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Research Report

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Improving Defense Acquisition

Insights from Three Decades of RAND Research

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About This Report

Improving the U.S. Department of Defense (DoD) acquisition system—the management and development processes by which the department acquires, develops, and sustains weapon systems, automated information systems, and services—has been an issue of sustained interest to policymakers since the beginning of the military establishment. Numerous actions have been initiated and implemented over decades to rein in the increasing life-cycle costs and to ensure a timely delivery of these systems to meet U.S. security needs. In 1986, a confluence of trends external and internal to the department prompted Michael Rich, Edmund Dews, and C. L. Batten, Jr., to write *Improving the Military Acquisition Process: Lessons from Rand Research*. In that report, the authors identified major trends expected to affect the acquisition of defense systems for DoD and drew on RAND Corporation research to develop a strategy for meeting the challenges imposed by these trends. Like that earlier work, this report is informed by open-source documents and draws on insights from publicly available RAND research to suggest potential improvements that might help address challenges in the defense acquisition process. The issues that we highlight are also informed by other organizations examining defense acquisition issues.

We expect this document to be of interest to DoD policymakers, congressional lawmakers and their staffs, and anyone interested in the acquisition of defense systems.

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We also thank our colleagues John Birkler, Irv Blickstein, and Cynthia Cook for their thoughtful reviews, additions, and suggestions for improvement. The report was substantially improved by and benefited from their insights. Any errors or oversights are ours alone.

We dedicate this report to Michael Rich, RAND president and chief executive officer. He conceived of a similar report in 1986 that this report is intended to update.

Summary

This report highlights the RAND Corporation's work over 35 years (1986–2021) analyzing and addressing challenges that the U.S. Department of Defense (DoD) has faced in acquiring weapon systems. We address strategic acquisition issues and offer approaches to meeting present-day acquisition challenges.

We begin by noting four overarching trends that affect the DoD acquisition system—the management and development processes by which the department acquires, develops, and sustains weapon systems, automated information systems, and services. First, **geopolitical changes** have widened the threat landscape; in addition to a resurgent Russia, growing Chinese economic and military power poses new threats to U.S. interests, while Islamic extremism remains a potent force. **Globalization** has altered the economic and technological landscape, creating new opportunities, as well as challenges, for DoD. Furthermore, the United States has **changing national priorities**: Defense issues remain important, but domestic policy issues compel policymakers to prioritize attention and resources. Lastly, **advancing commercial technologies** are creating new challenges and opportunities for an acquisition system that was not designed to import and adapt technologies developed outside the traditional defense industrial base.

These trends are linked to the following challenges for DoD's acquisition of weapon systems:

- **Responding to evolving missions.** A wider range of missions demands a more flexible, responsive, and faster approach to acquisition.
- **Leveraging a changing defense industrial base.** The prominence of the commercial technology sector, a consolidating defense industrial base, and a challenging contracting environment demand attention.
- **Accommodating interoperability.** Increased cooperation among U.S. components, allies, and partners requires weapon systems that are more interoperable.
- **Building in cybersecurity.** More-sophisticated cybersecurity threats that can disrupt, damage, degrade, or destroy system capabilities require more attention to securing systems.
- **Planning for technology refresh and insertion.** Longer service lives of weapon systems may require more attention to designing systems with modular or easily upgradable characteristics.
- **Rebuilding the acquisition workforce.** Underinvestment in maintaining the acquisition workforce in the 1990s has weakened the workforce's capability to manage an increasingly complex acquisition system.
- **Managing the acquisition cost of systems.** Weapon system cost growth continues to be a concern.

- **Aligning incentives, organizations, and processes to acquisition goals.** The complexity of the acquisition landscape has grown, making it essential to reconsider the organizational and procedural norms to ensure alignment.

RAND research on acquisition can offer significant insight into confronting these challenges. No new primary research was conducted for this report; rather, we examined findings from 44 publicly available RAND reports on acquisition published between 1986 and 2020. That examination led us to the following three overarching insights:

- To achieve desirable acquisition outcomes, **acquisition strategies, organizational roles and responsibilities, and reporting structures must be tailorable to the unique characteristics of each program**. There is no one-size-fits-all approach that works with every program, and attempts to force programs into a single paradigm lead to problems and inefficiencies.
- It is important to broaden and plan for the defense industrial base. **An inclusive industrial base must be better engaged to fully exploit its innovation potential** and must be focused on sustaining key parts of the defense industrial base.
- **The acquisition workforce must be properly sized, trained, and incentivized to make the smart decisions that flexible acquisition approaches and partnering productively with industry entail.**

In addition, in 1986, RAND published a report by Michael Rich, Edmund Dews, and C. L. Batten, Jr., that similarly drew on RAND research to identify major trends expected to affect the acquisition of defense systems for DoD.[1] An element of that report that continues to be as relevant now as it was then is that DoD needs to continue improving its ability to track and analyze important attributes of the acquisition system. Broadly improving acquisition data collection and analysis would help DoD evaluate the effects of major changes in acquisition policy and better plan for the long term.

In closing, because most reforms require several years for their full effects to be realized, DoD must be patient in letting acquisition reforms play out before implementing additional changes. Indeed, since its inception, DoD's acquisition system has been subjected to a nearly constant stream of reform initiatives, many of which harken to earlier efforts whose effects may not have been fully assessed. Thus, it is only through a patient, data-driven evaluation of reform initiatives that DoD can tell what worked, what did not, and where DoD should go to improve acquisition outcomes.

[1] Michael Rich, Edmund Dews, and C. L. Batten, Jr., *Improving the Military Acquisition Process: Lessons from Rand Research*, Santa Monica, Calif.: RAND Corporation, R-3373-AF/RC, 1986.

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1. Introduction

Improving the U.S. Department of Defense (DoD) acquisition system—the management and development processes by which the department acquires, develops, and sustains weapon systems, automated information systems, and services—has been of sustained interest to policymakers since the beginnings of the military establishment. In 1986, a confluence of trends external and internal to the department prompted Michael Rich, Edmund Dews, and C. L. Batten, Jr., to write *Improving the Military Acquisition Process: Lessons from Rand Research*.[2] In that report, the authors examined years of prior RAND Corporation research and identified the following four trends, which they anticipated would have significant effects on DoD's acquisition of systems:

- escalating enemy threats
- resource constraints and uncertainties
- longer retention of weapon systems in the operational inventory
- increasing difficulties of producing at an affordable cost.

Our goal with this report is to look broadly at RAND's acquisition research, as Rich, Dews, and Batten did in 1986. Although the context for weapon system acquisition has changed since 1986, the four trends identified in the earlier work remain just as relevant today for system acquisition in DoD. That said, there have been some additional challenges since 1986 that have affected DoD's acquisition of weapon systems, and we expect them to continue to do so in the coming years.[3] Moreover, defense acquisition reforms have remained a major policy issue and continue to be the subject of significant legislative and regulatory efforts—as evidenced by such initiatives as Congress's Weapon Systems Acquisition Reform Act of 2009, DoD's Better Buying Power initiatives in the early to mid-2010s, a burgeoning set of defense innovation initiatives and organizations since 2014, and the sweeping changes to the DoD acquisition regulation in 2020 that yielded the Adaptive Acquisition Framework.[4] Some may argue that these efforts have been positive steps toward improving acquisition outcomes, but acquisition reform is still very much a concern, as indicated by continued debate in Congress over changes to the acquisition system. Inspired by the approach in Rich, Dews, and Batten (1986), we turned to RAND's research on defense acquisition to understand the current trends and challenges shaping that debate and to identify solutions that might improve weapon system acquisition.

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[2] Michael Rich, Edmund Dews, and C. L. Batten, Jr., *Improving the Military Acquisition Process: Lessons from Rand Research*, Santa Monica, Calif.: RAND Corporation, R-3373-AF/RC, 1986.

[3] These challenges are outlined in further detail later in this report.

[4] Office of the Under Secretary of Defense for Acquisition and Sustainment, *Operation of the Adaptive Acquisition Framework*, U.S. Department of Defense Instruction 5000.02, Washington, D.C., January 23, 2020.

In our view, the continued importance of and changes to DoD's acquisition system present a need to synthesize insights from RAND research since 1986. To that end, we begin with a focus on four major trends that affect DoD acquisition:

- geopolitical change
- globalization
- changing national priorities
- advancing commercial technologies.[5]

Through our review of both RAND research and the broader acquisition policy documents, we determined that these trends are linked to the following challenges for system acquisition in DoD:

- responding to evolving missions
- leveraging a changing defense industrial base
- accommodating interoperability
- building in cybersecurity
- planning for technology refresh and insertion
- rebuilding the acquisition workforce
- managing the acquisition cost of systems
- aligning incentives, organizations, and processes to acquisition goals.

These challenges span modern acquisition programs and therefore represent the variety of potential challenges that a program executive officer might confront when creating an acquisition strategy tailored to a given situation.[6]

RAND research suggests several actions for DoD policymakers and acquisition leaders to consider that may serve as a starting point to address these challenges; achieve desirable weapon system acquisition cost, schedule, and performance outcomes; and inform approaches to developing system performance requirements. These actions are structured around three main themes:

- Acquisition strategies, organizational roles and responsibilities, and reporting structures must be tailored to the unique characteristics of each program.
- An inclusive industrial base must be better engaged to fully exploit its innovation potential.

[5] These trends are a distillation of recurring themes that we identified during a review of existing RAND and external research published since 1986. Themes identified during this effort were discussed with RAND subject-matter experts to flesh out the framework proposed in this report. These trends are not exclusive of additional possibilities; rather, we present a framework to discuss acquisition challenges since the Rich, Dews, and Batten (1986) report.

[6] Some focus areas will be more applicable than others, depending on the unique circumstances of acquisition programs.

- The acquisition workforce must be properly sized, trained, and incentivized to make the smart decisions that flexible acquisition approaches and partnering productively with industry entail.

Methodological Approach and Scope

Our research approach relied on relevant resources to inform the current trends influencing acquisition decisions and leaned heavily on a sampling of RAND's 89 publicly available reports on weapon system acquisition practices since 1986 to draw insights and lessons learned.

We examined reports that touched on broad trends, future challenges to acquisition, and comprehensive solutions, similar to that presented in Rich, Dews, and Batten (1986). We did not substantially use (and do not cite) research that was similar to other later work; for instance, RAND conducted periodic assessments of a defense workforce initiative and acquisition reform activities and did cost and schedule evaluations for specific programs. Instead of examining each assessment, we chose the most recent one that captured the results of all previous iterations. In other cases in which RAND researchers made similar recommendations to address similar problems across different reports, we chose the report that offered the clearest articulation of the argument.

Using these criteria, we identified 44 relevant RAND reports from the initial list of 89 reports published since 1986. We created a spreadsheet template to qualitatively assess reports based on acquisition issues across all military services, the joint establishment, and all warfighting domains and organized in the following 13 topic areas:

- defense acquisition policy
- program cost
- program schedule
- risk in acquisition
- defense industrial base
- defense innovation
- acquisition workforce
- development and design of weapon systems
- lessons learned from acquisition programs
- joint acquisition
- space and cyber acquisition
- data in defense acquisition
- international acquisition.

The appendix provides an annotated bibliography of the 89 reports, by topic area. To provide more context, we also supplemented the broad themes and challenges identified in these reports with themes and challenges identified in other RAND and non-RAND research not related specifically to acquisition.

Finally, we acknowledge that the acquisition system that we examined in this research is only part of the process of developing and fielding weapon systems. The process of setting materiel requirements and resourcing them through the Joint Capabilities Integration and Development System (JCIDS) and the Planning, Programming, Budgeting, and Execution process is also critical and requires further examination. Unfortunately, we were unable to identify recent RAND-published research that tackles these issues. However, we included some insights on these interdependent aspects that were mentioned in the RAND research we did examine.

Organization of This Report

Chapters 2 and 3 characterize the broad trends and acquisition-related challenges that are influencing the defense acquisition process. Those chapters will be of most interest to acquisition policy researchers and political scientists interested in understanding the relationships between geopolitical trends and military acquisition, as well as others focusing on the basic motivators of acquisition policy. Chapter 4 identifies solutions to acquisition-related challenges from the RAND research, and those solutions are organized into three policy themes. That chapter will be of interest to policymakers crafting acquisition reforms or assessing their effectiveness. Chapter 5 offers concluding remarks. Lastly, the appendix provides an annotated bibliography that summarizes all 89 reports we reviewed.

2. Trends

This chapter focuses on four trends affecting the acquisition environment: geopolitical change, globalization, changing national priorities, and advancing commercial technologies. We do not offer a comprehensive treatment of these issues but rather highlight areas that affect weapon system acquisition.

Geopolitical Change

The long Cold War between the Soviet Union and the United States decisively shaped the U.S. defense acquisition system in three ways. First, the Cold War solidified the materiel requirements needed to support U.S. defense around enduring goals optimized for fighting a nuclear-equipped and conventionally dominant adversary.[7] Second, it normalized a resource allocation process that valued sustained, long-term investment around those goals.[8] Third, the defense acquisition process itself became standardized across all of DoD as the Office of the Secretary of Defense exerted more centralized authority.[9]

The fall of the Soviet Union created a unipolar moment in which the United States was the lone great power, and it eliminated the *raison d'être* behind the processes, norms, and incentive structures of the defense acquisition system.[10] The United States' global responsibilities shifted in focus from deterring Soviet aggression to managing and maintaining peace, especially in Southeast Asia, the Middle East, and the Balkans. This proved to be challenging with a post–Cold War military that was much smaller and fiscally constrained.[11]

Two geopolitical trends have ended this unipolar moment. First, the terrorist attacks of September 11, 2001, followed by the U.S. military engagements in Afghanistan and Iraq and the global war on terror, presented non-state actors as a new threat to U.S. interests, particularly in the Middle East and North Africa, but also at home.[12] The United States addressed these threats

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[7] William G. Braun III and Charles D. Allen, "Shaping a 21st-Century Defense Strategy: Reconciling Military Roles," *Joint Force Quarterly*, Vol. 73, April 2014, p. 53.

[8] John Speed Meyers and Jonathan P. Wong, "In Defense of Defense Analysis," *War on the Rocks*, September 2, 2016.

[9] J. Ronald Fox, *Defense Acquisition Reform, 1960–2009: An Elusive Goal*, Washington, D.C.: U.S. Army Center of Military History, 2011, p. 9.

[10] On the unipolar system, see Stephen M. Walt, "Alliances in a Unipolar World," *World Politics*, Vol. 61, No. 1, January 2009.

[11] Bernard Rostker, *Right-Sizing the Force: Lessons for the Current Drawdown of American Military Personnel*, Washington, D.C.: Center for a New American Security, June 2013, p. 13.

[12] Brian Michael Jenkins and John Paul Godges, eds., *The Long Shadow of 9/11: America's Response to Terrorism*, Santa Monica, Calif.: RAND Corporation, MG-1107-RC, 2011, p. 115.

by waging significant counterinsurgency and counterterrorism campaigns that required significant rethinking of DoD's acquisition approach.[13]

Second, and more significantly, peer threats have begun to reassert themselves. China has emerged as a powerful actor on the world stage, and Russia has re-emerged as a spoiler of U.S. interests.[14] China has used its economic power to enhance its security and influence by exerting territorial control in the East China and South China seas, and these efforts threaten U.S. interests in the region.[15] Russia also regained its military footing, fighting military campaigns in Crimea, Ukraine, and Syria while engaging in hybrid war activities in the Balkans. Moreover, both states have articulated foreign policy goals that are inimical to U.S. interests. Both states observed the U.S. military in action in the 21st century and have invested in military capabilities meant to exploit its weaknesses. It is now clear that Russia and China present peer-quality threats to U.S. interests in Europe and Asia.[16]

The upshot of these new geopolitical trends is that they place increasing stress on the acquisition system's foundational assumptions, which were established during the Cold War. Different capabilities might be needed. More-flexible and more-responsive resource allocation might be demanded. The defense acquisition system might need to respond to these imperatives with substantial alterations to its fundamental incentive and priority structures.

Globalization

The trend of globalization, particularly since the publication of Rich, Dews, and Batten (1986), has also had a major impact on the defense industry. Although globalization has political, economic, and cultural components, a helpful macro definition of the term is the "growing economic interdependence of countries worldwide through the increasing volume and variety of cross-border transactions in goods and services and of international capital flows, and also

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[13] Chad C. Serena, *A Revolution in Military Adaptation: The US Army in the Iraq War*, Washington, D.C.: Georgetown University Press, September 2011, pp. 160–174.

[14] Shuxen Chen and Charles Wolf, Jr., *China, the United States, and the Global Economy*, Santa Monica, Calif.: RAND Corporation, MR-1300-RC, 2001, p. 25; and DoD, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, Washington, D.C., 2018. Note that this research was completed in April 2021, before the February 2022 Russian invasion of Ukraine. It has not been subsequently revised.

[15] For a concise summary of Chinese strategic interests and resulting disputes with the United States, see Timothy M. Bonds, Joel B. Predd, Timothy R. Heath, Michael S. Chase, Michael Johnson, Michael J. Lostumbo, James Bonomo, Muharrem Mane, and Paul S. Steinberg, *What Role Can Land-Based, Multi-Domain Anti-Access/Area Denial Forces Play in Deterring or Defeating Aggression?* Santa Monica, Calif.: RAND Corporation, RR-1820-A, 2017, pp. 15–21.

[16] Raphael S. Cohen, Nathan Chandler, Shira Efron, Bryan Frederick, Eugeniu Han, Kurt Klein, Forrest E. Morgan, Ashley L. Rhoades, Howard J. Shatz, and Yuliya Shokh, *The Future of Warfare in 2030: Project Overview and Conclusions*, Santa Monica, Calif.: RAND Corporation, RR-2849/1-AF, 2020, pp. 35–43.

through the more rapid and widespread diffusion of technology."[17] For better or worse, globalization has dramatically changed the nature of virtually all industries throughout the world, including the traditionally insular U.S. defense industrial base.

One of the most-important repercussions for the defense industry from globalization is its impact on the economic potential of various countries interested in developing their own indigenous capabilities. Other countries' improved economic competitiveness has provided further opportunity for defense firms to expand their footprint overseas for a myriad of reasons, including lower labor wages, improved access to raw materials, and occasionally superior manufacturing capabilities and engineering expertise. Although the world's defense industrial base is ever changing, globalization has blurred the difference between domestic and foreign companies.[18] Domestic prime contractors are now more reliant on foreign firms for research and development (R&D) and production, especially in critical lower-tier areas of high technology, such as microelectronics.[19] This could lead to supply-chain risks of guaranteed access, as well as delivery of not only quality components but also embedded threats within those components. This development can certainly optimize DoD systems through augmented performance, competition, and cost reduction, but there is a risk that the diffusion of critical technologies to potential U.S. adversaries could have unfavorable consequences for national security.[20]

Additionally, globalization is blurring the lines of ownership for companies, increasing the possibility that sensitive technologies may be transferred. For example, privately owned companies developing technologies with dual military and commercial uses can raise funds or attract investment from international sources.[21] Chinese participation in the U.S. venture capital market increased from an average of about 3 percent of all venture deal value during 2010–2014 to approximately 16 percent in 2015.[22] Additionally, foreign merger and joint venture activity in commercial aerospace may provide further avenues for foreign access to sensitive technologies, although current activities

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[17] International Monetary Fund, *World Economic Outlook—Globalization: Opportunities and Challenges*, Washington, D.C., May 1997, p. 45.

[18] For an in-depth analysis of this trend and its consequences on U.S. national security, see Caolionn O'Connell, Elizabeth Hastings Roer, Rick Eden, Spencer Pfeifer, Yuliya Shokh, Lauren A. Mayer, Jake McKeon, Jared Mondschein, Phillip Carter, Victoria A. Greenfield, and Mark Ashby, *Managing Risk in Globalized Supply Chains*, Santa Monica, Calif.: RAND Corporation, RR-A425-1, 2021.

[19] O'Connell et al., 2021.

[20] The movement of critical technologies, especially dual-use technologies, to potential peer and near-peer threats can occur through foreign direct investments and cross-border mergers and acquisitions. This underlies a 2021 effort by DoD to identify trusted funding sources for defense technology startups. See Jackson Barnett, "DOD Nudges Innovative Startups Toward 'Trusted Capital' with New Digital Marketplace," *FedScoop*, January 23, 2021.

[21] Barnett, 2021.

[22] Michael Brown and Pavneet Singh, *China's Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable a Strategic Competitor to Access the Crown Jewels of U.S. Innovation*, Silicon Valley, Calif.: Defense Innovation Unit Experimental, January 2018, Chart 1.

have not yet posed a discernable national security threat.[23] The trend toward globalized supply chains and ownership can present a challenge to ensuring a reliable source of critical technology and materials to defense products and the U.S. defense industrial base.

Changing National Priorities

In the immediate post–Cold War period, the U.S. defense budget shrank from 65 percent of all federal discretionary budget authorities in 1986 to 50 percent in the 1990s (see Figure 2.1). Complicating this already challenging reduced-budget acquisition environment was the Goldwater-Nichols Department of Defense Reorganization Act, a 1986 law representing the most significant set of defense reforms enacted in many years.[24] Two casualties of the shrinking defense budgets were the acquisition workforce, which contracted by about half in end strength, and the defense industrial base, which underwent dramatic consolidation.[25] To maintain as much capability as possible, cost savings and process efficiency became the focus of the DoD acquisition system. To attain these goals, DoD allowed some acquisition responsibilities to be transferred from the government to contractors (e.g., the Total System Performance Responsibility initiative[26]).

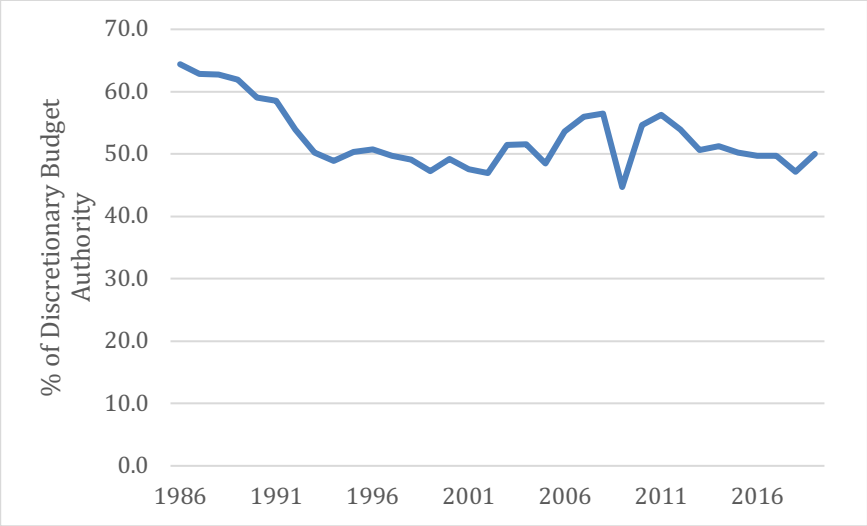
[23] Chad J. R. Ohlandt, Lyle J. Morris, Julia A. Thompson, Arthur Chan, and Andrew Scobell, *Chinese Investment in U.S. Aviation*, Santa Monica, Calif.: RAND Corporation, RR-1755-USCC, 2017, pp. 81–84.

[24] The Goldwater-Nichols Act involved numerous significant changes to the DoD structure, including changes to the military services' role in acquisition. The act is discussed in further detail in Charles Nemfakos, Irv Blickstein, Aine Seitz McCarthy, and Jerry M. Sollinger, *The Perfect Storm: The Goldwater-Nichols Act and Its Effect on Navy Acquisition*, Santa Monica, Calif.: RAND Corporation, OP-308-NAVY, 2010.

[25] For a description of the broad effects of the post–Cold War defense industrial consolidation, see John Birkler, Anthony G. Bower, Jeffrey A. Drezner, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, Fred Timson, William P. G. Trimble, and Obaid Younossi, *Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry*, Santa Monica, Calif.: RAND Corporation, MR-1656-OSD, 2003.

[26] Henry P. Pandes, *A Quest for Efficiencies: Total System Performance Responsibility*, thesis, Maxwell Air Force Base, Ala.: Air Command and Staff College, 2001.

