The Impact of Changes in DoD Policy on Reliability and Sustainment

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Key Words: policy, reliability, reliability program, reliability growth, developmental test and evaluation, sustainment KPP

SUMMARY & CONCLUSIONS

Taxpayer and Congressional confidence in the ability of the Department of Defense (DoD) to acquire and sustain effective, affordable weapons has been seriously undermined by failed procurements such as the US Air Force Tanker procurement, Government Accountability Office (GAO) reports documenting major delays in schedule and cost overruns, and internal DoD assessments that systems do not meet requirements and are not deployable.

The Weapons Systems Acquisition Reform Act of 2009 [1] and updated policy have strengthened Pentagon oversight and accountability for schedule and cost control. Revitalized Systems Engineering processes are in place to reduce risk. A Sustainment Key Performance Parameter provides for early design influence to meet operational needs and reduce ownership costs. Reconstitution of an adequately staffed, trained and experienced workforce is underway.

1 INTRODUCTION

The paper assesses the impact policy changes on reliability and sustainment in the following areas:

- Strengthening of Systems Engineering (SE) Preliminary Design Review (PDR) and the Critical Design Review (CDR) as critical program decision points.
- Increased focus on risk avoidance/mitigation early in the life cycle.
- Ensuring the stability of user requirements to minimize program destabilization and cost growth.
- Assessment of the impact of technology on reliability and sustainment via Technology Readiness Assessments and Competitive Prototyping.
- Specification of user requirements for the Sustainment Metric Key Performance Parameter (KPP), Materiel Availability, and its Key System Attributes (KSA) of Materiel Reliability and Ownership Cost.
- Initiatives in Reliability, Availability and Maintainability (RAM) policy, to include reliability program plans, reliability growth tests, review criteria, and “enablers” that facilitate the RAM/sustainment outcomes.

2 SYSTEMIC ISSUES

2.1 Government Accountability Office (GAO) Reports

Table 1 details the GAO’s March 2009 assessment of DoD’s Major Defense Acquisition Programs (MDAPs) [2]. Since 2003, the number of programs has increased from 77 to 96, and investment increased from $1.2 trillion to $1.6 trillion.

![Image showing Table 1 – GAO Analysis of DoD Acquisition Programs](source: GAO Report 09-326P)

Table 1 – GAO Analysis of DoD Acquisition Programs

<table>
<thead>
<tr>
<th>Portfolio Status</th>
<th>FY 2003 Portfolio</th>
<th>FY 2007 Portfolio</th>
<th>FY 2008 Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Programs</td>
<td>77</td>
<td>95</td>
<td>96</td>
</tr>
<tr>
<td>Total Planned Commitments</td>
<td>$1.2 T</td>
<td>$1.6 T</td>
<td>$1.6 T</td>
</tr>
<tr>
<td>Commitments Outstanding</td>
<td>$724 B</td>
<td>$875 B</td>
<td>$786 B</td>
</tr>
<tr>
<td>Change in Total R&amp;D Cost from First Estimate</td>
<td>37%</td>
<td>40%</td>
<td>42%</td>
</tr>
<tr>
<td>Change in Total Acquisition Cost from First Estimate</td>
<td>19%</td>
<td>26%</td>
<td>25%</td>
</tr>
<tr>
<td>Estimated Total Acquisition Cost Growth</td>
<td>$183 B</td>
<td>$301 B</td>
<td>$296 B</td>
</tr>
<tr>
<td>Share of Programs With 25 Percent or More Increase in Program Acquisition Unit Cost</td>
<td>41%</td>
<td>44%</td>
<td>42%</td>
</tr>
<tr>
<td>Average Delay in Delivering Initial Capabilities</td>
<td>18 mos.</td>
<td>21 mos.</td>
<td>22 mos.</td>
</tr>
</tbody>
</table>

Source: GAO Report 09-326P

While cumulative cost growth was higher in 2008 ($296B) than 2003 ($183B), it was less than 2007 when adjusted for inflation. Research and Development (R&D) costs for 2008 programs are 42 percent higher than originally estimated and the average delay in delivering initial capabilities increased to 22 months. Perhaps most importantly, total Acquisition Cost Growth is $296B. The impact of these trends is that needed capabilities are not deployed in a timely manner and that funding cannot support the number of needed systems.

