review, and assessments of operational effectiveness and suitability. The Live Fire Test (LFT) oversight function was created and added to the DT&E office responsibilities in the mid-1980s. Later, the LFT oversight function was moved to the DOT&E organization.

In 1999, the DT&E organization was dismantled by DoD. Many functions were moved to DOT&E, including test ranges and resources, and joint T&E oversight. Some of the remaining T&E personnel billets were eliminated to comply with a congressionally mandated (AT&L) acquisition staff reduction. The residual DT&E policy and oversight functions were separated and moved lower in the AT&L organization.

A 2000 DSB Task Force Study on Test and Evaluation Capabilities recommended that DoD create a test and evaluation resource enterprise within the office of the DOT&E to provide more centralized management of T&E facilities. This recommendation ultimately led to removing the test ranges and resources oversight from DOT&E, abandoning the notion of centralized management, and the establishment of the Test Resource Management Center (TRMC) in AT&L (as directed by the National Defense Authorization Act for Fiscal Year 2003).

*Findings:*

Current policy as of December 2007 mandates that developmental and operational test activities be integrated and seamless throughout the system life cycle. There must be enough experts in OSD with the ability to understand and articulate lessons learned in early testing and the ability to execute the new T&E policy. That policy is to "take into account all available and relevant data and information from contractors and government sources" in order to "maximize the efficiency of the T&E process and effectively integrate developmental and operational T&E."

- Currently there is not an OSD organization with comprehensive DT oversight responsibility, authority, or staff to coordinate with the operational test office:
  - The historic DT organization has been broken up and residual DT functions were moved lower in the organization in 1999, and lower yet in 2002;
  - Programmatic DT oversight is limited by staff size and often performed by generalists vice T&E experts;
  - Recruitment of senior field test personnel is hampered by DT's organizational status;
  - Existing residual organizations are fragmented and lack clout to provide DT guidance;
  - System performance information and DT lessons learned across DoD have been lost;
  - DT is not viewed as a key element in AT&L system acquisition oversight;
  - Documentation of DT results by OSD is minimal.
- Access to models, data, and analysis results is restricted by current practice in acquisition contracting, and by the lack of expertise in the DT organization.
- TRMC has minimal input to program-specific questions or interaction with oversight organizations on specific programs.
  - Organizational separation is an impediment.

*Recommendations:*

- Implementation of integrated and seamless DT and OT will require, at a minimum, greater coordination and cooperation between all testing organizations.
- Consolidate DT-related functions in AT&L to help reestablish a focused, integrated, and robust organization:
  - Reestablish program oversight and policy, and Foreign Comparative Test (FCT);
  - Have Director, DT&E directly report to Deputy Under Secretary of Defense, Acquisition and Technology (DUSD[A&T]);
  - Restore TEMP approval authority to Director, DT&E.

- Integrate TRMC activities early into DT program planning:
  - Make TRMC responsible for reviewing the resources portion of the TEMP.
- If such an organization is established and proves itself effective, consider as part of a future consolidation moving LFT back to its original DT location.

The LFT change requires the concurrence of DOT&E and a legislative change to Title 10 because of the change in reporting official. All the other recommendations made throughout the report can be implemented within current DoD authority.

## Other issues

Several other issues were addressed as a part of the study. A discussion of each of the following topics, along with findings and recommendations, may be found in the body of the report.

- Program Structure
- Requirements Definition
- Contractual Performance Requirements
- Alignment of DoD Technology with Systems Engineering Procedures
- Commercial Off-The-Shelf
- Systems of Systems

## Summary and implementation status

In summary, the single most important step required to remedy the high suitability failure rates is to insure that programs are formulated to execute a viable systems engineering strategy from the beginning, including a robust RAM program, as an integral part of design and development. A second and related priority is to ensure that government organizations reconstitute a cadre of experienced T&E, engineering and RAM personnel to support the acquisition process. A third priority is to integrate developmental and operational testing to the extent practicable. A Reliability Improvement Working Group was established in March 2008 to address these three issues.

The reliability subgroup worked on developing a reliability acquisition policy and framework that includes consistent, concise sample RFP language that will encourage developers to plan for and resource a reliability growth program as a part of design and development; Phased templates to evaluate RAM activities throughout program reviews; and Standard evaluation criteria to provide a consistent way to evaluate an acquisition program's reliability health throughout the development process. On July 21, 2008 the Undersecretary of Defense for Acquisition, Technology, and Logistics signed a policy memo on Reliability, Availability, and Maintainability which implements the key RAM recommendations in the DSB report.

The personnel subgroup addressed four major issues: first, a policy to enable workforce reconstitution; second, a plan to reconstitute RAM and T&E personnel where necessary, third, training and education for RAM and T&E personnel; and fourth, establishing and staffing Centers of Excellence and expertise.

The integrated testing subgroup developed guidelines for early involvement in requirements and RFP development; contractual language for data access and sharing; and synchronization of the Test and Evaluation Master Plan (TEMP) and Systems Engineering Guide.

Further implementation of these and other recommendations in the report will not be easy, but will pay large dividends in improvements to the acquisition process and reduced life cycle costs. ❑

*PETE ADOLPH has over 45 years experience in test and evaluation and systems acquisition. Following three years as an Air Force officer, he held a variety of positions with the Air Force from 1960 to 1987, advancing to technical director at the Air Force Flight Center. From 1987 to 1994, he held several positions in the Office of the Secretary of Defense (OSD). For most of that period, he was director, Test and Evaluation, Acquisition and Technology. He also served as interim director of Operational Test and Evaluation and interim director of Defense Research and Engineering. He was a senior vice president for SAIC from 1994 to 2000 and served as the manager of the SAIC test and evaluation group. He is currently a consultant.*

*CHRIS DIPETTO is deputy director, Developmental Test & Evaluation (DT&E), Office of the Under Secretary of Defense for Acquisition, Technology and Logistics.*

*DR. ERNEST SEGLIE is science advisor, Office of the Director, Operational Test and Evaluation (DOT&E), the Pentagon, Washington, D.C. He provides scientific and technical guidance on the overall approach to Department of Defense (DoD) evaluation of the operational effectiveness and suitability of major DoD weapon systems; provides technical review of test reports; and serves as chief technical advisor to the Director, DOT&E.*

## References

Department of Defense. May 2008. "*Report of the Defense Science Board Task Force on Developmental Test and Evaluation*." Office of the Under Secretary of Defense for Acquisitions, Technology, and Logistics. The complete DT&E report is available on the Defense Science Board website at: http://www.acq.osd.mil/dsb/reports/2008-05-DTE.pdf.