Figure 2.1. DoD's Percentage of All Discretionary Budget Authorities



SOURCE: Authors' analysis of data from Office of Management and Budget, "Historical Tables," webpage, White House, undated, Tables 5.4, 5.6, and 8.7.

The September 11, 2001, attacks and the following decade saw a return to substantial defense budgets, but those budgets prioritized immediate needs over long-term investment.[27] According to the Congressional Budget Office, defense spending increased substantially after fiscal year (FY) 2002, peaking at $800 billion in FY 2010 before dropping to around $700 billion annually in subsequent years.[28] A substantial proportion of these budgets were overseas contingency operation funds, which are meant for immediate operational needs, although these funds have also ameliorated the reductions mandated in the Budget Control Act of 2011. Delays in congressional funding have also affected long-term investments but have left immediate funding needs unaffected.[29]

The budget increase trend leveled off in the early 2010s and fluctuated fitfully in the latter half of the decade. This was driven in one direction by the recognition that the United States faced a resurgent peer and near-peer threat that demanded more (and different) investment. At the same time, non-defense priorities and changing administration priorities tempered increases;

[27] Jonathan P. Wong, *Balancing Immediate and Long-Term Defense Investments*, Santa Monica, Calif.: RAND Corporation, RGSD-378, 2016, pp. 35–36.

[28] All amounts are in constant FY 2020 dollars. See Congressional Budget Office, *Long-Term Implications of the 2020 Future Years Defense Program, Congress of the United States*, Washington, D.C., August 2019.

[29] Stephanie Young and J. Michael Gilmore, *Operating Under a Continuing Resolution: A Limited Assessment of Effects on Defense Procurement Contract Awards*, Santa Monica, Calif.: RAND Corporation, RR-2263-OSD, 2019, pp. 38–39.

the consensus at the beginning of the 2020s is that DoD's topline budgets will be flat or decreasing despite new threats.[30]

Finally, exogenous issues that cannot be addressed by DoD will also alter national priorities as their effects become apparent. The coronavirus disease 2019 pandemic has forced policymakers to reconsider what the United States prioritizes and invests in for national security; initial estimates suggest that the pandemic's economic impact will reduce defense budgets by between $350 billion and $600 billion over ten years, assuming that the defense budget as a portion of gross domestic product is held constant.[31] Climate change has the strong potential to affect military infrastructure and geopolitical security issues.[32] Such issues may eventually force policymakers to devote further attention and resources away from purely national security issues into more-intersectional ones.

Advancing Commercial Technologies

The past three decades have involved accelerating advancements in technology, especially in electronic systems. Since the "second offset" of the 1970s and 1980s and the development of a precision-guided conventional weapon capability in response to a potential non-nuclear Soviet attack on U.S. forces,[33] technological advancement has revolutionized weapon system capabilities in data collection and processing; transmission and communications; precision targeting; power generation and distribution; unmanned and autonomous systems and machine learning; networked and integrated systems; speed, stealth, and lethality; and other areas. Over the past decade, DoD has explored these technology areas. In 2018, it summarized these interests in a list of 11 modernization priorities, which we present in Table 2.1.[34] These technologies are distinguished by two characteristics: Many are dual-use,[35] and several of the most-impactful ones are driven by software advancements.

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[30] Kathleen H. Hicks, Andrew P. Hunter, Mark F. Cancian, Todd Harrison, and Seamus P. Daniels, *What to Look for in the FY 2020 Defense Budget Request*, Washington, D.C.: Center for Strategic and International Studies, January 31, 2019.

[31] Daniel Egel, Howard J. Shatz, Krishna B. Kumar, and Ted Harshberger, "Defense Budget Implications of the COVID-19 Pandemic," *Real Clear Defense*, April 7, 2020.

[32] See Abbie Tingstad, *Climate Change and U.S. Security in the Arctic*, Santa Monica, Calif.: RAND Corporation, CT-517, 2019; and Maria McCollester, Michelle E. Miro, and Kristin Van Abel, *Building Resilience Together: Military and Local Government Collaboration for Climate Adaptation*, Santa Monica, Calif.: RAND Corporation, RR-3014-RC, 2020.

[33] Robert Work, "The Third U.S. Offset Strategy and Its Implications for Partners and Allies," speech at the Willard InterContinental Hotel, Washington, D.C., January 28, 2015.

[34] Office of the Under Secretary of Defense for Research and Engineering, "Modernization Priorities," webpage, undated.

[35] Dual-use products have both military and commercial uses.

Table 2.1. DoD Modernization Priorities

Technology	Dual Use?
Artificial intelligence	✓
Biotechnology	✓
Autonomy	✓
Cyber	✓
Directed energy	
Fully networked command, control, and communications	
Microelectronics	✓
Quantum science	✓
Hypersonics	
Space	✓
5G	✓

SOURCE: Office of the Under Secretary of Defense for Research and Engineering, undated.
NOTE: 5G = fifth-generation technology standard for wireless networks.

Many DoD Technologies Are Dual-Use

DoD is increasingly seeing the military benefit of technologies developed by the private sector for commercial uses.[36] A prime example of this trend can be seen in DoD's modernization priorities. As of 2021, the preponderance of research, development, and investment activity for eight of the 11 priorities is commercial (see Table 2.1). This includes activity related to artificial intelligence, which is one of DoD's highest priorities.[37] The dual-use nature of these technologies means that DoD can capitalize on private-sector R&D investment and benefit from a wider innovation base more than ever before.[38]

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[36] Comments by Michael Brown, director of DoD's Defense Innovation Unit, accessible at Ronald Reagan Presidential Foundation and Institute, "Harnessing and Securing American Innovation: How Venture Capital Impacts National Defense," 2019 Reagan National Defense Forum, Panel 5, Simi Valley, Calif., 2019.

[37] Danielle C. Tarraf, William Shelton, Edward Parker, Brien Alkire, Diana Gehlhaus, Justin Grana, Alexis Levedahl, Jasmin Léveillé, Jared Mondschein, James Ryseff, Ali Wyne, Dan Elinoff, Edward Geist, Benjamin N. Harris, Eric Hui, Cedric Kenney, Sydne Newberry, Chandler Sachs, Peter Schirmer, Danielle Schlang, Victoria Smith, Abbie Tingstad, Padmaja Vedula, and Kristin Warren, *The Department of Defense Posture for Artificial Intelligence: Assessment and Recommendations*, Santa Monica, Calif.: RAND Corporation, RR-4229-OSD, 2019, pp. 1–6.

[38] One capability area where these technology trends are converging is in the concept of joint all-domain command and control, which seeks to integrate artificial intelligence (a technology with commercial origins) into a command and control construct to enable faster decisionmaking. See Sherrill Lingel, Jeff Hagen, Eric Hastings, Mary Lee, Matthew Sargent, Matthew Walsh, Li Ang Zhang, and David Blancett, *Joint All-Domain Command and Control for Modern Warfare: An Analytic Framework for Identifying and Developing Artificial Intelligence Applications*, Santa Monica, Calif.: RAND Corporation, RR-4408/1-AF, 2020.

Software-Driven Advances Are Increasingly Important

Additionally, advances in many militarily-relevant technologies are increasingly driven by developments in software.[39] Software development practices differ significantly from hardware development, and these differences can affect defense acquisition processes that have yet to acknowledge software's growing role. First, some software development methods, such as Agile and DevOps, make software a continuous process of refinement.[40] Second, software products are less tangible than hardware products are. This makes project management and security more challenging in the DoD acquisition system. Lastly, software development is inexorably linked to the commercial sector. Foundational code libraries are often open source or otherwise publicly accessible.

The increasing influence of software is also evident in the development of weapons. The Department of the Air Force's digital acquisition strategy exemplifies this. The department is seeking to leverage digital engineering practices, open systems architecture, and agile software development to increase acquisition speed and drive down the total cost of a capability portfolio.[41] Advances in software and associated technologies offer renewed potential for advances in not only weapon systems but also the acquisition process.

A common attribute of recent trends in defense technology is that technological advancements are more accessible to U.S. adversaries than ever. Previous pathbreaking military technologies (e.g., precision-guided weapons) were developed and controlled by the United States, and acquiring similar technologies required the resources of a nation-state. This is less true for DoD's new technology priorities. Chinese and Russian advances in hypersonics may be comparable to U.S. programs.[42] Dual-use technologies, such as artificial intelligence, are even more available; their commercial origins inherently make them accessible to nation-state and non-state actors alike.

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[39] David M. Tate, *Software Productivity Trends and Issues*, Alexandria, Va.: Institute for Defense Analysis, conference paper, March 2017.

[40] Defense Science Board, *Design and Acquisitions of Software for Defense Systems*, Washington, D.C.: Office of the Under Secretary of Defense for Research and Engineering, February 2018.

[41] Will Roper, *There Is No Spoon: The New Digital Acquisition Reality*, Washington, D.C.: Department of the Air Force, October 7, 2020.

[42] Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, Washington, D.C.: Congressional Revenue Service, R45811, November 6, 2020.

3. Challenges for System Acquisition in DoD

The trends discussed in Chapter 2 present challenges for the future acquisition of systems in DoD. As described in Chapter 1, in reviewing the body of RAND research on defense acquisition, we identified the following eight broad challenges that were articulated by research sponsors:

- responding to evolving missions
- leveraging a changing defense industrial base
- accommodating interoperability
- building in cybersecurity
- planning for technology refresh and insertion
- rebuilding the acquisition workforce
- managing the acquisition cost of systems
- aligning incentives, organizations, and processes to acquisition goals.

In the following sections, we discuss these challenges and their implications for the DoD acquisition system going forward.

Responding to Evolving Missions

The scope of geopolitical change will require the United States to prepare a wide variety of military capabilities if it desires to maintain its current level of influence and responsibilities. The increased quality, volume, and geographic breadth of Soviet combat capabilities that Rich, Dews, and Batten wrote about in 1986 could be addressed by improving the mobility and supportability of U.S. platforms.[43] The 2018 National Defense Strategy called for the United States to focus on peer threats, such as China and Russia, while preserving some capability to confront non-state actors.[44]

Confronting non-state actors in Iraq and Afghanistan required capabilities that were previously considered prohibitively expensive to use, but at considerably greater scale. Meeting the intelligence needs required to support counterinsurgency and counterterrorism campaigns demanded investment in reconnaissance and intelligence support systems. The intensity of the demand required capabilities that were economically scalable; the results were unmanned aerial systems built for permissible environments and support systems that focused on link analysis over general-purpose intelligence analysis.[45]

[43] Rich, Dews, and Batten, 1986, p. 18.

[44] DoD, 2018.

[45] Walter L. Perry and John Gordon IV, *Analytic Support to Intelligence in Counterinsurgencies*, Santa Monica, Calif.: RAND Corporation, MG-682-OSD, 2008, pp. 17–22.

The recent U.S. military efforts also required large-scale force protection capabilities, which are nonfungible. These campaigns required significant ground personnel presence, which the enemy responded to by saturating contested territory with improvised explosive devices. Defending against them required purpose-built mine-resistant, ambush-protected vehicles, and the United States invested $50 billion to field 24,000 vehicles. It also invested $17 billion in electronic attack capabilities to disrupt remotely detonated improvised explosive devices. Both capabilities, defined broadly, may have some utility against a peer threat. However, the vehicles and electronic attack systems developed for Iraq and Afghanistan had many shortcomings and may already be outclassed.[46]

These capabilities are less likely to be useful in deterring or defeating peer threats. Confronting Russia or China would likely demand different investments characterized by a stronger emphasis on air, sea, and cyberspace domains; greater intensity; and greater lethality. DoD investments in armored forces, air-delivered munitions, short-range air and missile defense, and resilient space systems, among others, would be necessary.[47]

This variety of potential missions presents a challenge to the defense acquisition system. The capabilities best suited for each mission are not very fungible; for instance, those best suited for counterterrorism missions are not optimal for deterring or defeating peer adversaries.[48] Thus, the acquisition process must be capable of efficiently and effectively delivering a wider variety of capabilities than before, each with unique acquisition challenges. Rapid development of new capabilities is also likely to be vital—to keep current during rapid technology improvement cycles and to respond to threats that are exploiting capability gaps.[49]

Leveraging a Changing Defense Industrial Base

Globalization and advancing technologies will present new challenges to (1) the way DoD manages its R&D efforts and (2) industry's ability to reliably produce complex military equipment at scale.

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[46] Wong, 2016, pp. 128–150.

[47] David Ochmanek, Peter A. Wilson, Brenna Allen, John Speed Meyers, and Carter C. Price, *U.S. Military Capabilities and Forces for a Dangerous World: Rethinking the U.S. Approach to Force Planning*, Santa Monica, Calif.: RAND Corporation, RR-1782-1-RC, 2017, p. 100.

[48] Christian Brose, *The Kill Chain: Defending America in the Future of High-Tech Warfare*, New York: Hachette Books, April 21, 2020, pp. 76–96.

[49] Richard Danzig, *Driving in the Dark: Ten Propositions About Prediction and National Security*, Washington, D.C.: Center for a New American Security, October 2011; and Defense Science Board, *2008 Summer Study on Capability Surprise*, Vol. 1: *Main Report*, Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, September 2009, pp. 48–54.

The Changing Innovation Environment Challenges DoD's Approach to Research and Development

Globalization and advancing technologies are altering the defense innovation landscape. Since 1986, the military aircraft industry has consolidated down to four prime contractors.[50] This consolidation has had numerous effects. For instance, it makes it possible that future DoD contracting decisions can eliminate a competitive aircraft industry unless it is willing to take more-active measures to manage industry health.[51] If competition is eliminated, DoD will have to rethink how it engages with a sole-source industry to control costs and spur innovation.[52] Lastly, industry consolidation will erode technical skill areas unique to military aircraft development, such as combat maneuver and propulsion, weapon system integration, and survivability.[53]

However, other changes in the aircraft industry have created new opportunities for research, development, test, and evaluation (RDT&E). Prime contractors have passed on more work to second- and third-tier firms while they focus on system integration, which creates opportunities for those firms to foster their own innovations.[54] This widens the innovation base but makes it more difficult for any stakeholder (e.g., DoD, prime contractors) to fully understand and leverage all the innovative activity taking place. Thus, these circumstances create new challenges for prime contractors and DoD to manage RDT&E efforts and leverage them to best effect.

Additionally, the industrial base for emerging dual-use technologies presents new RDT&E management challenges for DoD. The dual-use industrial base is less beholden to DoD's R&D agendas. Foreign ownership of technology companies and sensitivity surrounding working with the military may create delicate business relationships with DoD.[55] These attributes make dual-use technologies less likely to be responsive to DoD's traditional RDT&E and procurement policies and approaches. When attempting to enter the U.S. defense industrial base, some firms face many barriers, including International Traffic in Arms Regulations and intellectual property

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[50] This includes General Atomics, which specializes only in unmanned aerial vehicles. See John Birkler, Paul Bracken, Gordon T. Lee, Mark A. Lorell, Soumen Saha, and Shane Tierney, *Keeping a Competitive U.S. Military Aircraft Industry Aloft: Findings from an Analysis of the Industrial Base*, Santa Monica, Calif.: RAND Corporation, MG-1133-OSD, 2011, p. 12.

[51] Birkler et al., 2011, pp. 77–80. Birkler et al. (2011) indicates that, to have a competitive aircraft industry, the United States must "maintain two or more companies capable of designing, engineering, producing, and supporting military aircraft" (p. 80).

[52] Mark V. Arena, John C. Graser, and Paul DeLuca, *Implications of an Air Force Budget Downturn on the Aircraft Industrial Base: An Exploratory Analysis*, Santa Monica, Calif.: RAND Corporation, RR-248-AF, 2013, p. 32.

[53] Arena, Graser, and DeLuca, 2013, pp. 20–21.

[54] Arena, Graser, and DeLuca, 2013, pp. 45–49.

[55] James Ryseff, "How to (Actually) Recruit Talent for the AI Challenge," *War on the Rocks*, February 5, 2020.

concerns.[56] Issues like these create an environment in which dual-use industrial base firms hesitate to conduct business with DoD, limiting the exposure of program managers to the most-current commercial technology. DoD will need new ways of engaging with these firms to fully reap the benefits of their innovations.

Changing a Supply-Chain Environment

Globalization and advancing technologies make it more difficult to reliably produce complex military equipment at scale. Diminishing manufacturing sources result from the fact that DoD is a small-volume customer compared with the commercial market and that, eventually, because DoD systems become obsolete, only a small number of producers or even a single producer is left. Therefore, for some of its parts or subsystems, DoD ends up in a predicament in which it has to simply accept what the producer makes. In addition, shortages of certain materials, such as rare earth metals, that are critical to DoD manufacturing of various key new technologies are imported and vulnerable to export restrictions and price volatility.[57] Although these are not completely new problems, both limited manufacturing and material sources create a challenge for program obsolescence timelines, as discussed in later sections of this report.

Consolidation of prime contractors and limited opportunities can also make it difficult to retain skilled capabilities and a skilled workforce.[58] The F-22A manufacturing base is a typical example. Less-frequent program starts mean that there will be problems of repaying fixed costs (such as requalifying the vendor base) and concerns about labor, process, facilities, and tooling availability.[59] This will be another challenge to scaling up the production of military equipment.

Contracts Are Challenging

Another facet of the changing defense industrial base relates to the types of acquisition contracts being pursued by DoD. Lead systems integrator contracts demand different oversight and technical expertise from the government team, for instance.[60] Furthermore, engaging the wider industrial base will require different approaches to contracting that are not common for most contracting officers today. The Air Force is starting to gain experience using other

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[56] Defense Science Board Task Force on Defense Industrial Structure for Transformation, *Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to Address the Coming Crisis*, Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, July 2008.

[57] Richard Silberglitt, James T. Bartis, Brian G. Chow, David L. An, and Kyle Brady, *Critical Materials: Present Danger to U.S. Manufacturing*, Santa Monica, Calif.: RAND Corporation, RR-133-NIC, 2013, p. 2.

[58] Birkler et al., 2003.

[59] Obaid Younossi, Kevin Brancato, John C. Graser, Thomas Light, Rena Rudavsky, and Jerry M. Sollinger, *Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options*, Santa Monica, Calif.: RAND Corporation, MG-797-AF, 2010, p. 76.

[60] In these types of contracts, prime contractors have heavy systems engineering responsibilities, such as concept development and system integration and testing.

transaction (OT) agreements to meet this demand, but Mayer et al. (2020) notes that scaling up that experience will require investment in the workforce and contracting tools.[61]

Accommodating Interoperability

Cooperation among the United States and its allies is of critical importance during this turbulent time for national security. The concept of interoperability is vital to U.S. international and inter-service relationships. For the purposes of this report, we define *interoperability* as the "ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them to operate effectively together."[62] Interoperability can reduce the costs of warfighting, increase burden-sharing, improve operational effectiveness, and enable future coalition or joint service operations.[63] Within the context of DoD acquisition, it is important to recognize that potential military partners may have differing levels of technical sophistication. Although certain North Atlantic Treaty Organization allies have defense systems that are compatible with U.S. systems, there are current and future partners whose technology may be incompatible with that of U.S. forces.[64] It is desirable for DoD to continue pursuing open systems architecture, when appropriate,[65] to allow interoperability between present and future allies.[66]

In the same vein, when the services and allied nations have joint acquisition programs, such as the Joint Strike Fighter program, this allows for interoperability and more-diverse missions. With that said, the cost implications of joint programs are mixed. On the one hand, joint programs offer a reduction in unit cost because total buys should increase with foreign customers. However, the pursuit of joint programs can potentially lead to higher overall management and acquisition costs because of the difficulty of reconciling diverse missions,

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[61] Lauren A. Mayer, Mark V. Arena, Frank Camm, Jonathan P. Wong, Gabriel Lesnick, Sarah Soliman, Edward Fernandez, Phillip Carter, and Gordon T. Lee, *Prototyping Using Other Transactions: Case Studies for the Acquisition Community*, Santa Monica, Calif.: RAND Corporation, RR-4417-AF, 2020, pp. 64–65.

[62] DoD, *DoD Dictionary of Military and Associated Terms*, Joint Publication 1-02, Washington, D.C., April 6, 1999.

[63] Eric Larson, Gustav Lindstrom, Myron Hura, Ken Gardiner, Jim Keffer, and Bill Little, *Interoperability of U.S. and NATO Allied Air Forces: Supporting Data and Case Studies*, Santa Monica, Calif.: RAND Corporation, MR-1603-AF, 2004, p. 5.

[64] Joint Chiefs of Staff, *Joint Vision 2020*, Washington, D.C.: U.S. Government Printing Office, June 2000, p. 16.

[65] It is appropriate to implement a Modular Open Systems Approach (MOSA) when the system architecture can be decomposed into subcomponents separated by standardized interface requirements. See Donald Firesmith, "Open System Architectures: When and Where to Be Closed," SEI Insights Blog, Software Engineering Institute, October 2015.

[66] Isaac R. Porche III, James Dryden, Kathryn Connor, Bradley Wilson, Shawn McKay, Kate Giglio, and Juan Montelibano, *Finding Services for an Open Architecture: A Review of Existing Applications and Programs in PEO C4I*, Santa Monica, Calif.: RAND Corporation, MG-1071-NAVY, 2011, p. 18.

operating environments, and performance requirements on a common platform.[67] As discussed in Drezner, Roshan, and Whitmore (2017), designing systems with component commonality is another method to achieve interoperability that does not necessarily carry with it the challenges of managing joint programs, although it brings forth challenges of its own.[68] Finally, another approach for facilitating interoperability is the use of common standards in a modular open systems architecture approach.[69]

The Foreign Military Sales program, in which DoD sells defense systems with the purpose of building relationships with foreign nations, is another conduit that promotes interoperability.[70] In terms of inter-service interoperability, developing systems with joint operations in mind is one way to enable improved communications, data-sharing, and other operational benefits between the services during military operations. To protect critical technologies, anti-tamper features need to be considered in the system designs.

Finally, the same theme of interoperability must be addressed within DoD components. The demand for interoperability is particularly acute in systems for command, control, communications, computers, intelligence, surveillance, and reconnaissance that contribute to identifying, targeting, and managing the engagement of targets by strike platforms across domains (known colloquially as the *kill chain*). The Air Force and the Army in particular are working on similar initiatives to link different systems together; the need for interoperability is clearly a motivator in both cases.[71]

Building in Cybersecurity

The increased prevalence of electronics and information technology (IT) in defense systems opens up the possibility of cyberattacks that disrupt, damage, degrade, or destroy system capabilities.[72] Fully addressing system cybersecurity requires effort in both hardware and

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[67] Mark A. Lorell, Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An, and Robert A. Guffey, *Do Joint Fighter Programs Save Money?* Santa Monica, Calif.: RAND Corporation, MG-1225-AF, 2013, p. 39.

[68] Jeffrey A. Drezner, Parisa Roshan, and Thomas Whitmore, *Enhancing Management of the Joint Future Vertical Lift Initiative*, Santa Monica, Calif.: RAND Corporation, RR-2010-OSD/JS, 2017.

[69] Brien Alkire, Sherrill Lingel, Caroline Baxter, Christopher M. Carson, Christine Chen, David Gordon, Lawrence M. Hanser, Lance Menthe, and Daniel M. Romano, *Command and Control of Joint Air Operations in the Pacific: Methods for Comparing and Contrasting Alternative Concepts*, Santa Monica, Calif.: RAND Corporation, RR-1865-AF, 2018.

[70] Derek Gilman, *Foreign Military Sales*, Washington, D.C.: Defense Security Cooperation Agency, September 30, 2014, p. 3.

[71] For a summary of these efforts, see John Hoehn, *Joint All-Domain Command and Control: Background and Issues for Congress*, Washington, D.C.: Congressional Research Service, R46725, March 18, 2021.

[72] The Stuxnet cyberattack first uncovered in 2010 is an example of a high-profile attack that demonstrated the importance of addressing cybersecurity. Although the Stuxnet computer worm was not targeted at a weapon system,

software realms and effort at all stages of the system life cycle, including planning, design, procurement, program management, operations, and maintenance.

