Acquisition Reform to Enable Military Effectiveness

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"You cannot allow any of your people to avoid the brutal facts. If they start living in a dream world, it's going to be bad."

James Mattis

Introduction

We are facing a potential national security crisis. At present the active military force structure is already near an all-time low, and existing equipment inventories are becoming older, smaller, and less effective against emerging technologies. Additionally, the DoD's costs for manpower, maintenance, and health care continue to increase, thereby constraining the funds necessary for the recapitalization, modernization, and transformation of the military (CBO, 2013).Can we continue to equip our military forces with the capabilities that they need to counter varied and rapidly-changing threats? Can we do it affordably? In order to answer yes to both of these questions, the DoD must make changes to its acquisition system.

Even though the post-Cold War security environment has changed dramatically, the DoD continues to rely on acquisition processes developed decades ago. Although there have been many attempts at reform (beginning with the Defense Reorganization Act in 1958), these generally have focused on creating, eliminating, or reorganizing the phases, milestones, and requirements of the acquisition system. Its linear structure has been left unchanged. In the end, the reforms have had little impact on improving outcomes.

Weapon system programs continue to exceed their planned schedules (which are already too long) and budget baselines. At times, these programs become so narrowly focused on reducing costs that they lose sight of their primary objective: to provide the necessary capability to the warfighter.

In light of today's ever-changing, chaotic threat environment, the DoD must transition away from the inflexibility and complexity that have characterized defense acquisition for decades—and toward agility and responsiveness. All of the major stakeholders have recognized that acquisition performance must be improved.

Between February and June of 2017 a cadre of defense experts convened a series of workshops to identify the needed changes. The goal of the workshops was to examine previous acquisition reform efforts, identify the root causes of the significant problems, review commercial and

international best practices, and make recommendations to help transform the DoD's acquisition processes – enabling the DoD to become a "world class buyer."

The workshop participants included senior aerospace and defense industry business executives and academics that collectively had over 300 years of defense acquisition experience in both the private sector and government (See Appendix I for the list of participants). This report summarizes the output from those workshops.

We begin by describing the large-scale changes in the national security environment. We then identify the fundamental problems with the existing defense acquisition process. Next, we define the attributes of a new process that will be more effective in today's environment. Finally, we introduce a new adaptive acquisition process.

A Changing National Security Environment

The national security environment has changed dramatically since the dissolution of the Soviet Union and the end of the Cold War. During the Soviet era, requirements were developed to maintain technological superiority over our adversaries' capabilities. To a large degree, improvements to U.S. weapons systems relied on requirements that, if not stable and predictable, were only slowly evolving.

The bipolar balance of power between the United States and Soviet Union has transitioned into a complex, multi-polar, environment marked by a wide range of threats including local and transnational terrorism, cyberattacks, regional instability, rogue state and non-state aggressors, the proliferation of weapons of mass destruction, and the rise of potential peer competitors. These threats are varied, unstable, and unpredictable; as a result, military requirements have taken on these same attributes. Unfortunately, the linear acquisition process is not well suited to delivering these requirements.

Not only have the threats changed, but so too has the source of technological innovation that is needed to counter them. Prior to and during the Cold War, U.S. technological innovation often occurred as a result of government research funding for military priorities. The resultant technologies (e.g., jet propulsion, satellites, computers, etc.) were then adapted ("spun off") to civilian and commercial applications. However, the end of the Cold War coincided with the start of what would become known as "the information revolution." Increasingly, research investments came from the private sector and were focused on commercial applications. By the dawn of the new millennium, the vector of technology transfer had reversed. Defense programs now strive to adapt the latest, rapidly-evolving, commercial developments and products.

The defense industrial base has also undergone a major transformation. As DoD spending began to decline in the mid-1980s, it led to a dramatic restructuring within the defense industrial base. In 1993, there were 21 U.S.-based companies performing major defense and aerospace work, which allowed the DoD to leverage competitive market forces; today there are five U.S.-based defense prime contractors (additionally, BAE Systems, a subsidiary of a British firm, has operations in the U.S). This consolidation (which included extensive vertical integration—with

the primes absorbing many of the suppliers) also had an impact at the lower levels. Many of the remaining suppliers shifted the focus of their business to the commercial sector, as they could no longer rely on the DoD to provide the majority of their business. Now, in many critical defense areas, the number of suppliers remaining—at either the prime contractor or lower tier levels—has declined to only one or two, which has had the effect of reducing competition and constraining innovation.

Adding to these challenges is the fact that the current regulatory environment creates disincentives and raises the barriers for non-traditional defense firms—firms that could expand the industrial base—from doing business with the DoD. These include government-unique standards, cost data requirements for commercial (or modified commercial) items, and unfavorable intellectual property requirements – all deterring commercial firms from doing business with the DoD.

The Need for Reform

In response to these dramatic changes within the national security environment, the DoD's acquisition process has remained fundamentally unchanged. Decades of reform efforts have generally focused on improving the same linear process for the acquisition of major systems. Most of these initiatives have had little impact on constraining cost and schedule growth; rather they have incrementally added regulations and oversight that have resulted in time consuming bureaucratic processes. This has not only had an adverse effect on cost and cycle times for major systems, but, more importantly, has slowed the acquisition of systems that are urgently needed by the warfighter to support combat operations. As a result, the current process continues to deliver systems that are over-budget, delayed, and often less capable than originally planned.

Numerous reports have highlighted the continuing problem of cost and schedule growth. A 2006 RAND study, one of several completed in recent years, compiled Selected Acquisition Reports (SARs) for a sample of 68 completed programs found that the total average cost growth (adjusted for quantity changes) was 46% over the baseline established at Milestone B (Arena *et al*., 2006). Another RAND report, this one published in 2008, examined 35 completed Major Defense Acquisition Programs (MDAPs) and found that average total cost growth was 60%, with most of this growth attributed to changes in quantity (22%), changes in requirements (13%), cost estimating errors (10%), and schedule changes (9%). A recent GAO study examined 16 programs then in production that had experienced the largest development cost percentage increases during fiscal year 2016. For 11 of the 16 programs, the addition of unplanned capabilities was given as the primary cause of the cost increase. See Appendix II for a summary of the findings from studies on cost and schedule growth.