GAO noted performance in some areas was driven by older programs, and recognized that newer programs have not shown the same degree of cost and schedule growth. It perceived causes of schedule slippage and cost growth were rooted in the use of immature technology, the impact of poorly defined requirements and requirements ‘creep’, poor or ineffective design, and a lack of Systems Engineering processes, to include disciplined software management and reliability programs featuring reliability growth test programs.

2.2 The Defense Science Board (DSB) Task Force on Developmental Test and Evaluation (DT&E)

User requirements are tested against Operational Effectiveness and Operational Suitability criteria. Operational Effectiveness addresses the degree of mission accomplishment in the operational environment, and Operational Suitability addresses the degree to which a system can be satisfactorily placed in use, given reliability, availability, maintainability, and supportability considerations, among other factors.

Figure 1 illustrates the results of the Director, Operational Test and Evaluation’s (DOT&E) evaluation of Initial
Operational Test & Evaluation (IOT&E) results over approximately the past 15 years. The evaluation showed 50% of programs tested in 2007 failed due to lack of Operational Suitability, highlighting a significant negative trend.

![Cumulative IOT&E Results Thru CY2007](image)

Source: DOT&E 2007 IOT&E Report

*Figure 1 – DOT&E Analysis of IOT&E Results*

### 2.2.1 Charter

The Defense Science Board (DSB) Task Force on Developmental Test and Evaluation (DT&E) was chartered in April 2007 to the address systemic causes in acquisition and Test & Evaluation (T&E) processes [3], to include:

- Organizational roles and responsibilities.
- Oversight policy and practices.
- Statutory changes required to establish oversight.
- Root causes of IOT&E failures due to lack of Suitability.

### 2.2.2 Principal Findings

Principal findings included:

- High Suitability failure rates experienced during IOT&E were caused by lack of a disciplined systems engineering process, including a robust reliability growth program, during system development.
- Workforce cuts and retirements adversely impacted DoD’s acquisition capability.
- The cancellation of guidance documents left a gap in technical and management processes.
- Strong Office of the Secretary of Defense (OSD) and Military Service commitment were vital for change.
- The Acquisition Reform provided flexibility but, impacted program formulation and execution.
- Systemic changes in program formulation and execution were required to correct DT&E process deficiencies.
- Reliability, Availability and Maintainability (RAM) shortfalls are frequently identified in Development Testing (DT), but program constraints (schedule and funding) often preclude incorporating fixes and delaying IOT&E.
- Additional emphasis on integrated testing will improve Test & Evaluation (T&E) process efficiency as well as allow for program cost reductions.

### 2.2.3 Recommendations

DSB reliability-related recommendations included:

- Identification and quantification of RAM requirements thru the Joint Capabilities Integration and Development System (JCIDS) process and mandatory incorporation into Request for Proposals (RFP) and Contracts.
- Mandatory “flow-down” of RAM requirements from the prime contractor to second and third tier subcontractors.
- Strengthening of the Systems Engineering process thru the conduct of mandatory reliability growth programs, and evaluation of progress as part of major program reviews, to include System Readiness Review (SRR), Preliminary Design Review (PDR) and Critical Design Review (CDR).
- Development of a military standard for RAM development and testing that can be contractually referenced.
- Reconstitution of the Defense Workforce with trained RAM and Test & Evaluation personnel in acquisition and engineering office staffs.
- Strengthening of cost and schedule controls with greater management accountability for RAM-related outcomes.