Until recently, cybersecurity was a late addition to programs rather than being integrated into a program early in the design phase.[73] For hardware component procurement, DoD requires that Application Specific Integrated Circuits be purchased from trusted manufacturers to reduce the risk of counterfeit or corrupted parts entering the supply system.[74] Although commercial-off-the shelf microchips are allowed, they are frequently limited to less-critical applications. Software design requirements include specific encryption and communication schemes to protect important software functions, and testing requirements verify appropriate system behavior.

Gonzales et al. (2020) notes that manufacturing and operations require particular attention to user authentication, network defenses, vulnerability scanning, software patching, security information and event management, and cyberattack response.[75] These and other cybersecurity issues must be considered at all stages of a program, including during the acquisition phase to ensure the integrity and security of weapon systems. Further heightening the challenge of cybersecurity are the quickly evolving cyber threat environment; the short obsolescence and innovation timelines of cyber and IT systems, which require the acquisition system to respond quickly; and the costs associated with defense investments across the defense industrial base.

Planning for Technology Refresh and Insertion

As was noted by Rich, Dews, and Batten (1986), the obsolescence and capability upgrade timelines for modern electronic components are very short, and in a resource-constrained environment, the desire for cost-effective, long-lived major weapon systems is challenged by

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it did target specific system subcomponents to significantly damage Iranian nuclear manufacturing capabilities. This attack demonstrated the potential damage that could be caused to weapon systems by cyberattacks, particularly when it is difficult to attribute the attack to any one source. See Jacopo Bellasio and Erik Silfversten, "The Impact of New and Emerging Technologies on the Cyber Threat Landscape and Their Implications for NATO," in A. Ertan, K. Floyd, P. Pernik, and Tim Stevens, eds., *Cyber Threats and NATO 2030: Horizon Scanning and Analysis*, Tallinn: North Atlantic Treaty Organization, Cooperative Cyber Defence Centre of Excellence, 2020.

[73] Don Snyder, James D. Powers, Elizabeth Bodine-Baron, Bernard Fox, Lauren Kendrick, and Michael H. Powell, *Improving the Cybersecurity of U.S. Air Force Military Systems Throughout Their Life Cycles*, Santa Monica, Calif.: RAND Corporation, RR-1007-AF, 2015.

[74] The Federal Information Security Management Act of 2002 mandated that the National Institute of Standards and Technology develop multiple new documents on security standards. Although many national security systems are exempted from these requirements, the institute developed its requirements in concert with DoD to ensure similarity to the DoD cybersecurity requirements contained in applicable DoD documents.

[75] Daniel Gonzales, Sarah Harting, Mary Kate Adgie, Julia Brackup, Lindsey Polley, and Karlyn D. Stanley, *Unclassified and Secure: A Defense Industrial Base Cyber Protection Program for Unclassified Defense Networks*, Santa Monica, Calif.: RAND Corporation, RR-4227-RC, 2020.

these short timelines.[76] New defense acquisition programs must therefore consider these resource constraints and plan for design growth. Doing so involves maintaining design margins within system parameters, as well as considering future periodic component upgrades to enable long service lives for systems by incorporating the latest technology. Maintaining a weapon system capability advantage is made challenging by long defense acquisition timelines that, in many cases, greatly exceed obsolescence and innovation timelines. These issues are managed, in part, by planning for periodic technology refresh and insertions, as well as software upgrades early in an acquisition program.[77]

Though a vital part of modern acquisition programs, planning for updates can unfortunately be costly and time-consuming.[78] The need for this investment is a key challenge for technology refreshment and insertion planning, which can take resources away from near-term planning efforts. Without early planning, however, unexpected obsolescence of parts or a low number of available replacement parts can delay or prevent important military operations through low equipment readiness.[79] All of these efforts require close alignment from requirements, acquisition, and budgeting stakeholders and thorough planning for various programmatic, budgetary, and operational contingencies that might affect technical development. The absence of contingency planning especially can result in significant impacts to program cost and schedule.[80]

MOSA design strategies can address some of these concerns. MOSA involves implementing systems of separately designed subcomponents that conform to widely adopted interface standards and upgrading these components according to prescheduled timelines. Subcomponent upgrade timelines could be driven by the need for rapid system capability improvement,

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[76] By *major weapon systems*, we mean aircraft, ships, submarines, and land vehicles that require a significant manufacturing investment for which typical acquisition cycles exceed ten years. A recent example of this is the Navy's service life extension for the F/A-18: Although no single reason for this service life program is documented, the reduced near-term availability of the F-35C variant is one factor that may have caused the need for such a program. See Meghann Myers, "Officials Extend F/A-18 Hornet Service Lives," *Navy Times*, March 7, 2015.

[77] DoD Instruction 7000.14 and DoD Instruction 5000.02 define technology *insertions* (capability upgrades) and *refreshments* (maintaining non-obsolete modern technology in weapon systems applications), respectively. See Office of the Under Secretary of Defense (Comptroller), *Financial Management Regulation*, U.S. Department of Defense Instruction 7000.14-R, Washington, D.C.: U.S. Department of Defense, May 2019; and Office of the Under Secretary of Defense for Acquisition and Sustainment, 2020.

[78] Yen-Chou Chou, *The Impact of Technology Refreshment on the Defense Acquisition Life Cycle*, dissertation, Aberdeen Proving Ground, Md.: Defense Acquisition University, May 2013; Office of the Under Secretary of Defense for Defense Procurement and Acquisition Policy, *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment*, Washington, D.C.: U.S. Department of Defense, January 31, 2003; and Linda Haines, "Technology Refreshment Within DoD," *Program Manager*, March–April 2001.

[79] Mary Chenoweth, Jeremy Arkes, and Nancy Y. Moore, *Best Practices in Developing Proactive Supply Strategies for Air Force Low-Demand Service Parts*, Santa Monica, Calif.: RAND Corporation, MG-858-AF, 2010.

[80] For more information, see Jeffrey A. Drezner and Michael Simpson, *Exploring Parallel Development in the Context of Agile Acquisition: Analytical Support to the Air Superiority 2030 Enterprise Capability Collaboration Team*, Santa Monica, Calif.: RAND Corporation, RR-1808-AF, 2017.

hardware obsolescence timelines, or life-cycle cost reduction, among other things. Schank et al. (2016) investigated MOSA's potential in shipbuilding, and Kim et al. (2020) did the same for space systems.[81] Both analyses found much potential in MOSA, but its utility depends on the context and program details, the universality and adherence to the standards selected, the level at which modularity is specified, and investments in organizational changes and workforce training.

From a technical standpoint, efforts to plan for technology refresh and insertion are also challenged to maintain a balance between designing a system for modularity and upgradability and falling within the available system design margin. The alternative to this measured approach is a more aggressive attempt to make substantial technological leaps with large up-front investments. Two separate RAND research efforts highlight poor outcomes that are likely from this approach. Research on cost overrun root causes by multiple RAND research teams from 2011 to 2014 shows that immature technology or unintended complexity is a leading factor in poor outcomes.[82] More substantially, Pernin et al. (2012) showed that such an aggressive approach resulted in the failure of the Army's Future Combat Systems program, which had deleterious effects on Army acquisition for years afterward.[83] Nevertheless, up-front investment in the design of a modular architecture helps maintain sustainable, cutting-edge capability in the long run. Because such investment must span different programs, DoD will need to address the challenges of ensuring stable funding for such an endeavor.

Rebuilding the Acquisition Workforce

During the 1990s, as defense budgets decreased, DoD reduced the size of its military and civilian acquisition workforce by about half and, by the mid-1990s, began relying more heavily on contractors to perform many acquisition support functions. Moreover, DoD reported that between 1998 and 2008—a period of *increasing* DoD procurement—the number of military and

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[81] John F. Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee, and Jerry Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs*, Santa Monica, Calif.: RAND Corporation, RR-696-NAVY, 2016; and Yool Kim, Guy Weichenberg, Frank Camm, Brian Dougherty, Thomas C. Whitmore, Nicholas Martin, Badreddine Ahtchi, *Improving Acquisition to Support the Space Enterprise Vision*, Santa Monica, Calif.: RAND Corporation, RR-2626-AF, 2020.

[82] See Irv Blickstein, Michael Boito, Jeffrey A. Drezner, James Dryden, Kenneth Horn, James G. Kallimani, Martin C. Libicki, Megan McKernan, Roger C. Molander, Charles Nemfakos, Chad J. R. Ohlandt, Caroline R. Milne, Rena Rudavsky, Jerry M. Sollinger, Katharine Watkins Webb, and Carolyn Wong, *Root Cause Analyses of Nunn-McCurdy Breaches*, *Volume 1:* Zumwalt-*Class Destroyer, Joint Strike Fighter, Longbow Apache, and Wideband Global Satellite*, Santa Monica, Calif.: RAND Corporation, MG-1171/1-OSD, 2011; and Mark V. Arena, Irv Blickstein, Daniel Gonzales, Sarah Harting, Jennifer Lamping Lewis, Michael McGee, Megan McKernan, Charles Nemfakos, Jan Osburg, Rena Rudavsky, and Jerry M. Sollinger, *DoD and Commercial Advanced Waveform Developments and Programs with Multiple Nunn-McCurdy Breaches, Volume 5*, Santa Monica, Calif.: RAND Corporation, MG-1171/5-OSD, 2014.

[83] Christopher G. Pernin, Elliot Axelband, Jeffrey A. Drezner, Brian B. Dille, John Gordon IV, Bruce J. Held, K. Scott McMahon, Walter L. Perry, Christopher Rizzi, Akhil R. Shah, Peter A. Wilson, and Jerry M. Sollinger, *Lessons from the Army's Future Combat Systems Program*, Santa Monica, Calif.: RAND Corporation, MG-1206-A, 2012.

civilian personnel performing acquisition activities decreased 14 percent.[84] Amid concerns about the skill gaps within the military and civilian workforce and the growing reliance on contractors, the Secretary of Defense announced his intention in April 2009 to "rebalance" the workforce mix.[85] By the end of FY 2020, DoD has increased the size of its acquisition workforce by about 47 percent since FY 2008.[86] In addition, many experts have expressed continued concerns about the quality of the acquisition workforce as a result of limited opportunities for training and career advancement.[87] To improve acquisition outcomes in the future, more-effective acquisition workforce planning must be supported by a better understanding of how workforce composition affects outcomes.[88]

Managing the Acquisition Cost of Systems

Post–Cold War budget reductions were accompanied by an unprecedented level of scrutiny on defense expenditures. Two major concerns that have been studied in depth as a result of this increased oversight are weapon system cost escalation and cost growth. There is considerable evidence that cost escalation for weapon systems—that is, inter-generational cost changes between weapon platforms[89]—significantly exceeds typical inflation measures for the general economy. RAND research by Arena et al. (2008) and Arena, Blickstein, et al. (2006) performed jointly for the Departments of the Navy and the Air Force explored average annual military aircraft and ship cost escalation from the 1970s through the 2000s.[90] Although the average annual cost escalation rate varied considerably by platform type, the average cost escalation rates

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[84] U.S. Government Accountability Office, *Defense Acquisition Workforce: Actions Needed to Guide Planning Efforts and Improve Workforce Capability*, Washington, D.C., GAO-16-80, December 2015; and Defense Science Board Task Force on Defense Industrial Structure for Transformation, 2008.

[85] Moshe Schwartz, Kathryn A. Francis, and Charles V. O'Connor, *The Department of Defense Acquisition Workforce: Background, Analysis, and Questions for Congress*, Washington, D.C.: Congressional Research Service, R44578, July 29, 2016.

[86] DoD, "Defense Acquisition Workforce: Key Information, OVERALL, as of FY20Q4," briefing slides, September 30, 2020.

[87] U.S. Senate Permanent Subcommittee on Investigations of the Committee on Homeland Security and Governmental Affairs, *Defense Acquisition Reform: Where Do We Go from Here? A Compendium of Views by Leading Experts*, Washington, D.C.: U.S. Government Printing Office, October 2014.

[88] John Birkler, Mark V. Arena, Irv Blickstein, Jeffrey Drezner, Susan M. Gates, Melinda Huang, Robert Murphy, Charles Nemfakos, and Susan K. Woodward, *From Marginal Adjustments to Meaningful Change: Rethinking Weapon System Acquisition*, Santa Monica, Calif.: RAND Corporation, MG-1020-OSD, 2010.

[89] Some, but not all, of this cost escalation may be attributed to increasing capability from generation to generation. See Mark V. Arena, Obaid Younossi, Kevin Brancato, Irv Blickstein, and Clifford A. Grammich, *Why Has the Cost of Fixed-Wing Aircraft Risen?* Santa Monica, Calif.: RAND Corporation, MG-696-NAVY/AF, 2008; and Mark V. Arena, Irv Blickstein, Obaid Younossi, and Clifford A. Grammich, *Why Has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs over the Past Several Decades*, Santa Monica, Calif.: RAND Corporation, MG-484-NAVY, 2006.

[90] See Arena et al., 2008; Arena, Blickstein, et al., 2006.

for all platforms were greater than U.S. economy-wide benchmarks, such as the Consumer Price Index and the gross domestic product deflator. About half of the escalation was related to typical inflation, as well as general price changes in material and labor. Unfortunately, there has not been an offsetting improvement in productivity to compensate for this growth, particularly for ships. Increases in system complexity are another driver in cost escalation—an issue that may worsen if increasing capability needs are accommodated in the way that they have been historically. Rather than designing all proposed capabilities into a single platform, a more agile approach using mature technologies, faster schedules, more-frequent system upgrades, and shorter production runs may stabilize costs while still providing opportunities to incorporate needed capabilities in response to emerging threats.[91]

Weapon system cost growth is another well-studied systemic issue for defense acquisition programs. RAND research by Younossi et al. (2007) explored the trends in cost growth for 46 programs executed during the 1970s, 1980s, and 1990s.[92] Whereas *cost escalation* refers to the inter-generational increases in the cost of similar systems, *cost growth* refers to cost increases associated with a single program over its life. After the researchers considered platform cost, dollar-weighted average development cost growth for these 46 programs across these three decades was almost 60 percent relative to the Milestone B (or Milestone II for older programs) estimate. Procurement cost growth was lower—nearly 40 percent—but also remained consistent over time. To better understand the drivers for this cost growth, further RAND research by Bolten et al. (2008) explored the sources of measured cost growth for 35 sample major defense acquisition programs (MDAPs) and concluded that poor cost estimation accounted for, on average, one-sixth of total program cost growth.[93] These and other quantitative evaluations of

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[91] This paragraph addresses development and procurement price escalation, but sustainment costs have followed a similar trend. For a discussion of U.S. Army Bradley vehicle sustainment price escalation, see Kathryn Connor and James Dryden, *New Approaches to Defense Inflation and Discounting*, Santa Monica, Calif.: RAND Corporation, RR-237-OSD, 2013.

[92] Obaid Younossi, Mark V. Arena, Robert S. Leonard, Charles Robert Roll, Jr., Arvind Jain, and Jerry M. Sollinger, *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs*, Santa Monica, Calif.: RAND Corporation, MG-588-AF, 2007.

[93] Other major sources of cost growth for these programs included other estimation or planning errors (4.6 percent); government decisions to change requirements, schedule, or ordered quantity (41.6 percent); financial matters (1.4 percent); or other miscellaneous sources (2.4 percent). Total mean cost growth for these programs was approximately 60 percent. See Joseph. G. Bolten, Robert S. Leonard, Mark V. Arena, Obaid Younossi, and Jerry M. Sollinger, *Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, MG-670-AF, 2008.

Improved planning and cost estimation do not necessarily result in actual cost savings, but they do provide decisionmakers with a better basis for deciding if a program should be pursued or not in a constrained budget environment. See Younossi et al., 2007.

cost estimation are not perfect because early program cost estimates are not typically compared with program expenditures after completion of the program, but they show a notable trend.[94]

The reasons for cost growth are varied. According to a series of RAND research reports examining programs that have faced breaches of the Nunn-McCurdy Amendment, cost overruns are the result of multiple root causes.[95] Immature technology or such external factors as rising material and labor costs, protests, and congressional dictates were the most-common root causes that contributed to the Nunn-McCurdy breach (or breaches). Additionally, poor contract language and quantity changes each contributed to beaches in three programs. Unstable funding also contributed to a breach in one program. Table 3.1 summarizes these causes.

Table 3.1. Root Causes of Nunn-McCurdy Breaches Across Select Programs

Root Cause	WGS	*Zumwalt*	Apache Longbow	F-35	SBIRS[a]	C-130[a]	JPATS[a]	H-1[a]
Quantity change		✓	✓		✓			
Unstable funding						✓		
Exogenous economic or operational considerations	✓				✓	✓	✓	✓
Poor contracting language or incentive alignment	✓					✓	✓	
Uncoordinated technical drawings								✓
Technology integration, testing, or coordination issues			✓	✓				✓
Immature technology or unanticipated complexity			✓	✓	✓	✓	✓	
Poor program or production management	✓			✓	✓			✓
Poor cost estimation						✓	✓	

SOURCE: Paraphrased from Blickstein et al. (2011) and Arena et al. (2014).
NOTE: JPATS = Joint Primary Aircraft Training System; SBIRS = Space-Based Infrared System; WGS = Wideband Global Satellite Communication Satellite.
[a] This program saw multiple Nunn-McCurdy breaches.

The consequences of these cost overruns are substantial. When budgets are tight, excessive cost escalation or unplanned cost growth can lead to programs being considered for cancellation.

[94] Mark V. Arena, Obaid Younossi, Lionel A. Galway, Bernard Fox, John C. Graser, Jerry M. Sollinger, Felicia Wu, and Carolyn Wong, *Impossible Certainty: Cost Risk Analysis for Air Force Systems*, Santa Monica, Calif.: RAND Corporation, MG-415-AF, 2006.

[95] In particular, we chose to highlight two of the five volumes of this research (Blickstein et al., 2011; Arena et al., 2014) because of their focus on root cause analysis for MDAPs.

To better manage expectations and program viability, programs require a multipronged approach involving, for example, careful accounting of programmatic risks (e.g., risks and changes in technology threat and missions) that could affect program costs, program budgets that promote stability in the industrial base, the ability to demonstrate budgetary estimate accuracy in comparison with actual expenditures,[96] and reworked acquisition policies to better align workforce incentives with desired acquisition outcomes.

Aligning Incentives, Organizations, and Processes to Acquisition Goals

The focus of many acquisition improvement and reform efforts since 1986 has been limiting weapon system program cost overruns and schedule delays. To help accomplish these measures, Congress and DoD have frequently created new regulations, guidelines, or oversight organizations or consolidated or changed existing ones. These actions often expose new problems and unintended consequences, which are dealt with, in turn, by further changes to regulation and oversight. At the same time, congressional and DoD strategic priorities may shift to address exogenous needs and trends, such as at the end of the Cold War, after the rise of Islamic extremism in the early 2000s, and today's renewed focus on peer conflict in the 2020s. This constantly evolving policy environment presents a perennial challenge to acquisition management. We summarize some of those policy changes, their goals, and outcomes in this section. This is not an exhaustive list, but it illustrates the shifting policy and management priorities of Congress and DoD as they pertain to weapon system acquisition. We also note the role of the requirements and resourcing processes as additional dimensions of the incentive, organization, and process alignment challenge.

Goldwater-Nichols Act: A Drive for Greater Centralization

The landmark Goldwater-Nichols Act of 1986 attempted to address systemic deficiencies in the military chain of command, personnel management, and acquisition stemming from a lack of inter-service integration. It introduced sweeping organizational changes that generally shifted authority and power away from the military services toward joint organizations.[97] As part of that reform, Goldwater-Nichols reorganized the acquisition enterprise to shift power from the military services to more-centralized oversight and authority that involved more civilians. However, this resulted in what Nemfakos et al. (2010) characterizes as division between a

[96] See, for example, Arena et al., 2008.

[97] A definitive account of the policy context and process that yielded the Goldwater-Nichols Act is James R. Locher III, *Victory on the Potomac: The Goldwater-Nichols Act Unifies the Pentagon*, College Station, Tex.: Texas A&M University Press, 2002.

civilian-run acquisition process and a military-run requirement process that is "inimical to the efficient and effective support of military forces and antithetical to the spirit of the legislation."[98]

Weapon System Acquisition Reform Act: A Focus on Cost and Schedule

DoD acquisition cost and schedule deficiencies continued to be a source of congressional dissatisfaction even after the Goldwater-Nichols reforms. The Weapon System Acquisition Reform Act of 2009 attempted to rectify these issues by establishing, renewing, and elevating various Pentagon positions responsible for tracking cost estimation, test and evaluation, systems engineering, and technological maturity for large defense acquisition programs.[99] Some analyses of outcomes from these recent acquisition improvement initiatives indicate some improvement,[100] while others suggest that some defense acquisition programs still experience significant cost and schedule issues relative to original baselines.[101]

More-Recent Efforts: A Focus on Speed and Innovation

In addition to continued efforts to limit cost overruns and schedule delays, more-recent reforms of the defense acquisition system imply a stronger DoD and congressional interest in enabling greater adaptability, flexibility, and innovation to make the acquisition enterprise fit for addressing the challenges of peer competitors in an environment dominated by advancing commercial technologies.

This intent is manifested in the 2016 and 2017 National Defense Authorization Acts. The acts sought, among other legislative priorities, to make DoD acquisition more adaptive and innovative by splitting the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics in two: the Office of the Under Secretary of Defense for Research and Engineering, which will focus on developing innovative technologies, and the Office of the Under Secretary of Defense for Acquisition and Sustainment, which will focus on delivering proven technology more efficiently.[102] This split was completed in 2017. Interestingly, this reorganization puts more power over the acquisition process into the hands of the military services and undoes some of the centralization of Goldwater-Nichols.

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[98] Nemfakos et al., 2010, p. xi.

[99] Moshe Schwartz, *Defense Acquisition Reform: Background, Analysis, and Issues for Congress*, Washington, D.C.: Congressional Research Service Report, R43566, May 23, 2014a; and Moshe Schwartz, *Defense Acquisitions: How DOD Acquires Weapon Systems and Recent Efforts to Reform the Process*, Washington, D.C.: Congressional Research Service Report, RL34026, May 23, 2014b.

[100] Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Performance of the Defense Acquisition System: 2016 Annual Report*, Washington, D.C.: U.S. Department of Defense, October 2016.

[101] Schwartz, 2014a.

[102] DoD, *Report to Congress: Restructuring the Department of Defense Acquisition, Technology and Logistics Organization and Chief Management Officer Organization*, Washington, D.C., August 2017, p. 3.

The drive for greater adaptability, flexibility, and innovation also was exhibited in internal DoD process changes. For example, the Adaptive Acquisition Framework, adopted in 2020, created acquisition pathways for urgent capability acquisition, middle-tier acquisition, and software acquisition, among others, implying that the goals of the acquisition system may vary depending on the weapon system or program.[103] Urgent capability acquisition would prioritize speed over performance or cost. Rapid prototyping might value speed and perhaps performance over cost. Although DoD has always needed to balance cost, schedule, and performance priorities in procurement, the new pathways may inject greater complexity by allowing program managers to exercise more judgment and critical thinking and giving overseers meaningful oversight (particularly for the new middle-tier acquisition pathways).

Perhaps more importantly, there are broader concerns about incentives when it comes to having an agile and innovative acquisition system and workforce that fields capabilities that keep up with changing threats. Conservative adherence to fixed processes that are safe from risk and criticism and a focus on local objectives rather than the effects of local actions on the larger mission of fielding capabilities for military advantage all involve incentive structures that need to be modified to improve acquisition outcomes.

Interdependencies on Requirements and Resourcing Processes Must Also Be Considered

Finally, the challenge of aligning incentives, organizations, and processes is further complicated by the fact that the acquisition system also relies of separate requirement-setting and resource allocation processes. The Planning, Programming, Budgeting, and Execution resource allocation process is particularly challenging. The strict and deliberate process results in resources being allocated two years after they are first proposed. This deliberate pace prevents the adoption of the latest technologies, particularly ones originating from the commercial sector, where product cycles are much faster.[104] The process also stymies fast adaptation and iteration, as funds that are programmed for one purpose cannot easily be reprogrammed for another without congressional approval, even when there is an opportunity to take advantage of an emerging development or an imperative to meet an unforeseen need.[105] These challenges complicate DoD's system acquisition challenges.