Absent change, cost growth may be substantially higher in the future, when funding is less available. According to the Institute for Defense Analysis (IDA; 2015), programs entering the engineering, manufacturing and development stage during "bust" phases of the DoD's "boom-

bust" funding cycle have much higher unit costs compared to those entering during a "boom" funding climate.

In order to advance meaningful reform, it must be recognized that the existing linear process is ill-suited to delivering innovative and transformative products, the development of which is inherently non-linear. Long development cycles already guarantee that some systems enter into service for the first time with components that are obsolete. It therefore seems unlikely that the existing process will be able to capitalize on new developments in diverse fields including robotics, quantum computing, nanotechnology, biotechnology, additive manufacturing, and augmented reality.

Furthermore, rising costs in personnel compensation, annual healthcare, facilities, and operations and maintenance (O&M) costs for existing weapons systems have constrained funding for the planned recapitalization, modernization, and transformation of the military as witnessed by the steadily decreasing (since 2010) procurement and R&D appropriations. This comes at a time when the active military force structure is already near an all-time low (*i.e.*, additional manpower reductions are unlikely) and existing equipment inventories are old, depleted, and less effective against emerging technologies. Recent DoD initiatives undertaken to control cost (e.g. Lowest Price Technically Acceptable [LPTA] criteria, contracting "tripwires", etc.), like their predecessors, have not targeted the acquisition process itself. Invariably, these "reforms" are touted as transformative; in reality, they are often transient and prove ineffective. They are also misguided, for rarely do they attempt to meet the twin objectives of reducing cost *and* enhancing warfighter capabilities. One could argue that, at times, the singular focus on reducing costs has come at too high a price.

The working group arrived at the consensus that the acquisition process must be fundamentally redesigned in order to meet present and future national security requirements. We are not alone in this way of thinking. In 2012, for example, the Defense Business Board (DBB) recommended that the DoD "zero-base" the entire acquisition system, including all directives and regulations.

Fundamental Challenges

A wealth of studies completed over the last two decades (by organizations including the Government Accountability Office, RAND, the Defense Science Board, the Institute for Defense Analyses, the DoD's Cost Analysis Improvement Group, the Office of the Secretary of Defense, and the Defense Business Board) are largely in agreement over the fundamental problems with the existing acquisition process (see Appendix III for an overview of each study's findings). We summarize these problems below.

- **Requirements that lack validity, solidity, and clarity**

  Determining the requirements for the development and production of a weapon system has major implications with regard to schedule, performance, and lifecycle costs. However, the Joint Capabilities Integration and Development System (JCIDs) process is document and process intensive and can be time consuming. And, although changes in

the high-level requirements are rare, it is not until after a program has been formally initiated that the many lower-level, technical requirements needed to complete a weapon system's design are defined. Given today's chaotic security environment, changes to requirements are often made during product development that adversely impact cost and schedule. Additionally, the DoD does not weigh operations and sustainment costs strongly enough when making early requirement and engineering tradeoffs, resulting in expensive logistical challenges later in the lifecycle of systems.

- **The use of fragmented, long-cycle, bureaucratic and risk-averse processes in design, development, and production**

  Most of the DoD's acquisition reform efforts have focused on "improving the process" for the acquisition of major systems. In general, these initiatives have had little impact on constraining cost and schedule growth; rather, they have incrementally added regulations and oversight that have accreted overtime, resulting in time-consuming bureaucratic processes that often add little to no value, and often have the opposite effect—increasing costs.

  These observations are supported by the amount of documentation that acquisition programs require. In fact, of 49 programs that the GAO (2015) surveyed, on average 5,600 staff days were required per program to document the information requirements necessary to move to the next milestone. Only half of these requirements were considered "highly valuable" by the acquisition officials surveyed. It is no wonder that GAO (2015) characterized the acquisition process as a system of "checkers checking checkers."

  The existing process also tends to sap the incentives for program personnel to take reasonable risks that might translate to more effective, innovative, and affordable products / systems. Pressure to justify budgets, demonstrate immediate utility to the warfighter, and advance careers all contribute to a high level of risk aversion. Consequently, the DoD is often driven to develop workarounds to the current process, especially in times of conflict, in order to acquire the systems that are urgently needed by the warfighter.

  Even at the higher levels, requirements, acquisition, and budget decisions (the three components of the 'Big A' acquisition system) are not well-integrated. Rather, decision making occurs in three separate domains, or "stovepipes", each of which is a "multi-layered, heavily bureaucratic series of sequential and oftentimes uncoordinated processes that are not linked" (DBB, 2012, p. 2).

  In an effort to overcome acquisition challenges, the DoD has initiated a variety of efforts in the area of rapid acquisitions (e.g. SOCOM-SOFWERX, Services' rapid capabilities offices) and tapping into the commercial sector (DIUx). These efforts show some promise, but are not necessarily scalable and further highlight the challenges within the current acquisition process.

- **The lack of early consideration for sustainment**

  A critical consideration must be to develop and produce systems that work reliably, and can be operated and maintained affordably. Furthermore, it is widely recognized that the best time to reduce life-cycle costs is early in the acquisition process (Land, 1997). Commercial sector firms address this challenge by incorporating mature technologies in new systems whereas DoD programs rely too heavily on increases in reliability occurring over time. As discussed previously, the result in less reliable systems and costly corrective action.