### 2.2.4 The Reliability Improvement Working Group (RIWG)

The DOT&E and the Under Secretary of Defense (USD) for Acquisition and Technology (A&T) chartered the RIWG in February 2008 [4] to implement the following Defense Science Board recommendations:

- Ensuring programs were formulated to execute a viable systems engineering strategy from the beginning, including a RAM Growth Program, as an integral part of design and development
- Ensuring Government organizations reconstituted a cadre of experienced T&E and RAM personnel.
- Implementation of mandated Integrated Developmental Test (DT) and Operational Test (OT), including the sharing and access to all appropriate contractor and government data and the use of operationally representative environments early in testing.

The RIWG identified the following initiatives for implementation by OSD and the Services/Defense Agencies:

- Establishment of reliability acquisition policy.
- Designation of Champions to sustain reliability initiatives.
- Use of proposed language in solicitations and contracts.
- Use of proposed guidance for early RAM planning and evaluation of program compliance.
- Reconstitution of a adequately staffed, trained, and experienced RAM and Test & Evaluation workforce.
- Implementation of an Integrated T&E Policy.
- Continuing assessment of implementation progress.
DoD policy is defined by Directives, Instructions, and Memorandum resulting from legislation and Departmental initiatives. DoD Directive 5000.01, the Defense Acquisition System [5], and DoD Instruction 5000.02, Operation of the Defense Acquisition System [6], define DoD’s Acquisition process. Policy Memorandums are also issued principally by the Under Secretary of Defense (USD) for Acquisition, Technology and Logistics (AT&L).

Figure 2 illustrates the Defense Acquisition System from two perspectives. The upper panel represents the Life Cycle from a Phase perspective, while the lower panel represents the Life Cycle from the relative durations of the Phases.

3.2 VCJCS Memorandum, “Key Performance Parameter Study Recommendations and Implementation” 17 August 2006

The Vice Chairman of the Joint Chiefs of Staff (VCJCS), acting in his capacity as the Chairman of the Joint Requirements Oversight Council (JROC) issued the Memorandum [11] to implement the Mandatory Sustainment Metric Key Performance Parameter (KPP), Materiel Availability, and its Key System Attributes of Materiel Reliability and Ownership Cost for all Major Defense Acquisition Programs (MDAPs) and select ACAT II and III programs. CJCSI 3170.01F, Operation of the Joint Capability Integration and Development System (JCIDS) [12] was issued on 1 May, 2007, requiring the inclusion of the Materiel Availability, Material Reliability and Ownership Cost metrics into Capability Development Document (CDD) and the Capability Production Document (CDD) requirements documents.

Over the past two years, discussions have centered on the language used to define Material Availability. CJCSI 3170.01F expressed Materiel Availability in terms of the percentage of the weapon system population (fleet) in operational status, as well as in terms of the system’s “uptime” as a faction of the sum of “uptime” and “downtime”, or total time. The latter definition was perceived by the members of the user community to be more appropriate to describe their operational circumstances from a “unit” perspective.

CJCSI 3170.01G [13] was issued on 1 March 2009 and expanded the Materiel Availability Key Performance Parameter (KPP) to include the “uptime”/“total time” or “Operational Availability” (Ao) definition of Materiel Availability, thereby addressing both the fleet-wide and unit level perspectives.


The Memorandum [14] established the Joint Staff’s Materiel Availability KPP and the Materiel Reliability and Ownership Cost KSAs as well as Mean Down Time (MDT) as metrics that OSD would use as goals for materiel readiness outcomes. The metrics are “established early in the concept decision process, refined throughout the design development process, and then carried through as baseline goals until system retirement.” Reporting requirements were established for
Program Review, to include the Defense Acquisition Board (DAB). Additionally, some 14 “Enablers” that positively impact the Life Cycle Sustainment Outcome Metrics were identified, and included the following reliability and sustainment related areas and activities:

- Performance-Based Logistics (PBL)
- Condition Based Maintenance Plus (CBM+).
  - Prognostics & Diagnostics.
  - Reliability Centered Maintenance (RCM).
- Diminishing Manufacturing Sources and Material Shortages (DMSMS)/Obsolescence Plan.