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[103] Office of the Under Secretary of Defense for Acquisition and Sustainment, 2020.

[104] William Greenwalt and Dan Patt, *Competing in Time: Ensuring Capability Advantage and Mission Success Through Adaptable Resource Allocation*, Washington, D.C.: Hudson Institute, February 2021, pp. 41–48.

[105] Jonathan P. Wong, "Bad Idea: Overly Focusing on Speed in Development and Acquisition," Center for Strategic and International Studies, December 15, 2020b.

4. Potential Actions for Improving the Acquisition Process

In this chapter, we offer an integrated set of potential actions synthesized from RAND research to help meet the acquisition system challenges described in Chapter 3. These actions are organized around three major themes, as outlined in Chapter 1:

- Acquisition strategies, organizational roles and responsibilities, and reporting structures must be tailored to the unique characteristics of each program.
- An inclusive industrial base must be better engaged to fully exploit its innovation potential.
- The acquisition workforce must be properly sized, trained, and incentivized to make the smart decisions that flexible acquisition approaches and partnering productively with industry entail.

No theme alone can address all of the challenges we have identified from RAND research. However, each has the potential to address numerous challenges, as indicated in Table 4.1.

Table 4.1. Potential Actions to Address Acquisition Challenges

Challenge	Tailor Acquisition Approaches	Better Engage an Inclusive Industrial Base	Properly Size, Train, and Incentivize the Acquisition Workforce
Responding to evolving missions	✓	✓	✓
Leveraging a changing defense industrial base		✓	
Accommodating interoperability	✓		
Building in cybersecurity	✓	✓	✓
Planning for technology refresh and insertion	✓	✓	✓
Rebuilding the acquisition workforce		✓	✓
Managing the acquisition cost of systems	✓		
Aligning incentives, organizations, and processes to acquisition goals	✓		✓

Tailor Acquisition Approaches

A key observation across RAND's acquisition research is that acquisition programs may benefit from management frameworks tailored to the circumstances and characteristics of the system being considered. Attributes that can be tailored include program timelines, contract strategies, oversight structures, and technical risk tolerance. For example, urgent operational

needs necessitate quick design and procurement timelines to help field equipment expeditiously. Short obsolescence timelines also drive quick turnarounds in program schedule. On the other hand, complex system developments require large investment and oversight, which makes an expedited timeline less feasible. In these cases, a long-term outlook with careful planning is more appropriate. An effective acquisition system should be sufficiently adaptable that it can respond to urgent and evolving operational needs when necessary and can incorporate deliberate and thoughtful planning when timelines and cost considerations require it.

That said, certain program considerations are more universal. For example, consideration must be given to ensuring the realism of requirements by using relatively mature technologies; maintaining budgetary and program resource stability; and managing interoperable systems, cybersecurity, and obsolescence. Moreover, some measure of accountability and responsiveness to oversight, adjusted to the amount of risk tolerated by stakeholders, is important.[106] Despite arguments by some that oversight is too burdensome and inimical to agility, oversight and accountability are necessary to sustain the political viability for programs and the acquisition enterprise generally.[107] These universal considerations never can be fully disregarded in the interest of acquisition agility.

As DoD reforms the acquisition system to accommodate approaches to reduce schedule and cost slippage *and* become more flexible and agile to contend with evolving threats, it should continue to consider these broad principles as the acquisition workforce learns to use new acquisition pathways and tools. This will be particularly important as acquisition leaders determine which tailored pathways are most appropriate for a given program. One way to synthesize these principles is by categorizing programs into four pathways along two dimensions: program need timeline (short timeline versus long timeline) and technology development risk (evolutionary versus revolutionary).[108] In some cases, operational circumstances dictate a timeline or level of technology risk. In others, program leaders must choose their timeline and the acceptable level of risk based on external limitations, such as budget. Table 4.2 summarizes key attributes for programs in each of these four archetypes, and we discuss each in further detail in the remainder of this section.[109] We believe that this

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[106] Cynthia R. Cook, Emma Westerman, Megan McKernan, Badreddine Ahtchi, Gordon T. Lee, Jenny Oberholtzer, Douglas Shontz, and Jerry M. Sollinger, *Contestability Frameworks: An International Horizon Scan*, Santa Monica, Calif.: RAND Corporation, RR-1372-AUS, 2016, pp. 100–101.

[107] Jonathan Wong, "Why You Can't Call In an Air Strike with an iPhone," *War on the Rocks*, July 2, 2020a.

[108] In the context of this report, evolutionary technology development refers to a gradual development of new capability, as opposed to the development of game-changing capability. The term *evolutionary* should not be confused with evolutionary acquisition, a DoD acquisition approach implemented in the early 2000s that involves *spiral development*, or increasingly detailed incremental system capability development phases (or design spirals) rather than traditional discrete phases.

[109] These summations are adapted from John Birkler, Giles K. Smith, Glenn A. Kent, and Robert V. Johnson, *An Acquisition Strategy, Process, and Organization for Innovative Systems*, Santa Monica, Calif.: RAND Corporation,

framework and its underlying principles will continue to be relevant as the program management and oversight landscape in DoD and Congress evolves.

Table 4.2. Associated Program Attributes, by Acquisition Program Archetype

	Technology Development Risk	
Timeline Length	**Evolutionary**	**Revolutionary**
Short	• Streamlined oversight • Increased prototyping • Limited changes to requirements	• Streamlined oversight • Increased prototyping • Increased program risk tolerance • Flexible contracts • Relaxed intellectual property ownership
Long	• Limited changes to requirements • Longer-term contracts • Increased life-cycle planning: operations and support (O&S), interoperability, technology refresh	• Increased prototyping • Increased program risk tolerance • Longer-term contracts • Increased life-cycle planning: O&S, interoperability, technology refresh

SOURCE: Adapted from Birkler et al., 2000.

For Short-Timeline Programs, Streamline and Decentralize Authority to Speed Fielding Times

As mentioned earlier, programs with short obsolescence timelines and programs responding to urgent operational needs require short development cycles to ensure delivery of the capability to the warfighter at the necessary speed. For example, RAND research on military cyber forces performed for the Army by Paul, Porche, and Axelband (2014) highlights the need for fast cyber and IT system procurement and advocates an acquisition approach for IT systems that is similar to that of U.S. Special Operations Command.[110] For systems being developed in response to an operational need for special operations forces, U.S. Special Operations Command has a self-contained, streamlined procurement system with limited oversight and increased tolerance for technical risk when developmental technologies are involved. The command's rapid acquisition programs are also relatively small-scale from a technical perspective and use prototyping and testing to reduce risk prior to employment. Early prototyping and system testing are beneficial for rapid acquisition programs because they provide an opportunity to demonstrate nonoperational technology. Paul, Porche, and Axelband (2014) suggests that quick obsolescence timelines and the ability for adversaries to quickly counter U.S. cyber and IT capabilities necessitate a similar approach for cyber forces. RAND research by Hura et al. (2007) draws

MR-1098-OSD, 2000. See also Richard H. Van Atta, R. Royce Kneece, Jr., and Michael J. Lippitz, *Assessment of Accelerated Acquisition of Defense Programs*, Alexandria, Va.: Institute for Defense Analyses, September 2016.

[110] Christopher Paul, Isaac R. Porche III, and Elliot Axelband, *The Other Quiet Professionals: Lessons for Future Cyber Forces from the Evolution of Special Forces*, Santa Monica, Calif.: RAND Corporation, RR-780-A, 2014.

similar conclusions for space systems, although launch schedule and cost are unique limiting factors that must also be considered for space programs.[111]

For Long-Timeline Programs, Leverage Stability to Reduce the Risks of Business and Technology Complexity

On the opposite end of the timeline spectrum, some programs can benefit from long-term agreements (e.g., multiyear contracts). Relatively longer program timelines can be necessitated by design time frame, higher complexity, and longer production time frame, such as for ship and aircraft acquisition. Arena et al. (2013), a RAND study on aircraft programs for the Air Force, suggests that increased use of multiyear contracting and long-term agreements for prime and subtier contracts, where feasible,[112] benefits the industrial base and government through more-stable business and cost reductions, respectively.[113] Long-term and higher-quantity contracting can also be beneficial at the material and component levels. Large cost fluctuations associated with volatile markets for raw materials or parts can be managed via stable, long-term contracts with suppliers to help keep costs in check.[114]

Another consideration for the development of long, complex weapon systems is the typically high cost and the related level of government oversight. As documented by numerous RAND case studies of Air Force MDAPs, maintaining a low level of program risk and limited cost growth is a major concern for the organizations overseeing high-cost, high-profile programs. As discussed earlier, when external oversight organizations identify program cost or schedule growth, program funding reductions or even cancellation can occur.[115] Because of the importance of funding and resource stability, high-cost programs should use longer timelines, more-realistic budgetary estimates, well-defined and unchanging requirements, and evolutionary technology development to keep costs low and reduce program risk. Along these lines, Arena, Younossi, et al. (2006) concludes that reducing program risks, such as technology risks, is one

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[111] Myron Hura, Gary McLeod, Lara Schmidt, Manuel Cohen, Mel Eisman, and Elliot Axelband, *Space Capabilities Development Implications of Past and Current Efforts for Future Programs*, Santa Monica, Calif.: RAND Corporation, 2007, Not available to the general public.

[112] According to the statute that governs the use of multiyear contracts (U.S. Code, Title 10, Section 2306b, Multiyear Contracts: Acquisition of Property), programs wishing to obtain multiyear contract authority must demonstrate that the program offers substantial savings and that the design, technical risks, and ordered quantity of the end item will be stable for the duration of the contract.

[113] Arena, Graser, and DeLuca, 2013.

[114] For example, titanium, a key raw material for modern aircraft airframes because of its high strength-to-weight ratio and corrosion resistance, has a volatile market that benefits from long-term contracting and planning. For more information, see Somi Seong, Obaid Younossi, Benjamin W. Goldsmith, Thomas Lang, and Michael Neumann, *Titanium: Industrial Base, Price Trends, and Technology Initiatives*, Santa Monica, Calif.: RAND Corporation, MG-789-AF, 2009.

[115] Mark A. Lorell, Robert S. Leonard, and Abby Doll, *Extreme Cost Growth: Themes from Six U.S. Air Force Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, RR-630-AF, 2015.

way to mitigate the likelihood of program cost growth and its associated outcomes.[116] Although the split of the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics into two offices and the devolution of many oversight functions to the military services have changed the oversight landscape, it remains to be seen whether these changes will create the conditions that reduce program risk and cost growth.

Longer programs can take advantage of their timeline to increase planning for other concerns identified in our eight acquisition challenges—specifically, planning for interoperability, cybersecurity, and technology refresh and obsolescence. Regardless of program timeline and technology risk, these are important considerations for all modern weapon systems and must be considered to some degree. However, programs with longer timelines have more schedule tolerance for increased long-term planning and should take advantage of this opportunity. Similar to the other considerations discussed in this section, rather than being tied to a one-size-fits-all framework, planning for each of these issues should be tailored to a program's specific needs and circumstances based on evaluation at the start of the program.

For Evolutionary Technology, Use a Simple Design Approach with Limited Changes to Requirements to Reduce Program Risk

When combined with program timeline, the level of technology development risk in a weapon system program is a major factor in the success or failure of that program. In some cases, significant technological advancement is required to achieve the desired operational capability. In many cases, however, more-evolutionary advancements or "step improvements" are sufficient. Programs involving evolutionary technological advancements do not face the challenges associated with game-changing technology development and therefore should focus their acquisition approaches on maintaining a low level of overall program cost and schedule risk. Drezner and Leonard (2002) presents case studies on the Predator and Global Hawk unmanned aerial vehicles and compares certain low- and high-risk program management approaches for weapon system programs.[117] These case studies suggest that straightforward design methods involving limited intertwined design spirals and concurrent development help maintain a low program risk level.[118]

Carefully limiting changes to the scope of requirements is another way to reduce a program's risk level. Some degree of change over a program's life is inevitable, especially during spiral

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[116] Arena, Younossi, et al., 2006.

[117] Jeffrey A. Drezner and Robert S. Leonard, *Innovative Development: Global Hawk and DarkStar—Transitions Within and Out of the HAE UAV ACTD Program*, Santa Monica, Calif.: RAND Corporation, MR-1476-AF, 2002, pp. 25–30.

[118] As previously mentioned, the term *design spiral* refers to incremental development phases for programs using spiral development.

developments.[119] This is because, by design, the final requirements are not known at the start of a spiral development. However, as documented in the previously mentioned Drezner and Leonard (2002) case studies, carefully managing the scope of changes to requirements and maintaining realistic technical requirements have been shown to be key elements of successful spiral developments. In certain cases, unchecked growth in requirements or unrealistic expectations regarding relatively unproven technologies contributed to complications in testing and fielding equipment, which led to significant cost overruns.[120]

For Revolutionary Technology, New Contracting Approaches, Increased Risk Tolerance, and Flexibility in Concept Definition Enable Success

Multiple RAND research reports on successful programs involving revolutionary technology developments suggest that atypical acquisition approaches may improve outcomes for these programs. For example, Held et al. (2006) shows that using nontraditional suppliers is a driver for innovation in defense programs.[121] However, Mayer et al. (2020) observes that these suppliers may choose not to do regular business with DoD because of their concerns with standard DoD regulations, including contractual rules, funding sources, and the government's desire for full ownership of intellectual property.[122] Some methods to overcome these obstacles and motivate innovative firms to work with DoD, as identified in RAND reports by Webb et al. (2014) and Horn et al. (1997), include using small oversight organizations specializing in technology development that better integrate design efforts with acquisition and logistics efforts, increasing use of OT contracts and venture capital funding,[123] and increasing emphasis on intellectual property arrangements that are agreeable to innovative businesses.[124] OT contracts and relaxed intellectual property restrictions are especially attractive to companies involved in early-stage technical developments because they provide flexibility for design iterations and can help suppliers identify military applications for their products.[125]

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[119] Software development is one example of a modern technology development that may use a spiral approach.

[120] Arena, Younossi, et al., 2006.

[121] Bruce Held, Thomas Edison, Shari Lawrence Pfleeger, Philip S. Antón, and John Clancy, *Evaluation and Recommendations for Improvement of the Department of Defense Small Business Innovation Research (SBIR) Program*, Santa Monica, Calif.: RAND Corporation, DB-490-OSD, 2006, pp. 32–37.

[122] Mayer et al., 2020, p. 8.

[123] Tim Webb, Christopher Guo, Jennifer Lamping Lewis, and Daniel Egel, *Venture Capital and Strategic Investment for Developing Government Mission Capabilities*, Santa Monica, Calif.: RAND Corporation, RR-176-OSD, 2014.

[124] Kenneth P Horn., Elliott I. Axelband, Ike Yi Chang, Paul S. Steinberg, Carolyn Wong, and Howell Yee, *Performing Collaborative Research with Nontraditional Military Suppliers*, Santa Monica, Calif.: RAND Corporation, MR-830-A, 1997.

[125] Mayer et al., 2020, pp. 64–65.

Once a program's leaders decide to pursue revolutionary technology development, other decisions and investments can be made to mitigate the risk of technical issues affecting program execution. A major finding in many RAND studies in this area is that prototyping and increased early testing are key to reducing technical risk and ensuring that equipment can be fielded quickly. Birkler et al. (2010) indicates that prototyping and testing are especially vital for programs involving innovative technologies because they provide a low-impact outlet for finding design issues and demonstrating a concept. Prototyping involves some additional up-front cost, but reducing the risk of system design early in the design process can save programs money in the long run.[126]

Although encouraging nontraditional supplier involvement and increased prototyping is an important enabler of success for innovative technology developments, a high program management risk tolerance is the vital underlying factor for high-risk technical developments. Birkler et al. (2000) provides detailed suggestions on an acquisition approach specifically for innovative, novel weapon systems.[127] As defined in that report, *novel systems* are those that might involve new technologies, might be being designed for a rapidly changing operational environment that makes defining stable requirements challenging, or might have an uncertain final production size. The modern acquisition system, with good reason, requires programs to fully define these areas early on, especially with regard to requirement stability. However, for first-of-a-kind or other novel efforts, experimentation without fear of program cancellation is critical. To that end, the RAND authors recommend iterative concept development and demonstration phases with the ability to modify the design concept between each phase, as well as an oversight structure tailored specifically to novel efforts.[128] A flexible approach like this one, with an allowance for design risk-taking, could improve DoD's success rate with completing programs involving revolutionary technology.

Challenges to Implementing Tailored Approaches

The tailored acquisition approach described here has not been implemented to the degree that empirical evidence of its effectiveness to improve acquisition outcomes is possible. DoD has been moving steadily toward emphasizing a tailored approach, including emphasis in the 2013 version of DoD Instruction 5000.02, as well as adoption of the Adaptive Acquisition Framework outlined in the 2020 version of the document.[129]

Nevertheless, RAND research highlights implementation obstacles that are likely to occur. Research by McKernan, Drezner, and Sollinger (2015) on acquisition-tailoring suggests that

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[126] Birkler et al., 2010.

[127] Birkler et al., 2000, pp. 7–10.

[128] Birkler et al., 2000, pp. 58–59.

[129] On the 2013 version, see McKernan, Drezner, and Sollinger, 2015. On the 2020 version, see Office of the Under Secretary of Defense for Acquisition and Sustainment, 2020.

various bureaucratic characteristics, such as high turnover among senior leaders, weak support for tailoring, and weak incentives and structures, constrain tailoring. Also, education and training are important so that the workforce knows how to tailor acquisition procedures. Tailoring requires a workforce that thinks critically about acquisition issues and understands the acquisition process in great detail.[130] Research by Bartels Drezner, and Predd (2020) that wargames elements of the Adaptive Acquisition Framework also suggests that the risks of transitioning programs between pathways (e.g., from middle-tier rapid prototyping and fielding to the more-traditional major capability acquisition process) are not well understood by acquisition practitioners.[131]

Having adequate training for tailoring, however, is only part of the difficulty with implementing tailored acquisition for weapon system programs. According to case studies of tailored programs documented by McKernan, Drezner, and Sollinger (2015), bureaucratic obstacles are another major challenge. Examples of such obstacles within DoD include high turnover among senior leadership, limited ground-level support for flexible program approaches, limited holistic understanding of the entire acquisition process within the acquisition workforce, and limited incentives to carry out alternative approaches.[132]

However, these challenges to tailored acquisition can be addressed by DoD's growing understanding of how program context can dictate which tailoring approaches are appropriate for best results in a given situation. Anton et al. (2020) examines 62 potential approaches to more-responsive acquisition by identifying 49 contextual program factors that are likely to influence the effectiveness of each approach.[133] Such insights as these are likely to be critical to effectively crafting tailored acquisition strategies.

In conclusion, an early evaluation of a program's purpose and circumstances, coupled with a selection of tailored acquisition approaches, would enable acquisition leaders to determine the most effective and appropriate management structure for each program. DoD is taking steps in the right direction to modernize defense acquisition by codifying a set of tailored pathways in the Adaptive Acquisition Framework, but it must remain ready to adjust and refine its approach; this body of research on tailoring can assist in that regard.[134]

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[130] Megan P. McKernan, Jeffrey A. Drezner, and Jerry M. Sollinger, *Tailoring the Acquisition Process in the U.S. Department of Defense*, Santa Monica, Calif.: RAND Corporation, RR-966-OSD, 2015.

[131] Elizabeth M. Bartels, Jeffrey A. Drezner, and Joel B. Predd, *Building a Broader Evidence Base for Defense Acquisition Policymaking*, Santa Monica, Calif.: RAND Corporation, RR-A202-1, 2020, pp. 7–9.

[132] McKernan, Drezner, and Sollinger, 2015.

[133] Philip S. Anton, Brynn Tannehill, Jake McKeon, Benjamin Goirigolzarri, Maynard A. Holliday, Mark A. Lorell, and Obaid Younossi, *Strategies for Acquisition Agility: Approaches for Speeding Delivery of Defense Capabilities*, Santa Monica, Calif.: RAND Corporation, RR-4193-AF, 2020, pp. 74–82.

[134] Jim Garamone, "Transformational Change Comes to DOD Acquisition Policy," U.S. Department of Defense, October 21, 2019.

Better Engage an Inclusive Industrial Base

Industry is the prime source of innovation for the defense acquisition system, and harnessing industry's innovation potential is key to maintaining the United States' warfighting advantage. Toward this end, two major priorities for the defense industrial base are to expand it to include nontraditional suppliers and to implement better long-term planning to ensure that the industrial base remains healthy. RAND research suggests that some tools already exist to enable further expansion of the industrial base and further improve long-term industrial base planning. In this section, we identify RAND research that highlights these existing tools to help enable their use more broadly through defense acquisition.

Expand the Industrial Base to Include Nontraditional Suppliers

Although sustaining members of the present defense industrial base is crucial, further expansion of the industrial base is necessary to better channel the innovation potential of industry. This expansion can be accomplished through improved DoD engagement with industry. DoD has made recent efforts in this area—for example, by establishing the Defense Innovation Unit in August 2015—but more action can be taken to diversify partnerships with the industrial base.[135]

One possibility is to pursue the further implementation of DoD venture capital funds. Designed to make equity investments in early-stage firms, venture capital funds and their organizational structures are a stimulus for innovation in the technology sector, according to a 2001 RAND study for the U.S. Army.[136] An example of DoD's limited use of venture capital programs to date is the Army Venture Capital Initiative, chartered by Congress and established in FY 2002. Based within In-Q-Tel (a venture capital firm funded mainly by the Central Intelligence Agency), the venture fund was created (1) to find innovative energy technologies and invest in their development and (2) to realize substantial net return for the investing organizations from commercial and Army markets.[137] The Army selected OnPoint Technologies to manage the fund and has invested in firms developing battery electrodes, printing solar cells on flexible substrates, and enhancing battery management devices.[138] An example of the success of the fund is the battery management technology created by PowerPrecise Solutions, which received excellent reviews from deployed soldiers in Iraq and Afghanistan and was estimated to

[135] The Defense Innovation Unit is a DoD initiative intended to increase agility and innovation in defense acquisition by serving as a bridge between DoD components, the military services, and companies operating at the leading edge of technology.

[136] Bruce Held and Ike Chang, *Using Venture Capital to Improve Army Research and Development*, Santa Monica, Calif.: RAND Corporation, IP-199, 2001, p. 2.

[137] John A. Parmentola and Robert S. Rohde, "Army Venture Capital Initiative," *Army AL&T*, November–December 2003, p. 29.

[138] Webb et al., 2014, p. 25.

save the Army approximately $375 million over a five-year period.[139] By providing modest funding at the right time, venture capital funds are a conduit to accessing the newest technologies and diversifying partnerships with nontraditional firms. Thus, as mentioned earlier, DoD should consider employing this venture capital model more widely—for example, in cyber and other technology areas that exhibit promise. [140]

In a similar vein, funding for the DoD Small Business Innovation Research (SBIR) program can be better distributed to already successful small businesses and those that DoD is already investing in via other avenues. Held et al. (2006) indicates that integrating the resources of the SBIR program with venture capital initiatives can provide a stream of funding throughout the life cycle of a nascent technology, which can be crucial to fielding new capability.[141]

An inherent reality of the defense industry is that many systems require significant, up-front capital expenditure for production. The infrastructure, materiel, and human capital investments required can be substantial, so both established and emerging markets continually seek ways to reduce such expenditures. This is visible in the established commercial satellite industry, in which operators deploying traditional satellites require up-front capital investment on the order of several hundred million dollars per program. Chang et al. (2016), a study for the U.S. Army, recommends that DoD pursue business arrangements and public-private partnerships that defray these capital expenditures for industry.[142] Commercial firms often operate under strict timelines, so there is not always excess capacity for DoD's needs. Early, up-front investment by DoD can allow firms to plan their operations more effectively to accommodate both commercial and defense programs.

Lastly, DoD should continue to reduce the administrative burdens involved in the acquisition process. DoD is encountering an environment in which nontraditional technology firms are reluctant to conduct business with it, partly because of such barriers as a cumbersome bidding process, unique cost-accounting reporting, and backlogs that create late payments and inconsistent guidance. These barriers add cost and time to the proposal process and can be especially problematic for smaller firms that do not solely rely on defense contracts for revenue. Cox, Moore, and Grammich (2014) suggests that, to alleviate these issues, DoD could streamline the bidding process by standardizing procedures and reducing required paperwork, creating a list

[139] Chadwick M. Steipp, "Funding Cyberspace: The Case for an Air Force Venture Capital Initiative," *Air and Space Power Journal*, Vol. 27, No. 4, July–August 2013, p. 122.