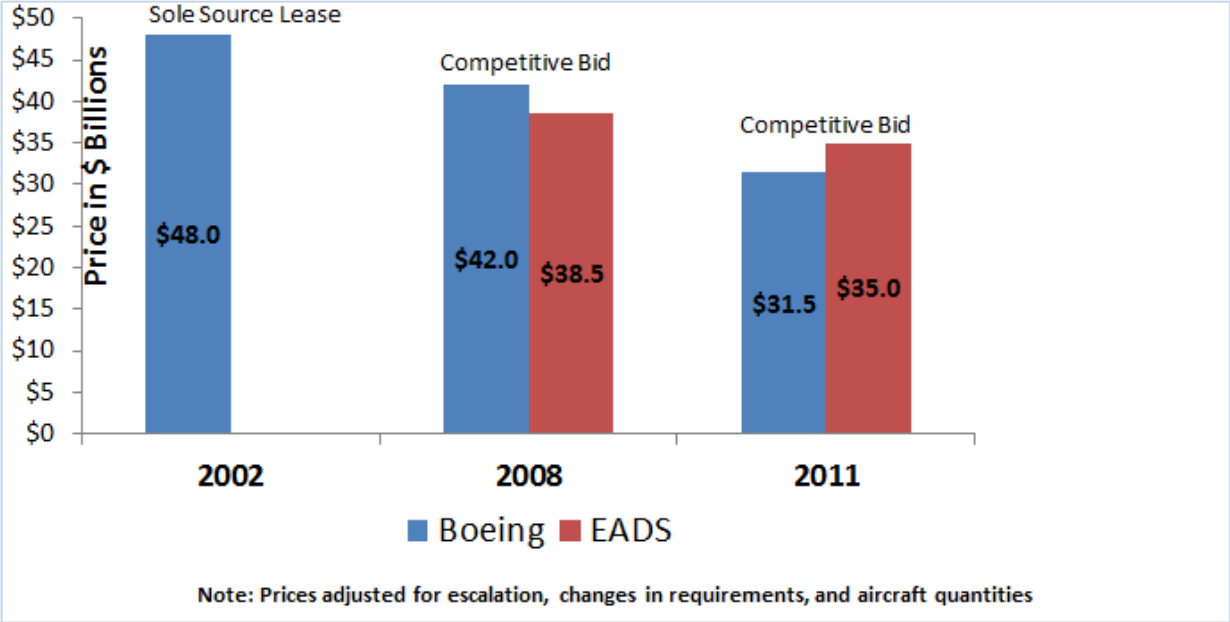
- **Excessive oversight**

  Defense acquisition management is based on a pronounced lack of trust. According to the 2006 *Defense Acquisition Performance Assessment*, "Quantity of review has replaced quality." The report also asserts that "oversight is preferred to accountability" as made clear by the myriad of regulations with which defense contractors must comply—regulations that are often selectively enforced and generally have no impact on national security, system performance, or accountability to the taxpayer.

  This problem is not at all new. In 1992, Murray Weidenbaum wrote that "Government policy-makers in the area of military contracting do not consider the cumulative and negative long-term impacts of this detailed oversight on company initiative and entrepreneurship." The same could be said today.

  The regulatory environment also significantly raises the barriers to entry for commercial firms that do not traditionally do business with the DoD—but are the source of many innovative dual-use technologies. These barriers include unique government procurement and oversight requirements, issues with intellectual property ownership, unique security requirements, export controls, and unique government cost accounting requirements.

  These effects must be mitigated by reducing these barriers to entry that limit the attractiveness of defense contracts to commercial firms. Additionally, acquisition strategies that rely on open system architectures should be used to enable greater competition; this can be especially effective at the lower tiers. Indeed, the DoD must also seek to fully leverage the benefits of global competition by encouraging companies from allied countries to compete for programs, especially when there is only one domestic source. The figure below shows the bid history for the Air Force's KC-X program following the cancellation of the original, sole source lease in 2002. The first contract award (to EADS) was protested by Boeing, and subsequently recompeted. The final contract was awarded to Boeing and resulted in significant savings to the Air Force.



KC-X Bid History

- **Inadequate engagement with industry**

  FAR Part 15.2 encourages exchanges with industry; yet engagement with industry is often adversarial, arms-length, and transactional. Even early in the process, program managers tend to limit communication with industry out of fear that they will provide competitors with grounds for a bid protest. Because the DoD's objectives are not clearly communicated, members of the defense industry often are unable to make the proper capital investments, direct the best use of limited R&D resources, or inform the DoD of the developments that they have achieved. This is especially true with regard to small businesses and non-defense firms.

- **Funding instability and poor cost estimates**

  Acquisition planning and strategies are often challenged by fluctuations in program funding. Program appropriations are subject to yearly changes by Congress. Secretary of Defense Jim Mattis described the problem in stark terms: "Despite the casualties, the loss of wonderful, beautiful young troops, thousands of them over the last sixteen-odd years, nothing has done more damage to the readiness of our armed forces than the continuing resolutions that stop us from taking initiative, than the lack of budget predictability" (Mehta, 2017, p. 1).

  At the same time, poor cost estimates, typically the result of optimistic assumptions, lead to program underfunding. As a result, the DoD must shift its priorities, which impacts the development and procurement of future programs and the sustainment and readiness of current ones. Moreover, poor estimates impact overall funding stability, when too many

programs are initiated based on optimistic estimates, laying the foundation for future budgeting challenges. As a result, the DoD's ability to realize efficient development and rates of production is compromised. This often leads to schedule slips and decisions to reduce procurement quantities, reducing value to the taxpayer. On the industry side, budget uncertainty makes business planning and supply-chain management difficult, generally leading to uneconomic outputs.