3.3 USD(AT&L) Memorandum, “Reliability, Availability, Maintainability Policy” 21 July 2008

The Memorandum implemented the Defense Science Board and RIWG recommendations to strengthen reliability programs and to reconstitute skills within the Federal workforce. It directed the Services to formulate programs to “execute a viable RAM strategy that includes a reliability growth program as an integral part of design and development.” The Military Departments were directed to establish reliability improvement acquisition policy to implement RAM practices to:

- Ensure effective collaboration between the requirements and acquisition communities in the establishment of RAM requirements that balance funding and schedule while ensuring system suitability and effectiveness in the anticipated operating environment.
- Ensure development contracts and acquisition plans evaluate RAM during system design.
- Evaluate the maturation of RAM through each phase of the acquisition life cycle.
- Evaluate the appropriate use of contract incentives to achieve RAM objectives.

Other policy provisions included:

- Integration of RAM within Systems Engineering processes.
- Documentation of RAM in the Systems Engineering Plan (SEP) and Life Cycle Sustainment Plan (LCSP).
- Inclusion of RAM policy in DoD 5000.02.
- Development of a manual to facilitate development of the Sustainment Metric Key KPP/KSAs and other appropriate metrics.
- Updating of the Defense Acquisition Guidebook (DAG) and appropriate Directives and Instructions.

The stated outcome of the policy is the establishment of reliability improvement policy in each Service, and the implementation the mandatory Materiel Availability KPP and Materiel Reliability and Ownership Cost KSAs.


The “LCM” Memorandum was issued with the objective of establishing DoD policy to achieve a seamless integration of Acquisition and Life Cycle Sustainment Policies for all MDAPs, as described in the following sections.

3.4.1 Reinforcement of Life Cycle Sustainment Metrics

Several significant initiatives were advanced by the Memorandum. Principally, the Memorandum reinforced the Sustainment Metric KPP/KSAs by requiring all MDAPs to establish target goals for the metrics, and to report on their status through the Defense Acquisition Management and Information Retrieval System (DAMIR). The Memorandum also clarified the use of the TLCMS metrics established in November 2005 USD(AT&L) Memorandum, noting their continuance as appropriate sustainment metrics.

3.4.2 Alignment of Resources to Readiness

The Memorandum established a Pilot Program with the DoD Comptroller and the Director, Program Analysis and Evaluation (PA&E) to determine the feasibility of annually assessing the attainment of the life cycle metrics as part of the Planning, Programming, Budgeting and Execution (PPB&E) System. This action responds to the concern of the impact of decisions prior to Milestone B without an understanding of the impact of the decisions on Materiel Availability, Reliability, and Ownership Cost.

3.4.3 Tracking of Performance Throughout the Life Cycle

The continuing tracking and evaluation of the metrics is critical to ensure their appropriateness and achievement. The Memorandum directed the reporting of the metrics at program milestones and periodic Defense Acquisition Executive (DAE) reviews following Initial Operational Capability (IOC) to ensure attainment. The Memorandum also directed the determination of both acquisition and sustainment policy and process changes necessary for Acquisition Strategies (AS) and Acquisition Program Baselines (APB) to adopt a greater life cycle management orientation. Enablers for this task include the incorporation of sustainment metrics in the System Engineering Plan (SEP) and the Life Cycle Sustainment Plan (LCSP).

3.4.4 Implementation of Performance-Based Life Cycle Product Support Strategies

DoDD 5000.01 policy identifies Performance-Based Logistics as the preferred approach to deliver readiness, reliability and ownership cost by focusing on “outcomes”, rather than “transactions”. The Memorandum emphasizes this concept and its applicability to both DoD organic and private sector providers, and directs strengthening of procedures in the Defense Acquisition Guidebook and the implementation by MDAPs of PBL approaches in Life Cycle sustainment planning.