[140] Steipp, 2013.

[141] Held et al., 2006, p. 92.

[142] Ike Chang, Steven Galing, Carolyn Wong, Howell Yee, Elliot Axelband, Mark Onesi, and Kenneth Horn, *Use of Public-Private Partnerships to Meet Future Army Needs*, Santa Monica, Calif.: RAND Corporation, MR-997-A, 1999, pp. 55–57.

of prequalified suppliers, accelerating payment transactions, and using alternative contracting vehicles.[143]

On the idea of using alternative contracting vehicles, OT contracts can alleviate administrative burdens by allowing DoD to contract with firms outside of the standard Federal Acquisition Regulation process. Research on OT usage by Mayer et al. (2020) suggests that OTs allow government contracting officers more flexibility than acquisition through the Federal Acquisition Regulation system, including greater ability to communicate with offerors and greater freedom to tailor solicitations and agreements.[144] However, Mayer et al. (2020) and Webb et al. (2014) note that OTs can limit transparency and require greater efforts by the government to balance flexibility with an appropriate level of discipline.[145] Under certain circumstances, OT agreements can be useful in reducing bureaucratic restrictions.

Improve Long-Term Planning to Sustain the Industrial Base

In addition to broadening the industrial base, DoD should look to augment the long-term planning of acquisition programs to maintain the health of the defense industrial base. Schank et al. (2011), a study for the U.S. Navy, found that, to maintain a technology and capability edge, planning is needed to integrate the respective design, production, and maintenance organizations in industry.[146] For example, in shipyards, it is important to involve builders, maintainers, operators, and the technical community in the design process of a program. The design engineers should collaborate with and incorporate feedback from these parties to ensure that the designed system can be produced and maintained in an efficient manner. This is often achieved through implementing a single integrated design and production contract with the prime contractor. For certain classes of weapon systems that are complex and high cost, such as aircraft or large ships, the infrequency of new acquisition programs endangers certain critical skills in the industrial base. For example, historically, there have been large time intervals between new aircraft carrier design programs, which put critical skills, such as design engineering, at risk of erosion. Some of these design engineering skills may be retained by employing some number of the low-workload engineers for a related program (e.g., for a new submarine) that shares some design features (e.g., pumps, instrumentation systems, and power generation or distribution equipment) during these periods.

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[143] Amy G. Cox, Nancy Y. Moore, and Clifford A. Grammich, *Identifying and Eliminating Barriers Faced by Nontraditional Department of Defense Suppliers*, Santa Monica, Calif.: RAND Corporation, RR-267-OSD, 2014, p. 24.

[144] Mayer et al., 2020, pp. 64–65.

[145] Mayer et al., 2020, pp. 65–67; Webb et al., 2014, p. 19.

[146] John F. Schank, Cesse Ip, Frank W. Lacroix, Robert E. Murphy, Mark V. Arena, Kristy N. Kamarck, and Gordon T. Lee, *Learning from Experience*, Vol. II: *Lessons from the U.S. Navy's* Ohio*,* Seawolf*, and* Virginia *Submarine Programs*, Santa Monica, Calif.: RAND Corporation, MG-1128/2-NAVY, 2011, p. 106.

Generalizing this lesson more broadly, DoD should analyze its demand for design and production assets in the industrial base and consider ways of smoothing this demand across related platform types. Key considerations for such planning include the production intervals, build duration, skill and facility requirements, desired force structure size, and platform life for each end item.

Another method of sustaining industry's technological capability during a fiscally constrained period is by maintaining several active design or prototyping programs. Birkler et al. (2003) shows that a reduction in acquisition funding can cause gaps in innovative design efforts, particularly for niche technologies, and developing a long-term plan to mitigate this is vital.[147] In an environment of limited major development and production programs, an option could be to fund some design projects, such as through the Advanced Technology Demonstration program or the Advanced Concept Technology Demonstration (ACTD) program. Drezner and Leonard (2002) and Thirtle, Johnson, and Birkler (1997) observe that, during the fiscally constrained 1990s, the Predator and Global Hawk ACTD programs, respectively, enabled the continued development of key unmanned aerial vehicle development efforts.[148] This is a way of channeling R&D investment so that specific technological capability is developed, retained, and ready to be used when production resumes.

Long-term acquisition program planning could also enable longer-term contracts with industry, which has multiple benefits under the right circumstances, according to RAND research by Birkler et al. (2000) for the Office of the Secretary of Defense.[149] Because of uncertain future funding, the employment of annual contracts is not conducive to industry making significant investment in facility modernization and training. Long-term agreements ensure a steady flow of capital and encourage firms to revitalize infrastructure and human capital training, among other cost-reduction initiatives. Longer-term contracts are also helpful in alleviating the effect of unexpected price increases during market volatility, as noted earlier. Seong et al. (2009) concludes that, when structured properly, long-term contracts for titanium could provide stability to DoD and industry amid unpredictability in global markets; this may be the case in other contexts as well.[150]

The challenge of maintaining a capable defense industrial base is likely to intensify. Efforts to broaden the industrial base to adapt commercial technologies for military use are necessary but may deflect attention away from the parts of the defense industrial base that do not contribute to commercial markets. One can look to the United Kingdom and Australia to see examples of

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[147] Birkler et al., 2003, p. 89.

[148] Drezner and Leonard, 2002; and Michael R. Thirtle, Robert V. Johnson, and John L. Birkler, *The Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process*, Santa Monica, Calif.: RAND Corporation, MR-899-OSD, 1997.

[149] Birkler et al., 2000.

[150] Seong et al., 2009, p. 102.

the challenge of modernizing military capabilities absent a robust domestic industrial base.[151] RAND research has helped these countries make difficult decisions about developing military ships and aircraft, but these options do not fully address the risks.

Properly Size, Train, and Incentivize the Acquisition Workforce

Since 1986, concerns over the size, mix, and quality of the acquisition workforce have driven numerous investigations and policy changes aimed at reshaping it. However, as many studies have shown, acquisition outcomes have not improved noticeably. To be sure, confounding factors unrelated to the acquisition workforce—for example, churn in broader acquisition policy and unstable acquisition program budgets—may challenge the establishment of a link between workforce characteristics and acquisition outcomes. Nevertheless, basic information needed to begin to assess the impact of acquisition workforce characteristics on acquisition outcomes is lacking. Establishing this link would support acquisition workforce planning because it would highlight current or expected gaps in the workforce and inform initiatives aimed at reshaping the acquisition workforce to address these gaps. Thus, drawing on RAND research, we argue in this section that DoD should expend efforts to establish a link between acquisition workforce characteristics and acquisition outcomes.[152] However, to improve acquisition outcomes, more-effective acquisition workforce planning must be supported by better understanding of how workforce composition affects outcomes and must be complemented by incentives that are aligned with acquisition goals, as we discuss next.

Map Workforce Characteristics to Acquisition Activities and Their Outcomes

To identify the impact of workforce attributes on acquisition outcomes, improvements must be made to both acquisition workforce data collection and appropriate acquisition outcome metrics.

As noted by Gates et al. (2008), data on the acquisition workforce are lacking for a few reasons. First, the definition of the organic acquisition workforce (military and civilian) has varied over the years and across DoD organizations, thereby precluding reliable trend analyses from before 2008. DoD should work to revise data collection policy guidance to improve

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[151] See, for example, Matt Bassford, Hans Pung, Nigel Edgington, Tony G. Thompson-Starkey, Kristin Weed, Mark V. Arena, James G. Kallimani, Gordon T. Lee, and Obaid Younossi, *Sustaining Key Skills in the UK Military Aircraft Industry*, Santa Monica, Calif.: RAND Corporation, MG-1023-MOD, 2010; and John Birkler, John F. Schank, Mark V. Arena, Edward G. Keating, Joel B. Predd, James Black, Irina Elena Danescu, Dan Jenkins, James G. Kallimani, Gordon T. Lee, Roger Lough, Robert Murphy, David Nicholls, Giacomo Persi Paoli, Deborah Peetz, Brian Perkinson, Jerry M. Sollinger, Shane Tierney, and Obaid Younossi, *Australia's Naval Shipbuilding Enterprise: Preparing for the 21st Century*, Santa Monica, Calif.: RAND Corporation, RR-1093-AUS, 2015.

[152] Susan M. Gates, Edward Keating, Adria Jewell, Lindsay Daugherty, Bryan Tysinger, Albert A. Robbert, Ralph Masi, *The Defense Acquisition Workforce: An Analysis of Personnel Trends Relevant to Policy, 1993–2006*, Santa Monica, Calif.: RAND Corporation, TR-572-OSD, 2008; and Susan M. Gates, *Shining a Spotlight on the Defense Acquisition Workforce—Again*, Santa Monica, Calif.: RAND Corporation, OP-266-OSD, 2009.

consistency of workforce data over time and across organizations. Second, to address the common criticism that the acquisition workforce lacks the skills to accomplish its workload, DoD should improve workforce metrics that capture the competencies necessary to do its work. Third, there is poor DoD-wide information on the number of support contractors in the acquisition workforce. Because support contractors constitute an important segment of the acquisition workforce, DoD cannot hope to manage the acquisition workforce from a total-workforce perspective if its insight into this segment of the workforce is severely limited.[153] Thus, DoD should collect the same kind of data on contractors that we recommend for the organic workforce.

As mentioned earlier, to enable acquisition workforce planning, workforce characteristics must be linked to appropriate acquisition outcome metrics.[154] Accomplishing this goal would require managers to develop metrics appropriate to the program, organization, or activity in question that plausibly inform the quality of the work being done; that is, they should develop metrics based on the things that the workforce could influence and that would ultimately be expected to affect outcomes. For example, if managers agree that providing timely systems engineering to support investment decisionmaking is a critical process indicator, they could track whether such activities are occurring and possibly assess the quality of those activities.[155]

Information could then be linked with data on that program's workforce to assess the relationship between workforce characteristics and these outcomes. Similarly, the tenure of program managers has been highlighted as a plausible factor influencing outcomes. This workforce characteristic could be tracked at the program level and related to program outcomes to determine whether there is a relationship between tenure and outcomes.

Align Incentives with Desired Acquisition Outcomes

In some respects, the challenge of shaping acquisition workforce behavior so that it is aligned with acquisition goals is similar to the challenge of other segments of the DoD workforce—or even the broader government workforce. For example, the manner in which the acquisition workforce is compensated may not optimally encourage effective work from the workforce. Asch and Warner (1994) indicates that the active-duty compensation structure could be revised to induce the workforce to supply more effort through increased intergrade pay spreads and by

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[153] Gates et al., 2008.

[154] Gates et al., 2008.

[155] Additional RAND research on the implementation of performance-based accountability systems in various service industries identifies circumstance-specific considerations that must be made when implementing workforce incentive systems. See Brian M. Stecher, Frank Camm, Cheryl L. Damberg, Laura S. Hamilton, Kathleen J. Mullen, Christopher Nelson, Paul Sorensen, Martin Wachs, Allison Yoh, Gail L. Zellman, and Kristin Leuschner, *Toward a Culture of Consequences: Performance-Based Accountability Systems for Public Services*, Santa Monica, Calif.: RAND Corporation, MG-1019/1, 2010.

tying part of compensation to performance.[156] Presumably, similar lessons hold for the civilian and contractor segments of the acquisition workforce. Indeed, this hypothesis regarding the civilian General Schedule personnel system motivated the DoD Civilian Acquisition Workforce Personnel Demonstration Project (AcqDemo), which is an initiative beginning in 1999 to reengineer the civilian personnel systems with greater flexibility (e.g., tying a greater portion of pay to performance) to meet the needs of the acquisition workforce. Lewis et al. (2016) indicates that, within AcqDemo, higher levels of contribution to the organizational mission were associated with higher salaries, more-rapid salary growth, more promotions, and a greater likelihood of retention,[157] but the perceived complexity of the project's evaluation system has been a long-standing concern.[158] Guo, Hall-Partyka, and Gates (2014), another RAND assessment of the acquisition workforce, illustrates that people who were in the AcqDemo project, or any demonstration pay plan, were retained longer than those in the General Schedule.[159]

We recommend that DoD continue implementing and evaluating compensation schemes that provide greater flexibility in rewarding performance that aligns with desired acquisition outcomes. In that vein, Savych (2005) examines how different compensation models in the labor economics literature may be adapted to help create greater flexibility in managing personnel and inducing desired performance in DoD.[160] As with our previous recommendation on workforce planning, the key to compensation schemes that employ performance incentives is defining metric-based dimensions (e.g., problem-solving, teamwork and cooperation, customer relations, leadership and supervision, communication, and resource management) that the workforce could influence and that would ultimately be expected to affect acquisition outcomes.[161] Consistent with our earlier theme of tailoring, Asch (2005) suggests that the most-effective pay incentives

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[156] Beth J. Asch and John T. Warner, *A Theory of Military Compensation and Personnel Policy*, Santa Monica, Calif.: RAND Corporation, MR-439-OSD, 1994.

[157] Jennifer Lamping Lewis, Laura Werber, Cameron Wright, Irina Danescu, Jessica Hwang, and Lindsay Daugherty, *2016 Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project*, Santa Monica, Calif.: RAND Corporation, RR-1783-OSD, 2016.

[158] Laura Werber, Lindsay Daugherty, Edward G. Keating, and Matthew Hoover, *An Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project*, Santa Monica, Calif.: RAND Corporation, TR-1286-OSD, 2012.

[159] Christopher Guo, Philip Hall-Partyka, and Susan M. Gates, *Retention and Promotion of High-Quality Civil Service Workers in the Department of Defense Acquisition Workforce*, Santa Monica, Calif.: RAND Corporation, RR-748-OSD, 2014.

[160] Bogdan Savych, *Toward Incentives for Military Transformation: A Review of Economic Models of Compensation*, Santa Monica, Calif.: RAND Corporation, TR-194-OSD, 2005. See also Robert Klitgaard and Paul C. Light, eds., *High-Performance Government: Structure, Leadership, Incentives*, Santa Monica, Calif.: RAND Corporation, MG-256-PRGS, 2005, Chapter 11.

[161] These performance dimensions were articulated as part of the AcqDemo project. See Werber et al., 2012, pp. 19–20.

will likely be highly dependent on situational factors, such as occupation, organizational mission, and costs of monitoring.[162]

In addition to revisiting personnel compensation, DoD should also reconsider policies that may create incentives for program managers or other decisionmakers that run counter to desired acquisition outcomes. For example, seeking efficiencies that generate savings for programs may not be encouraged if all of the savings are subsequently removed from the program's budget. In a similar vein, programs are incentivized to execute funds in accordance with generic benchmarks from the Office of the Secretary of Defense, even if it is premature for the program to do so, because under-execution of funds can be punished by cutting current or later program funding. As a result, incentives may exist to prematurely award contracts or to spend funds unnecessarily, and those incentives are contrary to desired acquisition outcomes. Program manager tenure is another area that may merit attention; tenures that are much shorter than the length of acquisition programs may incentivize short-term decisionmaking.[163] Assuming that program manager tenure is a driver of acquisition outcomes, DoD should consider resolving these conflicting incentives so that lengthy tenure in a program can be advantageous for promotion.

[162] Beth J. Asch, "The Economic Complexities of Incentive Reforms," in Robert Klitgaard and Paul C. Light, eds., *High-Performance Government: Structure, Leadership, Incentives*, Santa Monica, Calif.: RAND Corporation, MG-256-PRGS, 2005.

[163] Better data in support of acquisition workforce planning could shed light on the strength of the correlation between program manager tenure and acquisition outcomes.

5. Conclusions

In this report, we identified four major forces—geopolitical change, globalization, changing national priorities, and advancing commercial technologies—that have, and will continue to have, important implications for the acquisition of systems for DoD. Through our review of RAND research and the broader acquisition literature, we identified the following challenges, or focus areas, for modern acquisition systems:

- responding to evolving missions
- leveraging a changing defense industrial base
- accommodating interoperability
- building in cybersecurity
- planning for technology refresh and insertion
- rebuilding the acquisition workforce
- managing the acquisition cost of systems
- aligning incentives, organization, and processes to acquisition goals.

To help address these challenges, we offered an integrated set of actions that may serve as a starting point for a comprehensive strategy to improve DoD's acquisition system. These actions, derived from RAND research since 1986, are structured around three main themes:

- To achieve desirable acquisition outcomes, **acquisition strategies, organizational roles and responsibilities, and reporting structures must be tailored to the unique characteristics of each program**. There is no one-size-fits-all approach that works with every program, and attempts to force programs into a single paradigm lead to problems and inefficiencies.
- It is important to broaden and plan for the defense industrial base. **An inclusive industrial base must be better engaged to fully exploit its innovation potential** and must be focused on sustaining key parts of the defense industrial base.
- **The acquisition workforce must be properly sized, trained, and incentivized to make the smart decisions that flexible acquisition approaches and partnering productively with industry entail.**

In closing, because most reforms require several years for their full effects to be realized, DoD must be patient in letting acquisition reforms play out before implementing additional changes. Indeed, since its inception, DoD's acquisition system has been subjected to a constant stream of reform initiatives, many of which harken to earlier efforts whose effects may not have been fully assessed. Thus, it is only through a patient, data-driven evaluation of reform initiatives that DoD can tell what worked, what did not, and where DoD should go to improve acquisition outcomes.

Appendix: Annotated Bibliography

This annotated bibliography details the 89 publicly available RAND research reports that, since 1986, have examined acquisition issues across all military services, the joint establishment, other nations, and warfighting domains. Reports are organized in 13 topic areas:

- defense acquisition policy
- program cost
- program schedule
- risk in acquisition
- defense industrial base
- defense innovation
- acquisition workforce
- development and design of weapon systems
- lessons learned from acquisition programs
- joint acquisition
- space and cyber acquisition
- data in defense acquisition
- international acquisition.

In each section, reports are listed in descending chronological order.

Defense Acquisition Policy

RAND research recommends that acquisition approaches be tailorable to the unique characteristics of each program. Acquisition policies support that flexibility. The following RAND reports analyze defense acquisition policies and their positive and negative effects on outcomes and provide recommendations for further development.

Building a Broader Evidence Base for Defense Acquisition Policymaking
Elizabeth M. Bartels, Jeffrey A. Drezner, Joel B. Predd
2020, RR-A202-1, https://www.rand.org/pubs/research_reports/RRA202-1.html

One of the primary responsibilities of the Office of the Under Secretary of Defense for Acquisition and Sustainment is to ensure the health of the overall defense acquisition system. The office can bolster the health of the defense acquisition system by developing and promulgating sound acquisition policy that improves the function and operation of the system at the enterprise level. The premise of this report is that acquisition policymaking should be data-driven. However, there are limitations to relying on empirical (e.g., historical) data to guide acquisition policy. Considering these limitations, the authors argue that acquisition policymaking should be evidence-based, in recognition of a wider variety of analytic tools that can be brought

to bear on acquisition policy questions. This report, intended for acquisition professionals, summarizes the case for a broader evidence base and then focuses on one specific tool that the authors suggest might add analytic value: policy gaming.

Policy gaming can be used to generate observations about how stakeholders might change their decisionmaking and behavior in light of changes in policy. Because the strengths and limitations of games differ from those of traditional tools for acquisition analysis, the authors argue that games complement the existing portfolio of analytic approaches. The authors describe a prototype game focused on middle-tier acquisition policy that RAND researchers developed to enrich the available evidence base to support acquisition policymaking, summarize insights from the game, and offer several next steps for the Office of the Under Secretary of Defense for Acquisition and Sustainment to consider.

Operating Under a Continuing Resolution: A Limited Assessment of Effects on Defense Procurement Contract Awards

Stephanie Young, J. Michael Gilmore

2019, RR-2263-OSD, https://www.rand.org/pubs/research_reports/RR2263.html

In this report, the authors assess that operating under continuing resolutions at the beginning of a fiscal year, which has become the norm for several years, has led to delays and increased costs in DoD weapon procurement. Purportedly, operating under a continuing resolution causes these effects by constraining the initiation of activities not previously approved and funded. The authors use data drawn from successive President's Budget submissions to compare projected and realized award dates and unit costs for 151 procurement awards that DoD made for FYs 2013 through 2015, which had the two longest continuing resolutions in recent history. They also compare outcomes of procurement awards originally projected for FY 1999, which had only three weeks under continuing resolutions, with outcomes for FYs 2013 through 2015. A qualitative analysis comparing anticipated and actual results of procurement awards about which DoD staff had expressed specific concern in light of continuing resolutions yields mixed results but does not provide strong evidence that these resolutions are causing delays or cost increases. However, the limited approach also does not provide definitive evidence for a lack of their occurrence. The results of this analysis should therefore not be interpreted as indicating that concerns about operating under a continuing resolution are misplaced. Rather, the analysis should be considered a first, limited step toward developing an empirical basis for assessing the consequences of operating under a continuing resolution.

Balancing Immediate and Long-Term Defense Investments

Jonathan P. Wong

2016, RGSD-378, https://www.rand.org/pubs/rgs_dissertations/RGSD378.html

The DoD process for allocating resources for acquiring weapon systems is optimized for long-term investments and guided by DoD's forecast of future threats, conflicts, and adversaries

and the possible U.S. responses to them. This dissertation examines how the DoD acquisition bureaucracy responds to unforeseen conflicts and adversaries by making immediate procurement investments. The author finds that DoD developed a surprisingly nimble and risk-tolerant process for making most immediate investments. DoD did require extensive senior leader intervention to make investments that were previously judged to be unnecessary. The author also indicates that DoD's process relied on the entrepreneurship and organizational savvy of individual program officers to identify funding sources and enlist stakeholder support. Wong concludes by recommending marginal changes to DoD policy, including granting greater flexibility to DoD components to spend previously allocated resources, allowing more bottom-up input to the immediate investment process, and anticipating the need for single-purpose task forces to provide senior leader intervention in contentious cases.

The Perfect Storm: The Goldwater-Nichols Act and Its Effect on Navy Acquisition
Charles Nemfakos, Irv Blickstein, Aine Seitz McCarthy, Jerry M. Sollinger
2010, OP-308-NAVY, https://www.rand.org/pubs/occasional_papers/OP308.html

The defense reforms begun in 1986 with the passage of the Goldwater-Nichols Department of Defense Reorganization Act ushered in an era of sweeping change in U.S. military acquisition policies and processes. Reform was necessary to correct genuine deficiencies in DoD's operational and acquisition practices, but implementation of the 1986 act—and subsequent legislation, including the National Defense Authorization Act of 1987—resulted in a host of unintended and undesirable consequences, especially in the Department of the Navy. Drawing on research, interviews, and their own professional experience, the authors examine both the climate surrounding the development of Goldwater-Nichols and each military service's implementation of the legislation. They trace the origins, construction, and fortification of the wall between the Department of the Navy's military-run requirement process and the civilian-run acquisition process—a divide inimical to the efficient and effective support of military forces and antithetical to the spirit of the legislation—and investigate the legislation's adverse effects on Navy personnel policies. The authors' recommendations focus on breaking down the wall, changing obstructive personnel policies, re-involving the Department of the Navy service chiefs in the acquisition process, and restoring some institutional balance.

Reexamining Military Acquisition Reform: Are We There Yet?
Christopher H. Hanks, Elliot I. Axelband, Shuna Lindsay, Mohammed Rehan Malik, Brett D. Steele
2005, MG-291-A, https://www.rand.org/pubs/monographs/MG291.html

In DoD, 63 distinct acquisition reform initiatives were undertaken from 1989 to 2002. This monograph classifies the initiatives according to various criteria: basic acquisition reform theme, relationship to acquisition functions, Army recognition, coverage in the DoD 5000 series of guidance, relationship to Under Secretary E. C. "Pete" Aldridge's five goals underlying the new

Acquisition Excellence philosophy, coverage in Defense Acquisition University curricula, and relationship to industry attractiveness and return-on-investment models. The analysis makes use of interviews with industry and Army Program Management personnel, who were asked: What has been good about acquisition reform? What has been bad? What would you change? In general, industry and Army Program Management personnel acknowledge that some good has come from some acquisition reform initiatives, but they argue that many serious structural and cultural impediments still remain that hinder the ability of the acquisition process to deliver desired cost, schedule, and performance outcomes.