- **Lack of leadership**

  Accomplishing long-term goals and policies is unrealistic when the positions with the most decision-making authority often lack the requisite experience and have a high level of turnover. The secretary of defense has a tenure averaging 30 months; the deputy secretary of defense tenure averages 23 months. Average tenure among other senior-level political positions ranges between 11 and 20 months. For 39 major acquisition programs started since March 2001, the average time in development was about 37 months. The average tenure for program managers of these programs during that time was 17.2 months (GAO, 2008a). Adding to this problem is the fact that vacancies last approximately 20 months for DoD political appointees. When positions are left vacant for long periods of time, and then turnover quickly once filled, priorities can change frequently. This has repercussions throughout the chain of command because DoD personnel are unable to anticipate how future resources will be allocated.

  Short tenures also provide incentives for making decisions that value short-term over long-term benefits, and create challenges with accountability; individuals may leave before the consequences of their decisions are fully realized. Finally, with so many senior-level DoD officials with a stake in acquisition programs, it is difficult to assign responsibility to any one individual for the outcomes of defense acquisition programs.

- **A challenged acquisition workforce**

  The composition (number and skills) of the acquisition workforce has a direct impact on the performance of the defense acquisition system. This workforce must be empowered to respond to a volatile international security environment, rapidly changing technology, a wide array of new military operations, significant budgetary pressure, and many legislative and regulatory changes. The impact of these considerations on the acquisition workforce has been significant—demanding new skills and acquisition strategies, as well as additional personnel. Unfortunately, the DoD faces several challenges in this regard, including a wave of retiring experienced workers, difficulties in recruiting, training, retaining new employees, and significant gaps in existing employee experience and credentials. In the words of the DBB (2012), "the acquisition workforce has atrophied." This challenge is only exacerbated by the barriers that hinder the movement of skilled acquisition professionals between the private and public sector, which must be reduced.

Mid-level private sector professionals should be actively recruited to bridge talent and experience gaps.

Additionally, the lack of clarity surrounding lines of authority and accountability, especially with regard to program managers (PMs) and contracting officers (COs), has resulted in growing tensions that can contribute to poor outcomes. The contracting officer binds the government to a contract, the legal document that specifies program requirements. In many instances, however, the CO does not report administratively to the PM who, of course, is responsible for overall program success, including contract execution. From the CO's perspective, success is often construed narrowly. Was the contract awarded? Were protests avoided? Have costs been minimized? (National Academies of Sciences, Engineering, and Medicine, 2016). In fact, COs often dictate contract type and terms to the PM, which can lead to negative outcomes (e.g., contracts may not take advantage of some of the flexibility available in the FAR; program managers may be prevented from hiring highly skilled engineering talent). As stated earlier, the focus must shift back to affordably providing the required capability to the warfighter, not exclusively on controlling costs and minimizing profits.

Laying the Groundwork

Once the working group agreed upon this list of challenges, it reviewed commercial best practices, other U.S. government agencies' acquisition processes, as well as some of our international partners' acquisition systems in order to inform the development of a new process.

Commercial firms— e.g. Boeing, Caterpillar, Cummins, Honda, and Motorola Solutions—use a process that is significantly more streamlined than that traditionally used by the DoD for major defense acquisition programs. Companies minimize the levels of review that determine whether a program is ready to advance to the next acquisition phase, resulting in a quicker, more efficient process. Senior management approval is only needed for a few of the most critical documents, i.e., the business case documents. Generally, commercial firms prepare documents similar to those used by DoD programs, such as development, test, engineering, and manufacturing plans, but most are approved at the program level with only a summary provided to the senior leadership for review (GAO, 2015a).

With regard to other agencies' acquisition processes, we noted that some, including NASA, invest more heavily in upfront systems engineering. NASA's process for acquiring flight systems is divided into two major phases: formulation and implementation. The official "program start" occurs only after the formulation phase is concluded. Similarly, we found that, in general, our international partners also dedicate more time and effort to systems engineering prior to the formal start of a program. The acquisition processes that they use then tend to rely on fewer milestones, with system cost and performance data that are more transparent. We also observed that some defense processes, including the U.K.'s, better facilitate trusted interaction between industry and government. "Smart Acquisition" initiatives introduced in the early 2000s saw the

implementation of long-term partnering (LTP) agreements in place of what were once described as taut, adversarial relationships between government and industry.

The DoD's Acquisition system must be refocused on warfighter requirements. Based on our examination of deficiencies within the existing system, in addition to our examination of commercial and international practices, we summarize seven categories of corresponding, corrective action.

Requirements

Leaders, at all levels, need to carefully guard against the additive result from incremental requirements increases, known as "requirements creep." Ineffective control of requirements changes (i.e., adding, deleting, and modifying a system's requirements during the development process) leads to cost growth and program instabilities. High levels of requirements volatility extend development, and, as a result, long-duration programs are viewed as works in progress that often fail to deliver the functionality initially envisioned. Consequently, failure to aggressively monitor and manage a system's requirements increases the development time and cost. Furthermore, based on the lengthy development cycles, our adversaries are often operating inside our "OODA loop"[1], putting the DoD in the positon of constantly reacting to their advances.

To mitigate these challenges the DoD should develop mission-focused, evolving requirements that can be adapted to counter changing threats, using a modular open systems approach to enable customization and modernization. The reality is that DoD can no longer tolerate a linear process, and must move to a more adaptive process.

Process

The DoD acquisition process (i.e. acquisition, budget, and capabilities) must be streamlined, integrated, and mission-focused. Clear lines of responsibility, accountability, and authority must be defined within a new culture that has incentives to encourage moderate risk taking and innovation. This agile system must effectively manage program risk and balance functional requirements (contracting, legal, audit, financial, airworthiness, testing, etc.) with a primary focus on mission outcomes.