Acting as a part of implementation of the Life Cycle Management Memorandum, the DUSD(L&M) established the Product Support Assessment Team (PSAT) to:

- Identify existing life cycle product support policies, guidebooks and legislation.
• Assess the Services’ implementation of life cycle product support strategies.
• Survey Components and Industry for impediments experienced during implementation.
• Assess long term impacts of current and proposed OSD and other policy on critical military-industrial interfaces.
• Make recommendations and chart the course for next generation life cycle product support management (including PBL).
• Report its findings in Fall 2009.

3.4.5 DoDI 5000.02, “Operation of the Defense Acquisition System” 8 December 2008

DoD Instruction 5000.2 was issued on December 8, 2009. Figure 3 illustrates the updated Management System’s Life Cycle Phases and decision points.

<table>
<thead>
<tr>
<th>Material Solution Analysis</th>
<th>Technology Development</th>
<th>Engineering &amp; Manufacturing Development</th>
<th>Operations &amp; Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materiel Development Decision</td>
<td>Technology Development</td>
<td>Engineering &amp; Manufacturing Development</td>
<td>Operations &amp; Support</td>
</tr>
<tr>
<td>IOC</td>
<td>EOC</td>
<td>IOC</td>
<td>FOC</td>
</tr>
</tbody>
</table>

Source: Defense Acquisition University

Figure 3 –DoDI 5000.02 Management System

Two Life Cycle Phases, Materiel Solution Analysis (MSA) Phase (formerly Concept Development) and the Engineering & Manufacturing Development (EMD) Phase (formerly System Design and Demonstration) have been redefined. Updated business rules/criteria for entry into the Acquisition process now require programs to enter at the MSA Phase for evaluation and determination of the appropriate entry phase rather than the previous practice of potential entry at any Milestone. This change underscores the importance of the JCIDS process to properly formulated programs to minimize risk and ensure needed capabilities are developed.

Other major changes include “Competitive Prototyping” within the Technology Development (TD) Phase to better develop system concepts and designs, allow for greater surety of technology maturation. The critical reliability and sustainment analyses of Failure Modes, Effects and Critical Analyses (FMECA), Reliability & Maintainability Prediction and Analysis, Fault Tree Analysis (FTA), Level of Repair Analysis (LORA) and Maintenance Task Analysis, which had formerly had been conducted in the System Design and Development Phase are now in Technology Development, thereby accomplishing the addressing of sustainment metrics “up-front & early” in the Life Cycle, which has been the “Holy Grail” of the reliability and sustainment communities.

The Systems Engineering discipline is strengthened by reliability growth programs, the emphasis on Preliminary Design Reviews (PDRs)/Post PDR Assessments and Critical Design Reviews (CDRs)/Post CDR Assessment as key factors in the decision process, and the establishment of Enclosure 12, Systems Engineering. Significant documentation requirements have been added, to include the Systems Engineering Plan (SEP), Life Cycle Sustainment Plan, the Replaced System Sustainment Plan, and the Data Management Strategy. The Reliability, Availability, Maintainability-Cost (RAM-C) Rationale Report Manual [17] was issued on 1 June 2009 as required by the USD(AT&L) Memorandum, Reliability Availability Maintainability Policy. The Manual will document the Sustainment Metric KPP/KSAs as contained in Capability Development Documents (CDD) and Capability Production Documents (CPD) at Milestones B/C.

3.5 Secretary of Defense Gates FY 2010 Budget Initiatives

On April 6 2009, Secretary Gates announced the Department’s FY 2010 Budget Requests. This action was taken with the President’s approval, but was unusual in that Defense Department Budget Requests usually revealed by the submission of the President’s Budget.

Mr. Gates discussed the requests in terms of the “capabilities, requirements, risks and needs for the purpose of shifting this Department in a different strategic direction.” He underscored the need to “ensure that requirements are reasonable and technology is adequately mature to allow the department to successfully execute the programs.”