Changing Bureaucratic Behavior: Acquisition Reform in the United States Army
Conrad Peter Schmidt
2000, MR-1094-A, https://www.rand.org/pubs/monograph_reports/MR1094.html

In 1994, then–Secretary of Defense William Perry directed the Army, Navy, Air Force, and Marine Corps to begin reinventing their acquisition systems and policies. One of the most important elements of the so-called Perry initiatives was the elimination of all military specifications and standards from use in military acquisition. At the request of the U.S. Army, this study examines three policy questions: (1) Is military specification and standard reform being implemented successfully by Army acquisition bureaucrats? (2) What factors or determinants affect the willingness and ability of Army acquisition employees to implement military specification and standard reform? (3) Having assessed implementation to date and understanding better what affects bureaucratic behavior, how can the Army best affect the underlying beliefs and perceptions of its personnel to influence behavior in support of military specification and standard reform? This study employs the Theory of Planned Behavior, a theoretical model of volitional behavior. The authors use a multimethod research approach, employing both expert interviews and a survey of Army personnel. Using causal modeling techniques (latent variable analysis), the authors determine that reform behavior within the Army acquisition workforce is determined by employees' attitudes toward the reform and their perceptions of behavioral control. In addition, multiple regression analysis of these factors reveals that attitudes and control perceptions vary based on the functional perspectives of acquisition employees. Three conclusions emerge: (1) Resistant employees are less likely to believe that the elimination of military specifications and standards will result in positive programmatic outcomes; (2) resistant employees were much more likely to view training and communication efforts as inadequate; and (3) current training efforts are effective in changing underlying attitudes. This study presents two overarching recommendations: (1) Use and improve existing training programs, and (2) target implementation efforts to the resistant elements of the workforce, focusing on changing the beliefs and perceptions important in forming attitude and control perceptions.

Three Programs and Ten Criteria: Evaluating and Improving Acquisition Program Management and Oversight Processes Within the Department of Defense
Robert V. Johnson, John Birkler
1996, MR-758-OSD, https://www.rand.org/pubs/monograph_reports/MR758.html

Acquisition in DoD is a major undertaking in which the defense agencies and the military departments expend significant funds to procure R&D, test and evaluation, production, operational support, and obsolescence. The opportunities for problems to occur and the unique challenges posed in dealing with those problems in a high-technology environment require constant vigilance at all levels of management within DoD. Problems in MDAPs, when accurately identified, can be a source of guidance for improving acquisition-management procedures. As part of a broader attempt to improve the acquisition-management controls and oversight processes used in the defense acquisition system, this report synthesizes lessons learned from an analysis of past problems and, in the process, identifies and evaluates innovative approaches to program management. The authors develop a framework for evaluating management practices in ongoing development and production programs. The framework then serves as the basis for reviewing and evaluating the technical aspects (e.g., organizational structuring, reporting channels) of the Navy's F/A-18E/F aircraft, the Air Force's F-22 fighter aircraft, and the Army's RAH-66 Comanche armed reconnaissance helicopter. This is done without directly comparing the three programs, because each program is its service's top priority.

Killing the Messenger: The Place of Systems Acquisition in the National Security Planning and Management Systems
James A. Winnefeld
1988, P-7417, https://www.rand.org/pubs/papers/P7417.html

Past efforts to reform the systems acquisition process in DoD have failed to view acquisition as part of a complex government planning and management system. The author of this paper considers whether the acquisition process can be reformed without changes in other elements of DoD management systems. It maps out the major components of the DoD management system and outlines their relationship to each other and to the acquisition subsystem. The author then identifies issues related to each component. The author suggests that future acquisition reform efforts should emphasize other components of the system rather than the acquisition process itself.

Program Cost

Effective program managers must balance acquisition costs, schedule, and performance. The following reports analyze programmatic trends that lead to cost overruns, how to minimize cost of defense acquisition programs, and defense acquisition enterprise costs.

Baselining Defense Acquisition
Philip S. Anton, Tim Conley, Irv Blickstein, Austin Lewis, William Shelton, Sarah Harting
2019, RR-2814-OSD, https://www.rand.org/pubs/research_reports/RR2814.html

DoD aims to improve mission effectiveness and efficiency. In support of this effort, the Office of the Secretary of Defense asked RAND's National Defense Research Institute to construct a baseline of DoD's government acquisition and procurement functions, including a functional decomposition and estimate of the cost of executing the government portion of DoD's acquisition enterprise. In this report, RAND researchers estimate these costs at between $29 billion and $38 billion in FY 2017 dollars. To gain perspective on these costs, the researchers identify commercial benchmarks for program management. The researchers estimate DoD's program management portion of DoD contracting obligations at about 1.5 percent in FYs 2008–2017, which is below industry benchmarks of 2–15 percent.

Expanding Operating and Support Cost Analysis for Major Programs During the DoD Acquisition Process: Legal Requirements, Current Practices, and Recommendations
Michael Boito, Tim Conley, Joslyn Fleming, Alyssa Ramos, Katherine Anania
2018, RR-2527-OSD, https://www.rand.org/pubs/research_reports/RR2527.html

The Weapon System Acquisition Reform Act of 2009 established the Office of Cost Assessment and Program Evaluation in the Office of the Secretary of Defense and mandated a broad set of cost analysis duties, including conducting independent cost estimates and independent cost assessments for MDAPs at key acquisition milestones. Subsequent laws have mandated additional duties, especially related to O&S costs, including requirements to conduct or approve life-cycle cost estimates early in acquisition, identify risk drivers in estimates at milestone decisions, and examine alternatives that may reduce O&S costs. The authors of this report assess the cost analysis requirements for O&S costs by reviewing relevant laws and DoD guidance; assess the resources available to conduct the analyses, including numbers of cost-estimating personnel, the data typically available to inform cost analyses, and cost-estimating processes and timelines; interview government and industry subject-matter experts to understand past and current DoD cost-analysis activities; review the literature; and develop recommendations to improve weapon system O&S cost analysis during the acquisition phase.

F-35 Block Buy—An Assessment of Potential Savings: Appendix B, Historical Case Studies of Multiyear Procurement and Block Buy Contracts
Mark A. Lorell, Abby Doll, Thomas C. Whitmore, James D. Powers, Guy Weichenberg
2018, RR-2063/1-AF, https://www.rand.org/pubs/research_reports/RR2063z1.html

In 2015, the United States and partner governments in the F-35 program began considering the use of a three-year block buy contract for procurement of F-35 aircraft during fiscal years 2018–2020. A block buy contract (which is similar to a multiyear procurement contract) can save

DoD money by providing prime contractors and their suppliers the incentive and ability to leverage quantity and schedule certainty and economies of scale, thus generating savings that would not be available under three annual single-lot contracts. This report presents an assessment of potential cost savings available through a block buy contract for F-35 procurement. The researchers independently assess savings for the aircraft's air vehicle and engine, consistent with the way contracting is handled in the program, and focus on recurring flyaway costs. For the air vehicle, the estimated savings are $1.8 billion, or 5.2 percent of the cost of contracting annually for three lots. For the engine, the estimated savings are $280 million, or 3.8 percent of the cost of contracting annually. Thus, the combined block buy savings are approximately $2.1 billion, or 4.9 percent of the cost of annual contracting. These savings are estimated relative to an annual contracting baseline computed by RAND and are roughly comparable to those estimated for historical multiyear contracts for other fighter aircraft. This appendix discusses how historical multiyear procurement and block buy contracts have been implemented and how they compare with each other. As context for an analysis of potential savings in an F-35 block buy contract, researchers examine 28 historical multiyear contracts spanning 17 different weapon systems (15 aircraft and two naval vessels). This appendix outlines the methodology and data sources for analyzing these contracts, provides a high-level overview of trends observed across the case studies, and provides in-depth discussion of the more-recent historical multiyear program case studies.

Program Characteristics That Contribute to Cost Growth: A Comparison of Air Force Major Defense Acquisition Programs

Mark A. Lorell, Leslie Adrienne Payne, Karishma R. Mehta

2017, RR-1761-AF, https://www.rand.org/pubs/research_reports/RR1761.html

This report is a companion to an earlier report that identified the main characteristics of six U.S. Air Force acquisition programs with extreme cost growth (see next entry). This report evaluates four recent Air Force MDAPs with low cost growth and compares and contrasts their key characteristics to the six programs evaluated with extreme cost growth from the earlier report. The purpose is threefold. First, the authors determine whether or not the key characteristics identified in the programs with extreme cost growth are present in the programs with low cost growth and, if not, why. Second, the authors determine common characteristics of the programs with low cost growth and whether such characteristics can be incorporated into future Air Force MDAPs. Finally, the authors revisit the main recommendations from the earlier report regarding approaches to mitigating extreme cost growth and, based on the findings from the low-cost-growth programs, determine whether those recommendations are still valid and broadly applicable to future Air Force MDAPs.

Extreme Cost Growth: Themes from Six U.S. Air Force Major Defense Acquisition Programs

Mark A. Lorell, Robert S. Leonard, Abby Doll

2015, RR-630-AF, https://www.rand.org/pubs/research_reports/RR630.html

This report identifies and characterizes conditions present in six U.S. Air Force MDAPs experiencing extreme cost growth, using case study analysis. This report is a companion to the previous entry in this annotated bibliography, as well as to another report that analyzed cost growth trends in U.S. Air Force MDAPs using Selected Acquisition Report data. The case study analysis provided in this document is based on government program documentation and publicly available open-source materials, as well as interviews with program officials and subject-matter experts.

The authors find that the key common attributes among the six programs with extreme cost growth can be grouped into two broad areas: (1) premature approval of Milestone B and (2) suboptimal acquisition strategies and program structure. The authors offer two broad recommendations for improving cost and schedule outcomes for Air Force MDAPs: (1) Establish credible baseline cost estimates at Milestone B to provide realistic baseline metrics for accurately measuring real cost growth, and (2) develop, refine, and implement robust evolutionary or incremental acquisition strategies and policies that reduce and control technological and programmatic risk, unless timely operational need has clear priority over cost savings.

DoD and Commercial Advanced Waveform Developments and Programs with Multiple Nunn-McCurdy Breaches, Volume 5

Mark V. Arena, Irv Blickstein, Daniel Gonzales, Sarah Harting, Jennifer Lamping Lewis, Michael McGee, Megan McKernan, Charles Nemfakos, Jan Osburg, Rena Rudavsky, Jerry M. Sollinger

2014, MG-1171/5-OSD, https://www.rand.org/pubs/monographs/MG1171z5.html

The report presents the results of two studies: The first compares the capabilities and development approaches used in the Joint Tactical Radio System wideband networking waveform and the commercial long-term evolution waveform, and the second analyzes military acquisition programs that have repeatedly exceeded certain cost thresholds. The first study compares differences in system designs, technical requirements, intellectual property protection schemes, and cost in the development of the wideband networking waveform. The authors also examine how technical risks and challenging requirements contributed to schedule and cost increases. The second study attempts to identify unique characteristics of programs that overrun their budgets more than once.

Management Perspectives Pertaining to Root Cause Analyses of Nunn- McCurdy Breaches, Volume 4: Program Manager Tenure, Oversight of Acquisition Category II Programs, and Framing Assumptions.
Mark V. Arena, Irv Blickstein, Abby Doll, Jeffrey A. Drezner, James G. Kallimani, Jennifer Kavanagh, Daniel F. McCaffrey, Megan McKernan, Charles Nemfakos, Rena Rudavsky, Jerry M. Sollinger, Daniel Tremblay, Carolyn Wong
2013, MG-1171/4-OSD, https://www.rand.org/pubs/monographs/MG1171z4.html

Concern with cost overruns in MDAPs led Congress to direct investigation of the root causes of overruns in programs that have breached Nunn-McCurdy thresholds. The authors calculate program manager tenure to determine whether tenures have lengthened since policy guidance was issued in 2005 and 2007. They also address whether existing decentralized systems used to track the cost growth and performance of acquisition category II programs are sufficient or whether additional centralized guidance and control from the Office of the Secretary of Defense are warranted. A third question deals with the management of cost and schedule risk and whether the identification of key assumptions, which the authors call *framing assumptions*, could be a useful risk management tool.

Root Cause Analyses of Nunn-McCurdy Breaches, Volume 2: Excalibur Artillery Projectile and the Navy Enterprise Resource Planning Program, with an Approach to Analyzing Complexity and Risk
Irv Blickstein, Jeffrey A. Drezner, Martin C. Libicki, Brian McInnis, Megan McKernan, Charles Nemfakos, Jerry M. Sollinger, Carolyn Wong
2012, MG-1171/2-OSD, https://www.rand.org/pubs/monographs/MG1171z2.html

Congressional concern with cost overruns, or breaches, in several MDAPs led the authors, in a partnership with the Performance Assessments and Root Cause Analysis Office in the Office of the Secretary of Defense for Acquisition, Technology, and Logistics, to investigate root causes by examining program reviews, analyzing data, participating in contractor briefings, and holding meetings with diverse stakeholders. In a companion study, the authors investigate cost overruns in four programs. The current study analyzes cost overruns in the Navy Enterprise Resource Planning program and Excalibur (a 155-mm extended-range guided artillery projectile). In addition, the authors develop some exploratory concepts of program risk and complexity as factors in the management of program acquisition. Despite the cost growth associated with the Enterprise Resource Planning program, it can be considered a qualified success. The program was re-baselined in 2006 and, since then, costs have stabilized and production delays have been limited. The authors determine that the primary driver of cost increases in the Excalibur program was the change in procurement quantities—specifically, a 79-percent reduction in rounds ordered. Inaccurate cost estimates, changes in concepts and technology, and urgent operational needs also contributed to the overruns.

Root Cause Analyses of Nunn-McCurdy Breaches, Volume 1: *Zumwalt*-Class Destroyer, Joint Strike Fighter, Longbow Apache, and Wideband Global Satellite
Irv Blickstein, Michael Boito, Jeffrey A. Drezner, James Dryden, Kenneth Horn, James G. Kallimani, Martin C. Libicki, Megan McKernan, Roger C. Molander, Charles Nemfakos, Chad J. R. Ohlandt, Caroline R. Milne, Rena Rudavsky, Jerry M. Sollinger, Katharine Watkins Webb, Carolyn Wong
2011, MG-1171/1-OSD, https://www.rand.org/pubs/monographs/MG1171z1.html

Congressional concern with cost overruns, or breaches, in several MDAPs led the authors, in a partnership with the Performance Assessments and Root Cause Analysis Office in the Office of the Secretary of Defense for Acquisition, Technology, and Logistics, to investigate root causes by examining program reviews, analyzing data, participating in contractor briefings, and holding meetings with diverse stakeholders. The analysis of cost overruns in four programs reveals several contributory factors, including changes in the economy, misestimation of costs, and inadequate program planning. Underestimation of baseline costs; increases in component costs; insufficient RDT&E; inflation; and increased, inadequate, or unstable program funding are identified as root causes in all four programs.

Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options
Obaid Younossi, Kevin Brancato, John C. Graser, Thomas Light, Rena Rudavsky, Jerry M. Sollinger
2010, MG-797-AF, https://www.rand.org/pubs/monographs/MG797.html

In April 2009, DoD decided to terminate production of the F-22A Raptor and close the production line after the last aircraft delivery. In advance of the decision, the Air Force asked RAND Project AIR FORCE to identify the costs and implications of various shutdown options on the industrial base. Because the F-22A manufacturing base is complex, shutting down the production line without making any investment in preserving key elements of production capability would make it expensive and difficult to restart production in the future, if that were desired. The authors of this monograph evaluate the implications of three shutdown options for the F-22A industrial capability: shutdown; shutdown and restart; and "warm" production, in which a small number of aircraft are produced until and if a decision is made to return to full-rate production. Such issues as the availability of skilled labor, processes, facilities, and tooling used by firms supporting F-22A production are likely to affect some suppliers.

Why Has the Cost of Fixed-Wing Aircraft Risen? A Macroscopic Examination of the Trends in U.S. Military Aircraft Costs over the Past Several Decades
Mark A. Arena, Obaid Younossi, Kevin Brancato, Irv Blickstein, Clifford A. Grammich
2008, MG-696-NAVY/AF, https://www.rand.org/pubs/monographs/MG696.html

This report explores why, in recent decades, military fixed-wing aircraft costs have escalated beyond the rates of commonly used inflation indices, examining both economy-driven factors that the military services cannot control and customer-driven ones that they can. The authors find that this trend of cost increases is true for all types of aircraft—patrol, cargo, trainer, bomber, attack, fighter, and electronic warfare. Economy-driven variables examined include costs for labor, equipment, and material. Customer-driven variables include the costs of providing the performance characteristics that the services want in their aircraft. The authors find several reasons for cost escalation: the increased demand for greater aircraft stealth; the requirement for reduced aircraft weight; and government regulations designed to protect U.S. industry and technology, the environment, and occupational health. Several options to reduce cost escalation are examined, including encouraging international competition for aircraft manufacture, stabilizing procurement rates, and incorporating lessons learned from prior development programs. Until this cost trend is curbed, the government will be able to afford fewer, increasingly expensive aircraft, especially if long-term defense investment spending remains relatively constant.

Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs
Joseph G. Bolten, Robert S. Leonard, Mark V. Arena, Obaid Younossi, Jerry M. Sollinger,
2008, MG-670-AF, https://www.rand.org/pubs/monographs/MG670.html

Previous studies have shown that DoD and the military departments have historically underestimated the cost of new weapon systems. Quantifying cost growth is important, but the larger issue is why cost growth occurs. To address that issue, the authors of this report use data from Selected Acquisition Reports to examine 35 mature, but not necessarily complete, MDAPs similar to the type and complexity of those typically managed by the Air Force. The programs are first examined as a complete set, then Air Force and non–Air Force programs are analyzed separately to determine whether the causes of cost growth in the two groups differ. Four major sources of cost growth are identified: (1) errors in estimation and scheduling, (2) decisions made by the government, (3) financial matters, and (4) miscellaneous sources. Total (development plus procurement) cost growth, when measured as simple averages among the program set, is dominated by decisions, which account for more than two-thirds of the growth. Most decision-related cost growth involves quantity changes (22 percent), requirements growth (13 percent), and schedule changes (9 percent). Cost estimation (10 percent) is the only large contributor in the error category. Less than 4 percent of the overall cost growth is due to financial and

miscellaneous causes. Because decisions involving changes in requirements, quantities, and production schedules dominate cost growth, program managers, service leadership, and Congress should look for ways to reduce changes in these areas.

Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs

Obaid Younossi, Mark V. Arena, Robert S. Leonard, Charles Robert Roll, Jr., Arvind Jain, Jerry M. Sollinger

2007, MG-588-AF, https://www.rand.org/pubs/monographs/MG588.html

In recent decades, there have been numerous attempts to rein in the cost growth of DoD acquisition programs. Cost growth is the ratio of the cost estimate reported in a program's final Selected Acquisition Report and the cost-estimate baseline reported in a prior report issued at a particular milestone. Drawing on prior RAND research, new analyses of completed and ongoing weapon system programs, and data drawn from Selected Acquisition Reports, this study addresses the following questions: What is the cost growth of DoD weapon systems, and what has been the trend of cost growth over the past three decades? To address the magnitude of cost growth, the authors examine cost growth in completed programs; to evaluate the cost growth trend over time, they provide additional analysis of a selection of ongoing programs. This sample of ongoing programs permits a look at growth trends in the more recent past. Changes in the mix of system types over time and dollar-weighted analysis are also considered because earlier studies have suggested that cost growth varies by program type and the cost of the program. The findings suggest that development cost growth over the past three decades has remained high and without any significant improvement.

Why Has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs over the Past Several Decades

Mark V. Arena, Irv Blickstein, Obaid Younossi, Clifford A. Grammich

2006, MG-484-NAVY, https://www.rand.org/pubs/monographs/MG484.html

Over the past several decades, the increases in acquisition costs for U.S. Navy amphibious ships, surface combatants, attack submarines, and nuclear aircraft carriers have outpaced the rate of inflation. To understand why, the authors of this report examine two principal source categories of ship cost escalation: economy-driven factors (which are outside the control of the Navy) and customer-driven factors (features for which the Navy has the most control). The authors also interview various shipbuilders to find out their views on other issues contributing to increasing costs. Using the results from their analysis, the authors propose some ways that the Navy might reduce ship costs in the future, including limiting growth in features and requirements and reconsidering the mission orientation of ships. It is recognized, however, that such reductions come at a cost, because the United States and the Navy understandably desire technology and capability that are continuously ahead of competitors.

Price-Based Acquisition: Issues and Challenges for Defense Department Procurement of Weapon Systems

Mark A. Lorell, John C. Graser, Cynthia R. Cook

2005, MG-337-AF, https://www.rand.org/pubs/monographs/MG337.html

Price-based acquisition (PBA) is a major acquisition reform measure being used by DoD in an effort to reduce costs and enhance acquisition efficiency. The essence of PBA is the simple but radical notion that DoD should establish fair and reasonable prices for goods and services without obtaining extensive cost data from suppliers. The thinking is that PBA, with its more commercial-like market pricing strategy, is more beneficial to the government than the traditionally used, heavily regulated cost-based acquisition method, which bases prices on contractor-provided certified cost data. Supporters of PBA argue that this approach will eliminate the regulatory premium paid by DoD, motivate suppliers to cut costs, and encourage civil-commercial firms to bid on DoD contracts for military-unique systems. The end result, according to PBA advocates, is that DoD will be able to procure more-capable, cheaper systems in less time. DoD has had relatively little real-world experience with pure PBA, but it has undertaken many programs with numerous PBA-like characteristics. The most important goal of the authors of this research is to systematically review the available evidence to determine whether PBA offers the benefits that its advocates claim, to ascertain possible pitfalls inherent in PBA, and to identify the most-appropriate circumstances and strategies for implementing PBA. The findings are based on extensive structured interviews with government and private-sector individuals involved in major PBA-like programs and on a review of more than 30 case studies of programs having important PBA-like features. A systematic taxonomy of PBA-like approaches used by DoD in the past is developed for aiding the case study assessment and for integrating the interview findings. All findings and lessons learned are enumerated.

Program Schedule

Long acquisition times have been a significant concern for DoD for decades. DoD organizations have used a wide variety of approaches to reduce the time required to field capabilities or to prevent schedule delays. The reports in this section examine different strategies and lessons learned from previous programs and provide recommendations to accelerate materiel solutions.

Strategies for Acquisition Agility: Approaches for Speeding Delivery of Defense Capabilities

Philip S. Anton, Brynn Tannehill, Jake McKeon, Benjamin Goirigolzarri, Maynard A. Holliday, Mark A. Lorell, Obaid Younossi

2020, RR-4193-AF, https://www.rand.org/pubs/research_reports/RR4193.html

To reduce the time required to field operational capabilities, various Department of the Air Force and other DoD organizations have used a wide variety of approaches to acquisition that are more responsive and more agile. In this report, the research team identifies and analyzes various approaches, assesses their suitability for different conditions and types of acquisition, and identifies implementation issues. The team also develops a selection framework and tool that help program managers and leadership identify relevant approaches.

Benchmarking Schedules for Major Defense Acquisition Programs

Thomas Light, Robert S. Leonard, Meagan L. Smith, Akilah Wallace, Mark V. Arena

2018, RR-2144-AF, https://www.rand.org/pubs/research_reports/RR2144.html

With the Secretary of the Air Force outlining new scheduling initiatives in 2015, the Air Force formally recognized the importance of managing schedules and reducing schedule slip. This report provides a framework for benchmarking MDAPs' proposed or planned schedules against the actual schedules of similar historical programs. The framework is applied to five Air Force MDAPs currently undergoing development: the Global Positioning System Next Generation Operational Control System, KC-46, F-22 Increment 3.2B Modernization, B61 Mod 12 Life Extension Program Tailkit Assembly, and Combat Rescue Helicopter programs. Schedule benchmarking approaches, such as the one developed in this report, can provide program staff, acquisition analysts, and decisionmakers with additional information from which to gauge the degree by which schedule estimates may be aggressive or conservative. The approaches can also inform the formulation of schedule targets or goals for incorporation into schedule incentives.