Sustainment

A significant share of a major weapon systems' life-cycle costs are incurred during sustainment. Although there are a number of mechanisms that can be used to reduce sustainment costs, the most effective actions are those that are taken during the system's development. In the commercial sector, the customer's expectation is that "when I turn the key it starts!" This imperative should be extended to the warfighter; an agile, expeditionary force must have reliable

[1] The phrase OODA loop refers to the decision cycle of observe, orient, decide, and act. This concept was first applied to the combat operations process, often at the strategic level. It this use we are applying the idea to the acquisition process.

systems. To ensure the appropriate consideration, two performance metrics, availability and reliability, should be treated as operational requirements and defined early, during trade-off analysis following robust and collaborative lifecycle cost analyses. For deployed systems, outcome/performance-based contracts have proven to be efficient and effective; however their use has been declining.

Oversight

The DoD must identify and potentially eliminate information requirements and reviews, when they have been demonstrated to add little value, or are no longer needed. For the necessary reviews and information requirements, alternative approaches must be considered, such as consolidating information requirements and delegating approval authority, which would provide for a more efficient milestone process.

Too often, DoD guidance can have the effect of constraining acquisition professionals' ability to "think critically," making it more difficult for the DoD to achieve best value. For instance, early in this decade Services and agencies responded to budgetary pressures by encouraging their reliance on lowest price technically acceptable (LPTA) criteria in assessing offerors' submissions. According to the GAO, use of LPTA within the DoD rose by 38% between 2009 and 2013 (Goodman, 2015). In many organizations LPTA became the default source selection strategy, even when it was clearly inappropriate.

Industry Engagement, Trust, and Transparency

In the interest of program performance, the DoD must foster greater communication between program offices and their industry partners to improve trust and transparency, while maintaining high ethical standards. The goal must be to improve collaborative engagement so as to develop an interactive government/industry partnership that culminates in the rapid delivery of improved capabilities to the warfighter. Both parties must work to build and sustain relationships characterized by trust and transparency. For its part, industry must provide the required capability fast, while providing the necessary degree of transparency (opening its books) to its customers.

Funding

Although Congress controls program funding, the DoD can improve funding stability by ensuring that program estimates are accurate. To that end, programs should use and budget to independent, realistic estimates.

Leadership

Every effort must be made to ensure that DoD's senior leaders responsible for acquisition have the appropriate experience (to include private industry experience) for their positions, are confirmed early, and are incentivized to extend their tenures. Improved coordination of Secretariat and Service staffs would help to improve the integration of the acquisition, requirements, and resourcing processes, enabling better cost, schedule, and requirements trade-

off decisions, helping to ensure more executable programs. At the program level, all possible actions must be taken, and incentives created, to ensure consistent high-performing program leadership by maintaining the stability of key personnel in order to increase program stability and accountability.

Acquisition Workforce

The success of any reform effort will rest on have the required human capital required for today's acquisition environment. To develop that workforce we believe that DoD must:

- strive for achievement of a high-quality, not merely a high-quantity, workforce;
- enhance recruitment by focusing on employing mid-level acquisition personnel through expanding internships and collaborative educational programs;
- accelerate efforts to streamline hiring processes;
- reduce barriers to enable and institutionalize mobility between government and industry;
- provide competitive wages, through revision of compensation packages to ensure current employees and potential hires are paid salaries comparable to the private sector; and
- examine the benefits of incentivizing employees for improved performance.

Toward Capability-Based Acquisition

Of course, in light of today's national security environment, the new process must do more than correct for existing deficiencies. A short cycle must be an inherent feature of the new process's design. The process must be responsive to changes in the threat environment such that new features can be quickly and easily incorporated into subsequent versions of the product or system at an affordable cost, so we rebalance the cost exchange ratio, where our adversaries are currently leading. In a word, the process must be agile. Today's process is rigid, in large part, because it relies on a lengthy, linear trajectory that is often unable to incorporate user feedback and is resistant to new capability insertion. In addition, the new process must move from one that is product-based to one that is capability-based and into one that incorporates cross-platform optimization; and, most importantly is focused on providing the require warfighter capabilities. The process must be aligned with the evolution of the actual threat, and not just the operational status of the platform designed to counter it. The DoD's current approach to identifying and acquiring the needed military capabilities is inadequate.

The GAO has conducted several reviews of the Joint Capabilities Integration and Development System (JCIDS). In 2008, it reported that the process is ineffective in "identifying and prioritizing warfighting needs from a joint, department-wide perspective" with most proposals for new capabilities sponsored by the individual military services (GAOb, 2008, p. 9). Specifically, JCIDS does not always consider trade-offs among cost, schedule, and performance objectives; prioritize requirements; consider redundancies across proposed programs; or prioritize and analyze capability gaps in a consistent manner (GAO, 2011). Additionally, JCIDS guidance does not require programs to provide complete and detailed sustainment information in the key areas of materiel availability, operational availability, reliability, and ownership cost

(GAO, 2012). Finally, and perhaps unsurprisingly, thousands of lower-level requirements are still defined after the start of a program, leading to uncertainty with regard to costs and capabilities (GAO, 2015b).

Unfortunately, little progress has been made in addressing these issues. In August of 2015, the GAO reiterated its findings, asserting that the process by which the DoD acquires its $1.4 trillion worth of weapons systems is "disjointed and potentially duplicative" (Koenig, 2015, p. 1). An October 2015 survey by the Government Business Council lends credibility to these findings. The survey indicated that 25 percent of Defense personnel were "not at all confident that the acquisition process provides the military services with the weapons they need." Forty-two percent were only "somewhat confident" (Weisgerber, 2015, p. 1).

It should be recognized that selecting the right mix of systems, one that can effectively counter current and emerging threats, is only part of the solution to a larger problem. For not only must the DoD invest in the right systems, but these systems must be integrated to deliver the required military mission effects. And, in the current fiscal environment, this must be accomplished as efficiently as possible. Solving this larger problem requires a new approach to weapons systems acquisition.