Mr. Gates announced the termination of several programs “where the requirements were truly in the exquisite category and the technologies required were not reasonably available to affordably meet the program's costs or scheduled goals.” Other imperative included the need to:

• Realistically estimate program costs.
• Provide funding stability for programs and fund them to.
• Adequately staff the government acquisition team.
• Guard against requirements “creep”.
• Validate the maturity of technology at milestones.
• Demand stricter contract terms and conditions.
• Provide disciplined and constant oversight.

Mr. Gates also announced his plan to reconstitute the defense workforce by converting 11,000 contractors to government employment and hiring 9,000 more government acquisition professionals by 2015, beginning with 4,100 in FY10.

4 LEGISLATIVE ACTION

President Obama signed Public Law 111-23, the Weapon Systems Acquisition Reform Act of 2009 on May 22, 2009. In its initial section, the legislation requires the Military Departments, through the USD(AT&L), to report their progress in several areas that were identified in the Defense Science Board (DSB), the Reliability Improvement Working Group (RIWG) Reports, the updated DoDI 5000.02 and USD(AT&L) Memorandum, to include:

• Reconstitution of an adequately staffed, trained and experienced Defense Workforce.
• Processes to ensure decisions are supported by rigorous systems engineering processes.
• Systems Engineering strategies to improve reliability as an integral part of design and development.
• Identification of RAM requirements in the JCIDS process.
• Incorporation of RAM requirements into contracts
• An independent Technology Readiness Assessment by the Director, Defense Research and Engineering (DDR&E)
• Completion of a Preliminary Design Review (PDR) and Post PDR Assessment, as well as a Critical Design Review (CDR) and Post CDR Assessment as strengthened Systems Engineering technical and management processes.
• The reduction of risk through the use of competitive prototyping before Milestone B, and the mandatory production of a prototype before Milestone B, even if competitive prototyping is waiver
• Establishment of needed development planning and systems organizations and processes.

The legislation strengthens cost and schedule oversight, by organizational changes, specifically:
• Office of Director of Cost Assessment & Program Evaluation (CAPE), with two Deputies, Director, Cost Assessment and Director, Program Evaluation
• Office of Director of Developmental Test and Evaluation.
• Office of Director, Systems and Software Engineering

New processes include:
• Changes in Certification Requirements at Decision Milestones, with increased focus on costs and risk.
• Conduct of independent cost estimates in advance of all Decision Milestones, (MS A, MS B, and MS C) as well as the Full Rate Production (FRP) Decision.
• Performance Assessments conducted by Senior OSD officials to oversee technical performance, management and schedule issues, and the root cause analysis of increases in procurement costs.
• “Presumption of Termination” for critical cost growth (Unit Cost Report) threshold breaches unless a detailed waiver based on a ‘root cause’ analysis is requested
• Detailed reporting addressing technological maturity, reviews of programs that have experienced critical cost growth, and the adequacy of program resources for DT&E and Systems Engineering organizations.

REFERENCES
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BIOGRAPHY
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Patrick M. Dallosta is a Performance Learning Director within DAU’s Center for Logistics and Sustainment. He is responsible for ensuring Defense Acquisition Workforce Improvement Act (DAWIA) Life Cycle Logistics (LCL) Career Field competencies, which include Reliability, Availability, Maintainability (RAM) and Supportability, are included in the DAU curriculum. Prior to joining DAU, Mr. Dallosta served as an Action Officer supporting the Assistant Deputy Under Secretary of Defense for Materiel Readiness. He participated in Systems Engineering Program Support Reviews (PSR) of Major Defense Acquisition Programs to ensure sustainment requirements and supportability considerations were addressed in the design process, and served as a member of the Reliability Improvement Working Group (RIWG). Mr. Dallosta has over thirty years of industry experience in Program Management, Systems Engineering, Reliability Engineering, and Logistics. He holds a Bachelor’s degree in Electrical Engineering from Christian Brothers University, a Master’s in Industrial Engineering from Texas A&M University and is a Candidate for a Master’s in Computer Information Systems. He holds a DAWIA Level III Certification in Life Cycle Logistics, a level II Certification in Requirements Management, and is a SOLE Certified Professional Logistician (CPL).