Prolonged Cycle Times and Schedule Growth in Defense Acquisition: A Literature Review

Jessie Riposo, Megan McKernan, Chelsea Kaihoi Duran

2014, RR-455-OSD, https://www.rand.org/pubs/research_reports/RR455.html

This report summarizes a selection of the defense acquisition literature from the 1960s to 2014 on potential sources of prolonged acquisition cycle times and schedule growth, as well as potential opportunities for improvement. It presents the variety of possible causes of schedule-related problems and recommendations cited for improving schedules by various authors and organizations. This report does not provide critical analysis or an assessment of the strengths or weaknesses of the claims made in the literature. Rather, it provides a starting point for further research or consideration by government acquisition professionals, oversight organizations, and

the analytic community. The authors identify the following reasons for schedule delays in the literature: (1) the difficulty of managing technical risk (e.g., program complexity, immature technology, and unanticipated technical issues), (2) initial assumptions or expectations that were difficult to fulfill (e.g., schedule estimates, risk control, requirements, and performance assumptions), and (3) funding instability. The most commonly cited recommendations for reducing cycle time and controlling schedule growth in the literature are strategies that manage or reduce technical risk. Some of those recommendations include using incremental fielding or evolutionary acquisition strategies, developing derivative products (rather than brand-new designs), using mature or proven technology (i.e., commercial, off-the-shelf components), maintaining stable funding, and using atypical contracting vehicles.

An Analysis of Weapon System Acquisition Schedules
Jeffrey A. Drezner, Giles K. Smith
1990, R-3937-ACQ, https://www.rand.org/pubs/reports/R3937.html

The time required to divine and develop a new weapon system is an important element of the overall acquisition process. This study identifies the major factors controlling the pace of typical weapon acquisition programs and suggests reforms that may yield overall benefits through reduction of typical development time. Results of the analysis show that, although there are large variations in the duration of programs in each decade, the time to design and develop programs has apparently lengthened. There is no single, narrowly focused policy option that would reduce the length of the acquisition cycle. Rather, coordination of several different initiatives involving the cooperation of DoD agencies and Congress is necessary. The authors find no strong association among the length of the plan, the factors affecting the plan, and the actual schedule outcome, suggesting that programs with fairly short plans can, in some circumstances, have successful schedule outcomes.

Risk in Acquisition

RAND research suggests that acquisition approaches should be tailored to the circumstances of each program. Success in tailoring requires that the acquisition community assess risks of each tailorable element to cost, schedule, and performance. The following RAND reports discuss how to assess risks to the cost, schedule, and performance of defense acquisition programs.

Quantifying Cost and Schedule Uncertainty for Major Defense Acquisition Programs (MDAPs)
Thomas Light, Robert S. Leonard, Julia Pollak, Meagan L. Smith, Akilah Wallace
2017, RR-1723-AF, https://www.rand.org/pubs/research_reports/RR1723.html

To help the Air Force better anticipate cost and schedule challenges and manage programs throughout their life cycles, the authors of this study develop a methodology that can be used to

evaluate the likelihood of cost growth and schedule slip for MDAPs based on program characteristics observable at Milestone B. RAND Project AIR FORCE has developed and maintains a comprehensive database of program cost and schedule information obtained by analyzing and summarizing the contents of Selected Acquisition Reports from the inception of each program through the latest out-of-cycle and annual Selected Acquisition Report submitted as part of each year's President's Budget. From this database, the authors calculate cost and schedule factors that serve as the outcome metrics for assessing MDAP performance from Milestone B to the final or FY 2014 President's Budget Selected Acquisition Report. These ongoing Selected Acquisition Report analyses have led to the creation of models that can be used to assess at program inception the risk of future cost growth and schedule slip. This report describes the technical approach and findings of this work. It should be of interest to analysts concerned with MDAP cost and schedule growth issues.

Impossible Certainty: Cost Risk Analysis for Air Force Systems
Mark V. Arena, Obaid Younossi, Lionel A. Galway, Bernard Fox, John C. Graser, Jerry M. Sollinger, Felicia Wu, Carolyn Wong
2006, MG-415-AF, https://www.rand.org/pubs/monographs/MG415.html

Uncertainty and risk affect countless aspects of everyday life: What investments should people make? Is eating this food good for humans' health? Cost analysts too must predict—sometimes very far—into the future how much money the military will spend on weapon systems. Similar to those making decisions about everyday life uncertainties, an analyst does not have perfect knowledge about tomorrow's technology, economic conditions, or any other future event. Actual costs could be substantially higher or lower than originally anticipated. Using literature reviews, numerous interviews, and analysis of historical cost data, the authors of this report look at how estimates for future weapon systems can be more realistic than in the past and how cost uncertainty analyses can be more comprehensive and informative. To help set the Air Force's cost uncertainty analysis policy, the authors recommend that the Air Force flexibly use multiple methods for different cases; have consistent, uniform communication formats between analysts and decisionmakers; periodically track and update cost estimate records; and consider risk reserves to fund costs that arise from unforeseen circumstances.

Defense Industrial Base

Industry is a critical source of defense technology, innovation, and capabilities. RAND research on acquisition identifies two major priorities with respect to the defense industrial base: (1) expanding it to include nontraditional suppliers and (2) implementing better long-term planning to ensure that the base remains healthy. The reports in this section examine challenges and opportunities to enhance the relationship between industry and DoD.

Assessing Bid Protests of U.S. Department of Defense Procurements: Identifying Issues, Trends, and Drivers

Mark V. Arena, Brian Persons, Irv Blickstein, Mary E. Chenoweth, Gordon T. Lee, David Luckey, Abby Schendt

2018, RR-2356-OSD, https://www.rand.org/pubs/research_reports/RR2356.html

Bid protests have been a feature of the U.S. defense acquisition environment for decades. If an interested party believes that DoD has made an error in issuing a solicitation for a bid, canceling a contract, or choosing a winning bid, it has the right to file a protest questioning the outcome. A company may file a protest with the contracting DoD agency, the U.S. Government Accountability Office, or the U.S. Court of Federal Claims. In recent years, the process has come under increased scrutiny. For example, it is unclear what level of resources DoD must dedicate to bid protests or to what extent they lead to higher costs or scheduling delays. There has also been concern that the current process may encourage frivolous protests. In response, the National Defense Authorization Act for FY 2017 called for a "comprehensive study on the prevalence and impact of bid protests on DoD acquisitions," including the systematic collection and analysis of information on the characteristics of bid protests and their associated contracting outcomes. The authors of the resulting study find tension between DoD's need to move forward with procurements and companies' need for information about how a contract award decision was made. However, the overall share of contracts protested was very small, and the outcome of protests depended greatly on the characteristics of the contracts.

Application of Logic Models to Facilitate DoD Laboratory Technology Transfer

Eric Landree, Richard Silberglitt

2018, RR-2122-OSD, https://www.rand.org/pubs/research_reports/RR2122.html

DoD laboratories are sources of new ideas and technologies that can provide military and capability advantages to the warfighter. However, for that advantage to be realized, these new ideas and technologies almost always must be transferred from the laboratory to industry or other organizations capable of developing products or services. Federal organizations have made efforts to accelerate the transfer of research findings and outputs to companies or other organizations. Still, there is not a universally accepted definition of successful technology transfer or guidance for monitoring transfer that can be applied across multiple laboratories or research organizations. This report describes a method to help DoD monitor and track technology transfer from laboratories to customers and assess the success of efforts that may lead to capability improvements. The researchers' method maps efforts associated with technology transfer into a logic model framework that describes the laboratory operations and can be used to create a definition of *successful technology transfer* that may be applied across the defense laboratory enterprise. The authors' method also provides guidance for developing measures for monitoring successful technology transfer.

Improving the Air Force Small-Business Performance Expectations Methodology
Nancy Young Moore, Amy G. Cox, Clifford A. Grammich, Judith D. Mele
2017, RR-1545-AF, https://www.rand.org/pubs/research_reports/RR1545.html

The Air Force is trying to increase small-business use and identify industries that have the most potential for increasing small-business utilization. This report examines the Air Force Small-Business Performance Expectations Methodology with the goal of improving it to identify small-business opportunities. The authors recommend that efforts to increase small-business spending should take into account differences between the Air Force's and other services' buying requirements, as well as the importance of budget categories, using industry, product or service code, and budget-category combinations to identify small businesses. Changing certain market definitions to identify areas with more or less small-business saturation would improve the methodology. Additionally, industry small-business size standards should be considered. A larger amount of data, including the last two to three years of data, would help monitor and refine accuracy.

Identifying and Eliminating Barriers Faced by Nontraditional Department of Defense Suppliers
Amy G. Cox, Nancy Y. Moore, Clifford A. Grammich
2014, RR-267-OSD, https://www.rand.org/pubs/research_reports/RR267.html

DoD purchases an enormous amount of goods and services from tens of thousands of contractors. In FY 2011, DoD awarded $375.4 billion in prime contracts for weapons, other goods, and services. Most of these purchases are from a relatively small number of suppliers; just ten suppliers accounted for more than one-third of DoD purchases in FY 2011. The possible challenges that suppliers that have not traditionally done business with DoD may have in contracting with DoD led Congress to request, in the National Defense Authorization Act for FY 2011, that the Secretary of Defense "review barriers to firms that are not traditional suppliers to the Department of Defense wishing to contract with the Department of Defense and its defense supply centers and develop a set of recommendations on the elimination of such barriers." DoD in turn asked the RAND Corporation to examine this issue. The authors consider a firm to be a *nontraditional supplier* of DoD "if it does not currently have contracts and subcontracts to perform work for the Department of Defense with a total combined value in excess of $500,000," as specified in the National Defense Authorization Act.

Implications of an Air Force Budget Downturn on the Aircraft Industrial Base: An Exploratory Analysis

Mark V. Arena, John C. Graser, Paul DeLuca

2013, RR-248-AF, https://www.rand.org/pubs/research_reports/RR248.html

The U.S. Air Force is facing several challenges as a result of the defense budget downturn, along with the uncertainty of its timing and magnitude. RAND researchers examine the challenge of modernizing the Air Force's aircraft fleet while trying to sustain the industrial base with limited funding. Complicating this challenge is that the pattern of Air Force spending has shifted dramatically away from new aircraft procurement, and a competitor with significant technical and economic capability has emerged. There is a need for careful strategic management of investment choices—and this goes beyond just aircraft. The Air Force will first need to define its capability priorities that fit within budget constraints, then use those priorities to shape a budget strategy. In this report, RAND researchers consider six budget strategies for aircraft procurement, including a new high-tech fleet and sustaining and modifying the existing one. Each strategy under a constrained spending future results in challenges and issues for the industrial base. The Air Force will need to help mitigate industrial base problems that result from its chosen budget strategy—but some issues may be beyond the Air Force's control. There are lessons from foreign acquisitions that the Air Force can leverage to avoid pitfalls. Most importantly, shortfalls in both industry and government skill bases can cause significant problems later during execution. Finding ways to sustain key skills during a spending downturn will be important for the future and potentially produce longer-term savings.

Keeping a Competitive U.S. Military Aircraft Industry Aloft: Findings from an Analysis of the Industrial Base

John Birkler, Paul Bracken, Gordon T. Lee, Mark A. Lorell, Soumen Saha, Shane Tierney

2011, MG-1133-OSD, https://www.rand.org/pubs/monographs/MG1133.html

For at least two decades, policymakers have expressed concerns that further consolidation could erode the competitive environment for military aircraft and degrade the industry's abilities to develop, manufacture, and support innovative designs. This monograph responds to a request by Congress to evaluate programs to ensure that more than one aerospace company could support design, development, and production of fixed-wing military aircraft in the future. The authors review a 2003 RAND evaluation of the risks and costs of the United States having little or no competition among fixed-wing military aircraft companies; examine changes in industrial-base structure and capabilities that have taken hold since that analysis was performed; and assess how these and future changes will affect the industrial base. The authors find that only by involving two prime contractors equally in performing RDT&E on a new large program, such as a bomber, could DoD sustain two firms through 2020 with RDT&E funding and through 2025 with procurement funding.

Evaluation and Recommendations for Improvement of the Department of Defense Small Business Innovation Research (SBIR) Program

Bruce Held, Thomas Edison, Shari Lawrence Pfleeger, Philip S. Antón, John Clancy

2006, DB-490-OSD, https://www.rand.org/pubs/documented_briefings/DB490.html

The broad goal of DoD's SBIR program is "to harness the innovative talents of [the United States'] small technology companies for U.S. military and economic strength." In this documented briefing, RAND researchers examine the DoD SBIR program to assess to what extent DoD is funding small businesses and to determine whether the program is indeed stimulating innovation both in the military and commercially. Overall, the researchers find that SBIR research topics align well with DoD's priorities while remaining flexible enough to focus in areas that are more appropriate for small businesses. But the researchers outline other trends that might be cause for concern for the future of the program. For example, the DoD SBIR program is managed in a manner that may be too lean. This finding reinforces the idea that the DoD SBIR program might be perceived more as a tax and burden to be borne by DoD than as an R&D resource to be leveraged. In light of their findings, the researchers recommend policy options for making the DoD SBIR program more responsive to the needs of DoD and to the broader defense mission.

Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry

John Birkler, Anthony G. Bower, Jeffrey A. Drezner, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, Fred Timson, William P. G. Trimble, Obaid Younossi

2003, MR-1656-OSD, https://www.rand.org/pubs/monograph_reports/MR1656.html

Defense policymakers have expressed concern that further consolidation in the industry that designs and manufactures U.S. military aircraft, which (in 2003) has three prime contractors (in contrast to 11 in 1960), will cause DoD to acquire aircraft that are designed and produced in a far less competitive and innovative environment than they were in the past. This report responds to the Senate's request that DoD prepare a comprehensive analysis of and report on the risks to innovation and cost of limited or no competition in contracting for military aircraft and related weapon systems by examining the future of the U.S. military-aircraft industrial base in relation to specific questions that Congress posed. The RAND research team translates the questions into four tasks:

1. Describe the military combat-aircraft industry.
2. Evaluate what is required to maintain a high level of innovation in the military combat-aircraft industry.
3. Assess prospects for innovation and competition in the military combat-aircraft industry.
4. Identify policy options open to DoD.

The researchers' findings indicate that procurement funding will likely be adequate to sustain the basic institutional structure of the current prime military-aircraft contractors through at least the

end of 2010. However, a DoD decision to begin a new major combat-aircraft program before 2010 would provide a stronger basis for sustaining current structure and capability. If the number and frequency of major aircraft programs continue to diminish, it will be increasingly difficult to sustain an industry of the present size and posture. Policy needs to address what role the government can play and what role it should play in the evolution of industry structure and capabilities that is under way. This research should be of interest to members of Congress, congressional staff members, industry executives, and others in the civilian and uniformed defense policy community interested in the future viability of the U.S. military-aircraft industrial base.

The U.S. Combat Aircraft Industry, 1909–2000: Structure, Competition, Innovation
Mark A. Lorell
2003, MR-1696-OSD, https://www.rand.org/pubs/monograph_reports/MR1696.html

In its FY 2002 Defense Appropriations Conference Report, Congress expressed concerns about reduced competition resulting in a decline in innovation in the U.S. fixed-wing military aircraft industry. Drawing on primary and secondary sources on the aircraft industry, this report provides a brief survey of industry structure, innovation, and competition in the U.S. fixed-wing combat aircraft industry from its earliest days to 2003. The report supports a much larger research effort that examines the future of the U.S. military aircraft industrial base in response to these congressional concerns. The study suggests that it is possible to identify at least five distinct technology eras over the history of fixed-wing, heavier-than-air combat aircraft, each of which began with a period of revolutionary innovation, high rates of technology advancement, and significant improvement in performance. The historical evidence suggests, but does not prove, that an industrial structure that includes numerous prime contractors is conducive to encouraging the onset of periods of higher innovation when demand changes and market conditions are right. Without such an industry structure, new DoD initiatives may be necessary to promote high levels of innovation. This is a companion volume to a report on the future viability of the combat aircraft industry: *Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry* (see previous entry). It should be of interest to members of Congress, congressional staff members, industry executives, and others in the civilian and uniformed defense policy community interested in the future viability of the U.S. military aircraft industrial base.

Going Global? U.S. Government Policy and the Defense Aerospace Industry
Mark A. Lorell, Julia Lowell, Richard M. Moore, Victoria Greenfield, Katia Vlachos
2002, MR-1537-AF, https://www.rand.org/pubs/monograph_reports/MR1537.html

Since the end of the Cold War, a dramatic decline in overall defense authorizations has led both the U.S. aerospace industry and that of Europe to undergo extensive consolidation—a trend that has led in turn to a significant growth in cross-border business relationships. Yet while

globalization has the potential to increase competition, foster innovation, encourage fair pricing, and promote interoperability among North Atlantic Treaty Organization allies, it also poses potential challenges, particularly with regard to the proliferation of advanced U.S.-developed military technologies. Accordingly, this report examines aerospace industry globalization trends with a view toward determining how and to what extent globalization can best be managed to further the U.S. Air Force's economic and political-military objectives while minimizing possible risks. The report confirms that the recent proliferation of cross-border business relationships has significant potential to promote allied standardization while simultaneously reducing costs. At the same time, however, enduring concerns over technology transfer issues, together with the increasing competitiveness of European and other multinational firms, may well undermine standardization efforts by encouraging the formulation of indigenous solutions. The authors conclude that further research is needed to fully clarify the manner in which the Air Force should respond to the continued consolidation and globalization of the aerospace industry.

Performing Collaborative Research with Nontraditional Military Suppliers
Kenneth P. Horn, Elliott I. Axelband, Ike Yi Chang, Paul S. Steinberg, Carolyn Wong, Howell Yee
1997, MR-830-A, https://www.rand.org/pubs/monograph_reports/MR830.html

This report discusses what the Army needs to do to attract more nontraditional military suppliers and what specific Army organizations and associated technologies are best suited for a pilot program designed to attract such suppliers. The authors find that there are significant opportunities for Army collaborations with nontraditional military suppliers, but the Army has had limited success attracting them using such traditional options as contracts, cooperative research and development agreements, and patent licensing agreements. To attract these suppliers, the Army must eliminate many cumbersome regulations—something that can be accomplished using cooperative agreements and OTs—but must also understand and identify the relevance of the Army's research in terms of the commercial markets. The Army can do three things to significantly improve its chances of successful collaborations with nontraditional military suppliers: Align technology objectives, produce business plans, and plan for success. Finally, an assessment shows five promising areas for a pilot to attract nontraditional military suppliers: Natick Research, Development, and Engineering Center (food, clothing, or biotechnology); Simulation, Training, and Instrumentation Command (advanced simulators); Director of Information Systems for Command, Control, Communications, and Computers (expert systems); National Automotive Center (vehicle technologies); and Army Research Laboratory (information warfare).

Defense Innovation

The defense acquisition community has developed innovative strategies to deliver technology to the warfighter in a cost-effective and timely manner, based on authorities granted outside of standard Federal Acquisition Regulations. RAND research on improving military acquisition suggests that tailored approaches and engagement with a broader industrial base lead to better outcomes. The reports in this section analyze unique approaches that the acquisition community has taken in order to acquire new capabilities for DoD.

Prototyping Using Other Transactions: Case Studies for the Acquisition Community
Lauren A. Mayer, Mark V. Arena, Frank Camm, Jonathan P. Wong, Gabriel Lesnick, Sarah Soliman, Edward Fernandez, Phillip Carter, Gordon T. Lee
2020, RR-4417-AF, https://www.rand.org/pubs/research_reports/RR4417.html

Researchers reviewed the U.S. Air Force's recent experience with using the authority for OTs for prototype projects. This authority allows DoD to develop prototypes outside of most federal laws and regulations governing contracts, grants, or cooperative agreements. Through literature reviews, interviews, and case studies, researchers reviewed recent U.S. Air Force experience in using this authority, identifying lessons for acquisition professionals and improvements for use. Participants from the cases stated that OTs provide flexibilities not inherent in Federal Acquisition Regulation procurements, such as allowing for more freedom to communicate with industry, tailoring solicitations and agreements, and working under conditions acceptable to nontraditional firms. Effective OT teams respond to this flexibility by engaging in a more commercial-like manner with industry while still applying an appropriate level of discipline. However, challenges with the effective use of OTs remain. Compliance-based training methods are insufficient, and establishing institutional knowledge is difficult. Furthermore, a compliance-based contracting culture results in personnel's discomfort with necessary risk-taking. The Air Force might be able to mitigate such challenges by developing case-based training that focuses on problem-solving, facilitating OT information-sharing, and strategically managing the OT workforce to include mentoring programs and provide for broader experience. To fully leverage such changes, the Air Force should continue to work toward shifting its culture to ensure that personnel using OTs are rewarded for their willingness to take risks to accomplish the mission using sound judgment.

Venture Capital and Strategic Investment for Developing Government Mission Capabilities
Timothy Webb, Christopher Guo, Jennifer Lamping Lewis, Daniel Egel
2014, RR-176-OSD, https://www.rand.org/pubs/research_reports/RR176.html

A wide variety of military capability improvement efforts have benefited from development and procurement methods that accommodate urgent operational needs. Changes in the threat

environment suggest a need for a fresh examination of the adequacy and suitability of acquisition methods for the coming decade. This report examines one class of acquisition method, known as government venture capital or government strategic investment. The research extracts general observations from previous cases and from a partial economic model of the government strategic investment type of initiative. Taken together, these analyses will help government acquisition managers judge more thoroughly the suitability of strategic investment methods for motivating future government mission–oriented innovation by private firms. The report does not explicitly compare government strategic investments and alternatives for their efficacy in advancing government mission objectives. If it had, it is likely that the main advantage of such investment would be improved access to information about alternative approaches available in the commercial market, resulting from the close relationships that the government strategic investment structure engenders between government and business.

Assessing the Use of "Other Transactions" Authority for Prototype Projects
Giles K. Smith, Jeffrey A. Drezner, Irving Lachow
2002, DB-375-OSD, https://www.rand.org/pubs/documented_briefings/DB375.html

An extensive set of laws, regulations, and mandated procedures govern the procurement of new weapon systems and ensure that DoD receives good value for the money spent and that government interests are protected. Some firms, especially those developing innovative technologies for the commercial market, find those rules burdensome and often refuse to work for the government. This prevents government access to the latest advances in key technologies. Congress authorized use OT in 1994 for the development of prototypes directly relevant to weapons or weapon systems so that contractors are not required to comply with procurement-specific laws and regulations. DoD asked RAND to assess the experience of such OT projects (started between 1994 and 1998), which yielded three conclusions: New industrial resources are now participating in DoD prototype projects, benefits of OT are broad, and some risks to the government are incurred. RAND researchers believe that the immediate rewards substantially outweigh the risks, and if the OT authority flexibility is removed, most or all of the benefits observed would again become unavailable to DoD.

Using Venture Capital to Improve Army Research and Development
Bruce Held, Ike Chang
2001, IP-199, https://www.rand.org/pubs/issue_papers/IP199.html

The U.S. Army is having difficulty balancing its need for new technologies with the resources available to develop them. Because it is unlikely that the Army will devote substantially greater resources to its R&D, the Army must find better methods for developing the technologies needed to stage its revolution in military affairs while keeping current equipment relevant and affordable. This issue paper introduces the idea that the Army should fund some of its technology development through a private venture capital organization. The concept exploits

venture capital's efficiency in developing technology, its access to the growing commercial technology sector, its capacity to respond with agility to changing technology, and its ability to leverage additional resources throughout the development cycle. The authors propose that the Army set up a venture capital fund as a not-for-profit corporation that makes equity investments in early-stage companies developing technologies that are important to the Army but that also have potential to find commercial markets in the longer term. The use of a venture capital model for development of relevant advanced technologies could significantly help the Army achieve the acquisition reform goal of affordably acquiring the leading-edge technologies that it needs.