The DoD has taken a step in the right direction in establishing an office responsible for mission engineering. Mission engineering is defined by the DoD (2017) as "the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to achieve desired warfighting mission effects." This approach stands in contrast to conventional acquisition approaches that are generally service-and platform-centric. Typically, systems are designed, developed, procured, managed, reviewed, budgeted, and supported on an individual basis. Similarly, individual program offices generally have segmented authority and responsibilities that only permit management of singular programs. When employed, systems are integrated with one another to provide the required military capabilities.

With a mission engineering approach, the platform-related constraints that characterize today's programs are explicitly deemphasized. According to the Navy (2012), ME consists of the development of "system-agnostic mission threads." In other words, the starting point is the mission capability, not the system. Strategies would center on how to provide required military capabilities—e.g. air defense, precision strike, battlespace awareness, or search and rescue—which, in many cases, would consist of systems from multiple services. Technical trades would exist at multiple levels, not just within individual services, systems, or components. With ME, there is explicit recognition that desired outcomes can be achieved using different combinations of systems and processes. The challenge lies in determining the combination that maximizes effectiveness and affordability.

ME also has the potential to mitigate, or at least better anticipate, unwanted emergent behaviors that today's acquisition strategies are not designed to predict. For example, the Navy (2012) has asserted that "current processes at the system and platform levels have unknowingly created safety issues at the mission level." Without a change in acquisition strategy, this challenge will

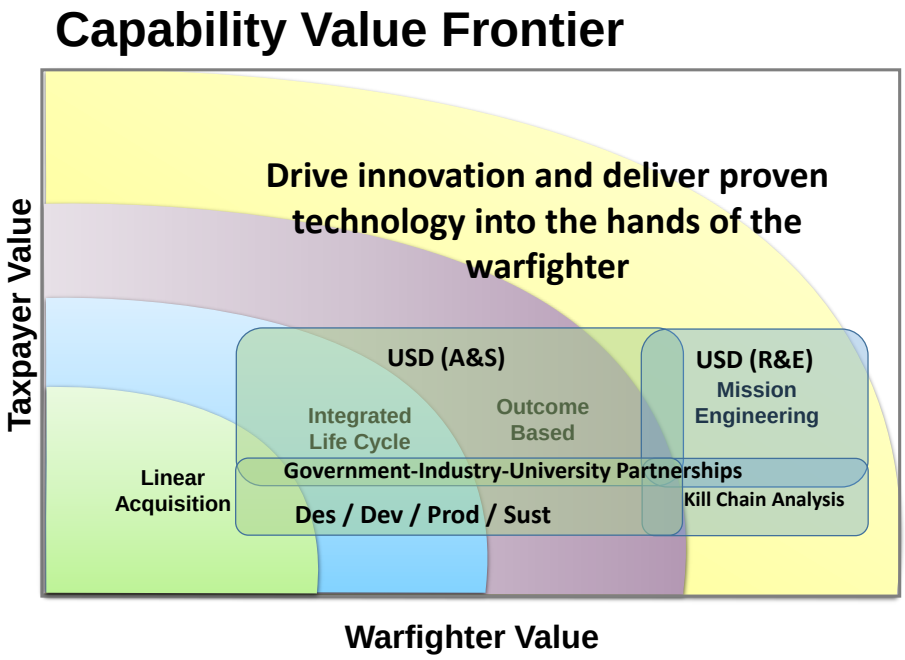
only grow as increasingly complex systems are deployed to counter threats in today's rapidly-changing environment.

To be maximally effective, ME strategies will have to be applied at the kill chain level. ME requires allocation of functions and integration across services, programs, and systems. Performance, cost and schedule trade-offs will need to be made at levels higher than the individual system or even system-of-systems. The distributed ownership and advocacy of individual systems creates a problem that new governance mechanisms must be designed to address. Without adequate mechanisms, program managers will continue to develop their systems in accordance with their program priorities, optimizing each individual system will likely result in a suboptimal mission capability.

The DoD (2017) believes that "well-engineered, composable mission architectures" will promote resilience, adaptability, and the rapid insertion of new technologies. We agree. We believe that ME may be effective in helping to solve a longstanding problem—long weapon system acquisition cycles and the resultant obsolescence, which can occur even before the system is fully fielded. The diagram below depicts the conceptual value—to both the warfighter and taxpayer—of the Mission Engineering approach.

The DoD has already started to move toward mission-centered acquisition as made clear by the proposed reorganization. First, there is the formation of the Strategic Intelligence Analysis Cell which is under the purview of the newly-created Office of the Undersecretary of Defense for Research and Engineering (USD (R&E). The new organization is to be responsible for "understanding the enemy's capabilities and vulnerabilities, conducting analysis on U.S. capabilities, tracking technology trends across the globe and assessing potential/emerging threats and/or future opportunities that warrant action [and/or] that merit investment" (DoD, 2017, pg. 8).

Second, the new organization creates a position for the Deputy Assistant Secretary of Defense for Mission Engineering & Integration, which will be responsible Developmental Planning and Mission Engineering Analysis (assured integration of capability). This organization will be tasked to establish a Department capability for "Joint Mission Engineering that analyzes and recommends technologies that eliminate or disrupt adversary kill chains or, alternatively, that deliver superior Blue Force kill chains" (DoD, 2017, pg. 12). Together, with the analysis from the Strategic Intelligence Analysis Cell, the recommended solutions should provide cost effective mission capabilities.



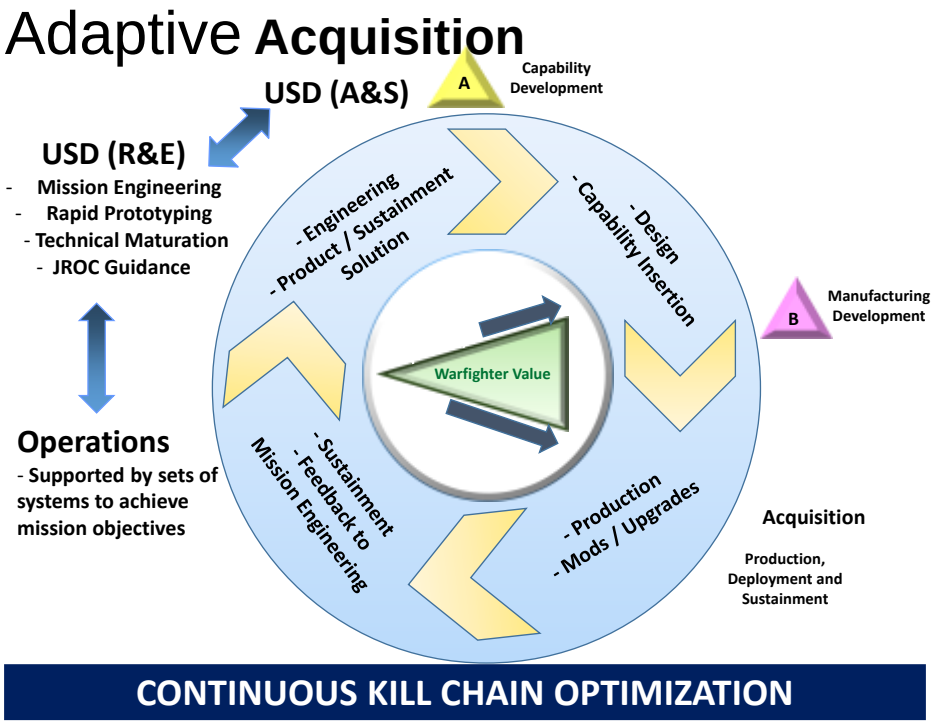
We also recommend that USD (R&E) co-chair the JROC, to ensure that requirements are imbued with technical pragmatism, i.e. they are achievable and affordable. Moreover, it is imperative that an enterprise-wide systems engineering master plan be developed prior to the development of any large-scale, complex system. The functional decomposition must be detailed enough so that the performance of the individual elements can be adequately specified. It is not enough to assume that a general architecture description will be able to provide the requisite detail for contractors to develop interoperable systems. Upfront systems engineering need not impede a system's technical evolution, but, on the contrary, should enable it.

Furthermore, the role of USD for Acquisition and Sustainment (A&S) should be centered on development, production, and sustainment activities. The Office of the USD (A&S) should focus on several priorities: developing and maintaining a systems engineering capability within the A&S organization, realigning the PEO structure to mission engineering portfolios, ensuring that programs make use of mature technologies (TRL 9), and reaffirming the primacy of program managers with regard to accountability and responsibility for program outcomes.

The Proposed New Process

The study group recommends a new, closed-loop (as opposed to linear) process. We believe that this process will provide continuous, iterative, delivery of improved capabilities. It begins with the users' operational mission requirements. Based on the JROC's guidance, the mission engineering analysis to identify the kill chain optimization will be initiated and will consider technologies that will be mature at the program's initiation. Once the mission systems are identified (new, existing, or modified) and the architecture is developed, the program can

proceed to Milestone A. Following approval, the USD (A&S) will initiate development, production, and deployment.



In line with our recommendation to streamline the acquisition process, eliminate documentation, and emphasize trust (over oversight) the new process eliminates Milestone C—the goal of which was "to determine if a program met all its Exit Criteria of the engineering, manufacturing, and development (EMD) phase to proceed into production and deployment (PD)." We regard this as a relic of the industrial age that has no place in today's acquisition system. The fact is that today low-rate initial production proceeds through block buys of improved capability; often, no meaningful distinction need be made between LRIP and formal production. Once the capability is deployed, it is continuously evaluated against evolving military requirements. As necessary, elements of the capability—system components, systems, and systems-of-systems—are honed to meet requirements in an uninterrupted closed-loop process.

Summary of Key Recommendations

- The Secretary of Defense should ensure that a robust mission engineering capability is established (to include networking the Component battle labs) within USD (R&E). Additionally, the USD (R&E) should be designated as the co-chair of the JROC.
- The focus of USD (A&S) should be on design, development, production, and sustainment of systems.
    - To accomplish these, a systems engineering capability must be developed and maintained within A&S organization.
    - The PEO structure must be realigned to correspond to the mission engineering portfolios.
    - The USD (A&S) must insist on mature technology (TRL 9) for inclusion in new systems.
    - The USD (A&S) must also re-affirm PM as accountable and responsible.
- Simplify the Acquisition Process
    - Eliminate unnecessary documentation.
    - Streamline milestone documentation providing a single, integrated plan to MDA, with detailed plans approved at a lower level.
    - Eliminate milestone C; in reality LRIP equals production.
- Rapidly implement outcome / performance based contracts for sustainment.

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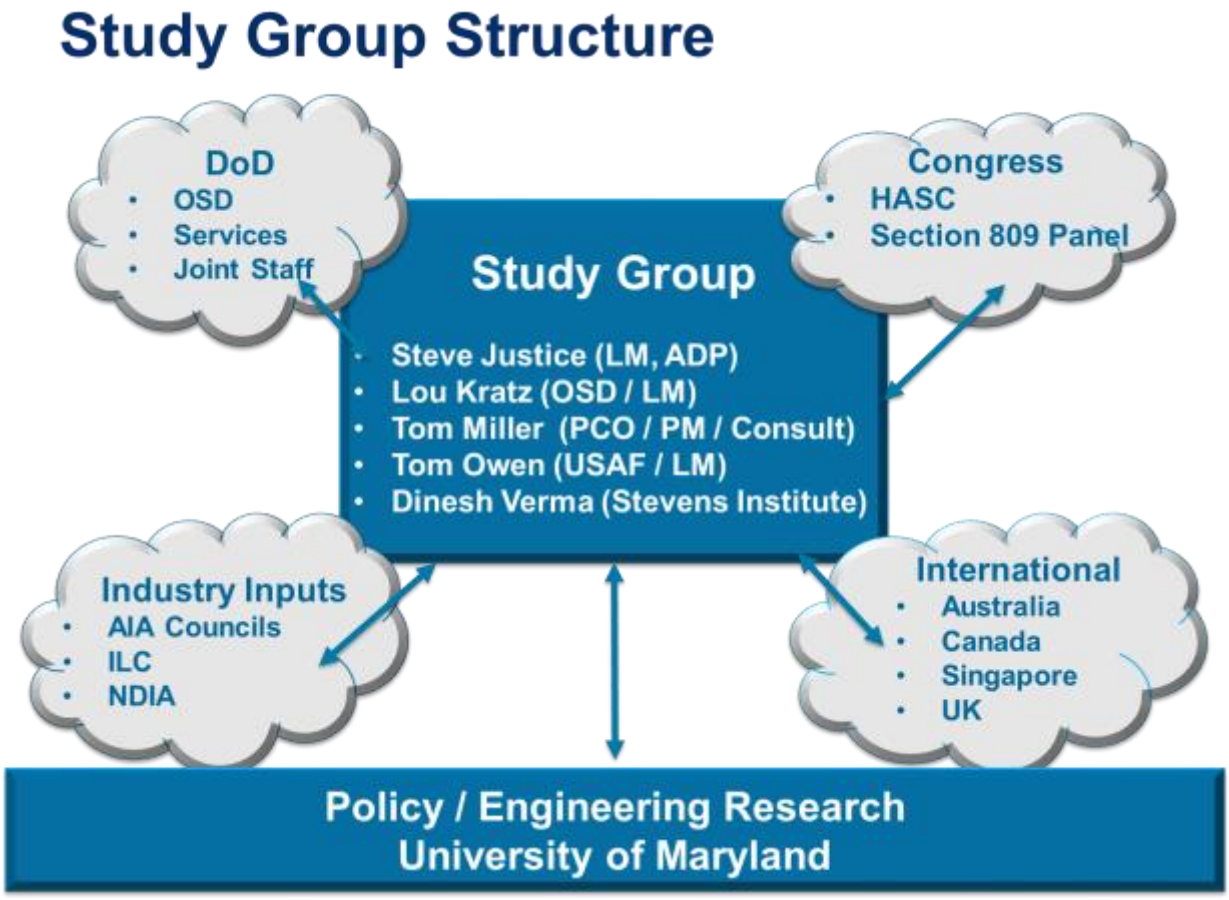
Appendix I Workshop Participants



Appendix II

Historical Cost and Schedule Growth Studies

Source	Sample	Findings
Fox 2012	38 major programs in '60s	38 ongoing programs in 1969 had cost estimates 50% higher than original
RAND 1979	17 mature programs in '70s	Mean cost growth was 34%, dollar weighted mean cost growth was 20%
RAND 2006	46 completed programs from 1968-2003	Mean total cost growth, adjusted for quantity changes, was 46% from Milestone II baseline
RAND 2008	35 completed programs	Total cost growth was 60%: 12.9% for requirements, 21.9% for quantity, 10.1% for cost estimate, 8.9% for schedule changes
2013 Performance of the Defense Acq System	MDAP Development Contracts (1970-2011)	Total median cost growth is 44% for the Army (97 programs), 30% for the Navy (146), and 31% for the Air Force (179)
2014 Performance of the Defense Acq System	Sampling of Development and Production MDAPs 2001-2013	Mean cost growth for development: 48-87% Mean cost growth for production: 18-30%

Appendix III

Key Problem Areas in Defense Acquisition (Program Factors)

Source	Sample	Findings
RAND (1993)	197 programs reporting through SAR in 1990	"No single factor explains a large portion of the observed variance on cost growth outcomes."
IDA (2004)	138 post- MS II programs with at least 3 years EMD	Cost growth causes: a decision to increase the capabilities of the system, an unrealistic cost estimate, poor program execution, and budget instability.
OSD CAIG (2006)	142 post-MS II programs	13% of total cost growth attributed to "decisions", 19% to "mistakes".
RAND (2008)	35 completed programs	Average cost growth was 60%: 13% attributed to requirements changes, 22% to quantity, 10% to estimating, 9% to schedule.
USD, AT&L (2014)	21 Nunn-McCurdy breaches since 2009	48% of breached programs impacted by poor program management, 29% by unrealistic baseline estimates.
IDA (2014)	151 of 309 MDAPs that filed at least one SAR between 1969 and 2007	PAUC growth tends to be substantially higher in a Relatively Constrained funding climate than in the Relatively Accommodating climate
IDA (2015)	119 programs experiencing cost growth during various "acquisition regimes"	Programs entering EMD during "bust" phases of the DoD's "boom-bust" funding cycle had much higher APUC cost growth than those entering during "boom" climate.
GAO (2016)	16 programs in production with largest development cost percentage increases during fiscal year 2016	Primary cause for development cost increase: 5 programs exhibited "deficiency" and 11 programs, "unplanned capability."

Key Problem Areas in Defense Acquisition (Process Factors)

Source	Sample	Findings
Defense Acquisition Performance Assessment Panel (2006)	Survey of senior government and industry executives	The "top five" problem areas: requirements management; budget and funding instability; technology maturity; organization, responsibility, authority and accountability; and regulation and policy interpretation.
DSB (2009)	Collaboration among 10 senior level executives	"Buy the right things;" Leaderships needs relevant experience; streamline acquisition process; improve execution
DBB (2012)	300 studies of the DoD's acquisition system from 1986 to 2011	The acquisition system is too complex; coordination between acquisition and requirements process is inadequate; acquisition workforce has atrophied.
GAO (2015)	Survey of 24 program managers and 40 other DoD officials	Acquisition programs spent, on average, over 2 years completing numerous information requirements for their most recent milestone decision, yet acquisition officials considered only about half of the requirements as high value.

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