The Global Hawk Unmanned Aerial Vehicle Acquisition Process: A Summary of Phase I Experience

Geoffrey Sommer, Giles K. Smith, John Birkler, James Chiesa

1997, MR-809-DARPA, https://www.rand.org/pubs/monograph_reports/MR809.html

There is a long history of efforts to improve the efficiency and effectiveness of the weapon acquisition process. The purpose of this case study is to understand how one such program, the High Altitude Endurance Unmanned Aerial Vehicle (HAE UAV), has benefited from certain changes from established acquisition procedures. The Defense Advanced Research Projects Agency, in conjunction with the Defense Airborne Reconnaissance Office, is embarking on development of two unmanned aerial vehicles: Tier II+ and Tier III−. The development programs incorporate many novel acquisition practices, including a rigid price cap for future production items, together with waivers of most acquisition-specific laws and policies. The authors of this study examine how the various innovations in acquisition management methods affect the program outcomes and how the lessons of these projects might be applied to a wider variety of projects to improve DoD acquisition strategies. The study was initiated in FY 1994 and continued through the first three phases of the program. A final report was issued at the end. This interim report covers Phase 1 of the Tier II+ segment of HAE UAV.

Acquisition Workforce

The acquisition workforce includes more than 169,000 personnel who are responsible for identifying, developing, buying, and managing goods and services to support the military.[164] RAND research suggests that the acquisition workforce must be properly sized, trained, and incentivized to make the smart decisions that flexible acquisition approaches and partnering

[164] Laura Werber, John A. Ausink, Lindsay Daugherty, Brian Phillips, Felix Knutson, and Ryan Haberman, *An Assessment of Gaps in Business Acumen and Knowledge of Industry Within the Defense Acquisition Workforce: A Report Prepared for the U.S. Department of Defense in Compliance with Section 843(c) of the Fiscal Year 2018 National Defense Authorization Act*, Santa Monica, Calif.: RAND Corporation, RR-2825-OSD, 2019.

productively with industry entail. The following reports discuss challenges and recommendations to enhance the development and retention of the acquisition workforce.

An Assessment of Gaps in Business Acumen and Knowledge of Industry Within the Defense Acquisition Workforce: A Report Prepared for the U.S. Department of Defense in Compliance with Section 843(c) of the Fiscal Year 2018 National Defense Authorization Act
Laura Werber, John A. Ausink, Lindsay Daugherty, Brian Phillips, Felix Knutson, Ryan Haberman
2019, RR-2825-OSD, https://www.rand.org/pubs/research_reports/RR2825.html

In 2018, Congress directed the Under Secretary of Defense for Acquisition and Sustainment to conduct an assessment of gaps in business acumen, knowledge of industry operations, and knowledge of industry motivation present within the acquisition workforce and to determine the effectiveness of training and development resources offered by providers outside DoD that were available to acquisition workforce personnel. In this report, RAND researchers use a mixed-methods approach, including interviews with DoD and industry professionals and reviews of acquisition workforce competency models, Defense Acquisition University course offerings, DoD policy, and academic and business literature. The authors find that the lack of standardized definitions obscures the need for knowledge related to business acumen, industry operations, and industry motivation, and, although knowledge gaps appear to exist in these areas, the lack of requirements and desired proficiencies further hinders an estimation of the gaps' extent. DoD uses a wide array of internal and external training and development assets to develop the acquisition workforce, but training gaps related to these types of knowledge were difficult to determine, partly because evidence about the effectiveness of different types of training and development is limited. The authors provide recommendations to DoD to improve how these types of knowledge are assessed and conferred, as well as recommendations to Congress for incentivizing DoD's use of external training and development providers.

Analyses of the Department of Defense Acquisition Workforce: Update to Methods and Results Through FY 2017
Susan M. Gates, Brian Phillips, Michael H. Powell, Elizabeth Roth, Joyce S. Marks
2018, RR-2492-OSD, https://www.rand.org/pubs/research_reports/RR2492.html

The defense acquisition workforce is charged with providing DoD with the management, technical, and business capabilities needed to execute defense acquisition programs from start to finish. This workforce must itself be managed so that the right numbers of the right personnel are in the right positions at the right time. Since 2006, RAND has been helping develop data-based tools to support analysis of this workforce. This report updates RAND's 2008 and 2013 reports (see Gates et al., 2013, and Gates et al., 2008, later in this section) by documenting revisions to methods, providing descriptive information on the workforce through FY 2017, analyzing

characteristics of recent cohorts entering DoD's civilian acquisition workforce, and describing the evolving policy environment.

Air Force Management of the Defense Acquisition Workforce Development Fund: Opportunities for Improvement

John A. Ausink, Lisa M. Harrington, Laura Werber, William A. Williams, John E. Boon, Jr., Michael H. Powell

2016, RR-1486-AF, https://www.rand.org/pubs/research_reports/RR1486.html

The Defense Acquisition Workforce Development Fund was established in 2008 to provide funds for the recruitment, training, and retention of acquisition personnel. Financed by a combination of direct appropriations and funds provided by military departments and defense agencies, the fund is meant to pay for initiatives in three major categories: recruit and hire new acquisition personnel, train and develop members of the existing workforce, and retain and recognize highly skilled personnel. Since the fund's establishment, the U.S. Air Force has contributed more than $600 million and received more than $451 million for various initiatives. The Air Force's director of acquisition career management is responsible for managing the Air Force's share of the money. In recent years, resources available to the Air Force through the fund have been sufficient to pay for all proposals received by the director. Recognizing that this will not always be the case, the Air Force asked the RAND Corporation to explore ways to ensure that the funds are used effectively. In this report, RAND researchers examine legislation, regulations, and other documents related to the fund; interview acquisition workforce subject-matter experts and users of fund money in headquarters organizations, major commands, and centers; analyze acquisition workforce databases; and interview managers in 21 companies that have been recognized by *Fortune* magazine as being among the 100 Best Companies to Work For. In this report, the authors suggests improvements in management processes, describe an evidence-based approach to justify and monitor initiatives of the Defense Acquisition Workforce Development Fund, and develop an evaluation framework to prioritize the fund's requests.

2016 Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project

Jennifer Lamping Lewis, Laura Werber, Cameron Wright, Irina Danescu, Jessica Hwang, Lindsay Daugherty

2016, RR-1783-OSD, https://www.rand.org/pubs/research_reports/RR1783.html

In August 2015, René Thomas-Rizzo, director of Human Capital Initiatives, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, asked the RAND Corporation to undertake a study to accomplish the FY 2016 assessment of AcqDemo mandated in the National Defense Authorization Act of FY 2011. AcqDemo aims to provide a system that retains, recognizes, and rewards employees for their contributions and supports their personal and professional development. The authors use multiple data sources to evaluate how well AcqDemo has performed with respect to these goals. The assessment directly addresses the

original 12 criteria enumerated in the National Defense Authorization Act, as well as five new criteria specified by the AcqDemo Program Office. These criteria call for a look at the following: AcqDemo's key features pertaining to hiring, appointments, and performance appraisal; the adequacy of its guidance, protections for diversity, efforts to ensure fairness and transparency, and means used to involve employees in improving AcqDemo; AcqDemo's impact on career outcomes, such as compensation, promotion, and retention, particularly with respect to similar outcomes for the General Schedule workforce; and AcqDemo's ability to support the acquisition mission. The RAND team finds that some aspects of AcqDemo are performing well, while others leave room for improvement.

Retention and Promotion of High-Quality Civil Service Workers in the Department of Defense Acquisition Workforce

Christopher Guo, Philip Hall-Partyka, Susan M. Gates

2014, RR-748-OSD, https://www.rand.org/pubs/research_reports/RR748.html

The defense acquisition workforce includes more than 151,000 military and civilian personnel who provide a variety of acquisition, technology, and logistics support (products and services) to U.S. warfighters. This report examines data from Defense Manpower Data Center files and draws from previous related RAND analyses to address questions about factors that affect personnel retention and career advancement in the acquisition workforce. First, the authors examine available measures of personnel quality and explore whether personnel retention and career advancement vary by quality. A higher average performance rating is generally associated with an increased hazard of separation (decreased retention). On the other hand, individuals with advanced education degrees (bachelor's, master's, or Ph.D.) are more likely to be retained than are those with less than a bachelor's degree. Second, the authors describe the characteristics of workers who rise to the senior executive service within the acquisition workforce. Third, they explore how being in the Acquisition Demonstration pay plan or another demonstration pay plan affects retention, after controlling for workforce quality metrics. The authors find that people who were in the Acquisition Demonstration pay plan and, in fact, any demonstration pay plan were retained longer than those in the General Schedule.

Analyses of the Department of Defense Acquisition Workforce: Update to Methods and Results Through FY 2011

Susan M. Gates, Elizabeth A. Roth, Sinduja Srinivasan, Lindsay Daugherty

2013, RR-110-OSD, https://www.rand.org/pubs/research_reports/RR110.html

The organic defense acquisition workforce consists of military personnel and DoD civilian personnel who provide the management, technical, and business capabilities needed to oversee defense acquisition programs from start to finish. This workforce must itself be managed so that the right numbers of the right personnel are in the right positions at the right time. Since 2006, RAND has been helping develop data-based tools to support analysis of this workforce. This

report updates a 2008 report by documenting revisions to methods, providing descriptive information on the workforce through FY 2011, and providing a user's manual for a model that can help managers project workforce needs through 2021 under different assumptions about the future. The report illustrates the use of the model.

An Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project
Laura Werber, Lindsay Daugherty, Edward G. Keating, Matthew Hoover
2012, TR-1286-OSD, https://www.rand.org/pubs/technical_reports/TR1286.html

The vast majority of DoD and federal civilian employees work on the General Schedule personnel system. However, some concerns have been raised about the system, including perceptions that poorly performing employees are tolerated for extended periods and that monetary rewards are not directly linked to performance. In response to concerns of this nature, Congress has authorized some demonstration projects, in which additional flexibilities are provided, intending to produce better outcomes than if the employees were in the General Schedule system. One such demonstration project, AcqDemo, is the subject of this report. Implemented on February 7, 1999, AcqDemo is an effort to reengineer the civilian personnel system to meet the needs of the acquisition workforce and to facilitate the fulfillment of the DoD acquisition mission. Congress required independent assessment of the program against 12 criteria by September 30, 2012. This report is that legislatively mandated assessment.

Shining a Spotlight on the Defense Acquisition Workforce—Again
Susan M. Gates
2009, OP-266-OSD, https://www.rand.org/pubs/occasional_papers/OP266.html

There is a dearth of evidence regarding whether and to what extent specific workforce issues contribute to poor outcomes. This paper contains a description of some of the key concerns related to the defense acquisition workforce, as well as an overview of the defense acquisition workforce and the policy environment influencing its management. The author also highlights areas where better evidence is needed to understand the linkage between workforce attributes and acquisition outcomes and recommends steps for assembling the information needed to make, refine, or dismiss the case for major new hiring or training initiatives.

The Defense Acquisition Workforce: An Analysis of Personnel Trends Relevant to Policy, 1993–2006
Susan M. Gates, Edward Keating, Adria Jewell, Lindsay Daugherty, Bryan Tysinger, Albert A. Robbert, Ralph Masi
2008, TR-572-OSD, https://www.rand.org/pubs/technical_reports/TR572.html

The defense acquisition workforce includes more than 126,000 military and civilian personnel responsible for providing a wide variety of acquisition, technology, and logistics support to U.S. warfighters. This report summarizes workforce analyses that RAND has

undertaken in support of the Defense Acquisition University, which is responsible for strategic human capital management of that workforce. The report covers the civilian acquisition workforce, the careers of acquisition workforce senior executive service members, and the relationship between the military and civilian acquisition workforce. It also describes a workforce inventory projection model that uses data on the civilian acquisition workforce as a key input. The authors conclude that better definition and tracking of the acquisition workforce would improve workforce planning and that workforce analysis is only one step in an overall strategic human capital planning effort.

Air Force Procurement Workforce Transformation: Lessons from the Commercial Sector
John A. Ausink, Laura H. Baldwin, Christopher Paul
2004, MG-214-AF, https://www.rand.org/pubs/monographs/MG214.html

At the time of this report, the Air Force was in the process of significantly changing the way it purchases goods and services, with the goals of reducing costs and increasing performance to better support its missions. A procurement transformation division was created to lead these implementation efforts, and the new division highlighted two related areas for particular emphasis: (1) implementation of cross-functional teams (commodity councils) to develop strategies for individual commodity groups and (2) procurement workforce development to support implementation. This monograph reviews commercial-sector commodity council activities and skills. A preliminary review of the Defense Acquisition University's and Air Force Institute of Technology's curricula indicates that they were covering many of the needed skills; however, there were fewer, if any, opportunities to learn some of the more-sophisticated skills associated with the new purchasing and supply management practices that the Air Force was implementing. The monograph's literature review and commercial sector interviews suggest that training programs tended to be multifunctional, involving personnel with diverse backgrounds that were relevant to new practices. Training programs were matched to learning goals; structured classroom or web-based learning was used to develop foundational skills, whereas more-applied forms of learning, such as formal on-the-job training and mentoring programs, were used to develop higher levels of expertise. Finally, the monograph includes a framework of metrics to track progress and refine efforts to develop the procurement workforce over time.

Development and Design of Weapon Systems

There are various acquisition approaches to designing and developing military systems. The following RAND reports analyze different strategies to effectively design and develop acquisition systems through the engineering, manufacturing, and development phase of acquisition.

Exploring Parallel Development in the Context of Agile Acquisition: Analytical Support to the Air Superiority 2030 Enterprise Capability Collaboration Team

Jeffrey A. Drezner, Michael Simpson

2017, RR-1808-AF, https://www.rand.org/pubs/research_reports/RR1808.html

In providing analytical support to the U.S. Air Force's Air Superiority 2030 Enterprise Capability Collaboration Team, RAND researchers explore how a parallel development approach in an agile acquisition environment can help more rapidly transition new technologies and concepts to the fleet. Parallel development is an approach that intentionally decouples the technological development and management of core elements of a weapon system—for example, decoupling the development of software architecture from applications that will run in that software environment. In this report, researchers identify five enablers of parallel development, as well as each enabler's underlying management actions, and draw lessons from ten historical development programs. The program review suggests that all five of the identified enablers must work together to successfully apply parallel development in an agile acquisition context. The framework presented is intended to be a first step in defining and understanding parallel development, and the authors offer next steps for further research.

Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs

John F. Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee, Jerry M. Sollinger

2016, RR-696-NAVY, https://www.rand.org/pubs/research_reports/RR696.html

In the face of challenges to acquire and support the numbers and types of ships needed to meet national security requirements in an environment of rapid change and shrinking defense budgets, this report explores the U.S. Navy's options for extending the service lives of operational ships by adopting the concepts of modularity and flexibility in ship design. These concepts can help mitigate the risks of uncertain future missions and technologies to which ships will need to adapt, as well as potentially reduce modernization costs and initial cost. The report examines the concepts of modularity and flexibility, technological trends, the current geopolitical context, and lessons from past incorporation of new missions and technologies into naval ships. It also provides a roadmap for future U.S. Navy modularity and flexibility efforts.

Finding Services for an Open Architecture: A Review of Existing Applications and Programs in PEO C4I

Isaac R. Porche III, James Dryden, Kathryn Connor, Bradley Wilson, Shawn McKay, Kate Giglio, Juan Montelibano

2011, MG-1071-NAVY, https://www.rand.org/pubs/monographs/MG1071.html

The U.S. Navy is moving toward an open architecture concept for its IT systems. The Program Executive Office for Command, Control, Communications, Computers, and Intelligence is spearheading this effort. In this report, the authors review Navy documentation on

costs and requirements and describe a series of interviews with subject-matter experts from various Navy program offices with the goal of proposing a set of ideal system characteristics and evaluating the utility and development and support costs of the available options. The authors also examine challenges associated with uptake and use of service-oriented architecture, as well as the implications for enterprises endeavoring to pursue such systems. A desirable long-term goal would be for the Navy to support a collection of services or an overall shared architecture that can span a ship, the entire Navy, or joint forces.

Innovative Development: Global Hawk and DarkStar—HAE UAV ACTD Program Description and Comparative Analysis

Robert S. Leonard, Jeffrey A. Drezner

2002, MR-1474-AF, https://www.rand.org/pubs/monograph_reports/MR1474.html

In 1994, the Defense Advanced Research Projects Agency, in conjunction with the Defense Airborne Reconnaissance Office, initiated an effort—designated the HAE UAV ACTD—whose goal was to facilitate the development of unmanned aerial systems through the use of a new and innovative acquisition strategy. This report addresses the effect of that acquisition strategy on the flight test program of the two air vehicles: the conventional Global Hawk and the low-observable DarkStar. The authors find that, because DarkStar was canceled after having logged only 6.5 flight hours, not enough flight experience was accumulated to allow for an understanding of the vehicle's flight characteristics or military utility. By contrast, Global Hawk accumulated ample experience to permit a demonstration of its military utility, achieving a level of performance that was close to predicted goals. The precise effect of the HAE UAV acquisition strategy remains the subject of debate. The strategy did, however, influence some key aspects of the flight test program, most notably its increased contractor involvement and its early operational testing in the form of user demonstrations. The flight test program also served to illustrate the vital need for early involvement of operational users to bolster the capabilities and perspective of the contractor.

Innovative Development: Global Hawk and DarkStar—Flight Test in the HAE UAV ACTD Program

Robert S. Leonard, Jeffrey A. Drezner

2002, MR-1475-AF, https://www.rand.org/pubs/monograph_reports/MR1475.html

This is a companion report to the previous entry in this annotated bibliography. This report addresses flight test and user demonstration outcomes and issues relevant to the HAE UAV ACTD program. In it, the authors assess the extent to which the innovative acquisition strategy used in this effort affected the conduct of the flight test program.

Lessons Learned from Acquisition Programs

The reports in this section holistically examine acquisition efforts from the perspectives of programs. RAND research suggests that acquisition approaches should be tailored to program circumstances. Understanding the interplay among policies, program characteristics, and other contextual factors is important to understanding how to tailor. These reports are based on acquisition literature, research, and case studies and identify common themes, analyze challenges, and provide recommendations to successfully acquire materiel and technology.

Development of Standardized and Best Practices for the USCG Boats Acquisition Program
Brendan Toland, Michael Vasseur, Aaron C. Davenport, Scott Savitz, Kathryn Giglio
2019, RR-2918-DHS, https://www.rand.org/pubs/research_reports/RR2918.html

The U.S. Coast Guard depends on its fleet of more than 1,600 boats to conduct its most-critical operations, which span all 11 of the Coast Guard's statutory missions. These boats must be replaced frequently, given the harsh environments and challenging operations in which they are used. To keep up with this demand in a cost-effective way, the Coast Guard has determined that it needs an enduring program management office to manage boat acquisition efforts. The RAND Corporation's Homeland Security Operational Analysis Center was asked to conduct a 90-day study to identify best practices and lessons learned for improving boat acquisition by reviewing the current acquisition program and similar programs inside and outside the Coast Guard and make recommendations for the structure, funding strategy, and processes of a future enduring boat acquisition program. RAND researchers review the current Coast Guard and similar programs, assess possible funding and structural strategies, and make recommendations on these topics for Coast Guard leadership.

Tailoring the Acquisition Process in the U.S. Department of Defense
Megan McKernan, Jeffrey A. Drezner, Jerry M. Sollinger
2015, RR-966-OSD, https://www.rand.org/pubs/research_reports/RR966.html

Regulations and guidance have permitted tailoring of the acquisition process as one of many ways in which the acquisition workforce can more efficiently achieve program objectives. Tailoring is frequently mentioned in regulations and guidance. Policy allows, and even encourages, program managers to customize regulation-based reviews, processes, and information requirements to accommodate the unique characteristics of a program while still meeting the regulations' intent for appropriate decision criteria and oversight processes. The extent to which programs take advantage of opportunities to tailor processes and documentation is not clear, but anecdotal evidence suggests that tailoring is more difficult in practice than guidance suggests. Widespread use of tailoring appears to be constrained by a variety of factors inherent in defense acquisition. In the exploratory research reported here, the authors review the literature and conduct interviews in the Office of the Secretary of Defense and the RAND

Corporation to determine whether this policy area would benefit from additional in-depth research.

Lessons from the Army's Future Combat Systems Program
Christopher G. Pernin, Elliot Axelband, Jeffrey A. Drezner, Brian B. Dille, John Gordon IV, Bruce J. Held, K. Scott McMahon, Walter L. Perry, Christopher Rizzi, Akhil R. Shah, Peter A. Wilson, Jerry M. Sollinger
2012, MG-1206-A, https://www.rand.org/pubs/monographs/MG1206.html

As of 2012, the Future Combat Systems program was the largest and most ambitious planned acquisition program in the Army's history. The program was intended to field not just a system but an entire brigade, a system of systems, with novel technologies integrated by means of an advanced wireless network. Moreover, the brigade equipped with the program would operate with new doctrine that was being developed and tested along with the materiel components of the unit. The Future Combat Systems program was central to Army modernization plans. In 2009, the program was canceled, and some of its efforts were transitioned to follow-on programs. In 2010, the Army Acquisition Executive asked RAND Arroyo Center to conduct an after-action analysis of the Future Combat Systems program in order to leverage its successes and learn from its problems. This report documents the program's history and draws lessons from multiple perspectives, including the conditions leading up to the program, requirements generation and development, program management and execution, and technologies.

Learning from Experience, Vol. II: Lessons from the U.S. Navy's *Ohio*, *Seawolf*, and *Virginia* Submarine Programs
John F. Schank, Cesse Ip, Frank W. Lacroix, Robert E. Murphy, Mark V. Arena, Kristy N. Kamarck, Gordon T. Lee
2011, MG-1128/2-NAVY, https://www.rand.org/pubs/monographs/MG1128z2.html

Large, complex submarine design and construction programs demand personnel with unique skills and capabilities supplemented with practical experiences in their areas of expertise. Recognizing the importance of past experiences for successful program management, the U.S. Navy asked the RAND Corporation to develop a set of lessons learned from previous submarine programs that could help inform future program managers. This volume presents lessons from three submarine programs. The RAND team looks at how the programs were managed, the issues that affected management decisions, and the outcomes of those decisions. All three submarine programs had tenuous beginnings. Each experienced cost overruns and schedule delays in the construction of its first-of-class submarine. The *Ohio* and *Virginia* programs made corrections, and both are viewed as generally successful. *Seawolf*, probably because of the changing threat and budgetary environment, was terminated before changes could be made to correct early missteps. An overarching lesson from the three programs is the importance of program stability. Stability applies in many areas—funding consistency, a long-term build

strategy, fixed operational requirements, program management, and an integrated partnership between the Navy and the shipbuilders.

From Marginal Adjustments to Meaningful Change: Rethinking Weapon System Acquisition
John Birkler, Mark V. Arena, Irv Blickstein, Jeffrey A. Drezner, Susan M. Gates, Melinda Huang, Robert Murphy, Charles Nemfakos, Susan K. Woodward
2010, MG-1020-OSD, https://www.rand.org/pubs/monographs/MG1020.html

Defense acquisition is one of the most urgent issues that DoD faces. In an effort to provide the department and the United States with guidance on defense acquisition challenges in several areas likely to be of critical importance to defense acquisition leadership, the authors compile six previously published RAND reports that offer thought-provoking suggestions based on decades of research, new quantitative assessments, a RAND-developed cost-analysis methodology, and the expertise of core research staff. The authors present detailed proposals to improve defense acquisition through initiatives focused on competition, novel systems, risk management, organizational factors, prototyping, and the acquisition workforce

Commonality in Military Equipment: A Framework to Improve Acquisition Decisions
Thomas Held, Bruce Newsome, Matthew W. Lewis
2008, MG-719-A, https://www.rand.org/pubs/monographs/MG719.html

Increasingly, the U.S. Army and DoD as a whole are developing families of systems built around common components. To inform the Army's decisionmaking process surrounding commonality, RAND Arroyo Center was asked to assess the advantages and disadvantages of commonality and how to best manage their trade-offs. To do so, the authors of this report use historical analysis, literature analyses, and case studies of commercial and military efforts to exploit commonality. They present analyses of the effects of commonality on costs, capabilities, and training and offer a decisionmaking aid that designers, developers, and procurers could use to inform their decisions about commonality. The report concludes with recommendations for the Army.

Lessons Learned from the F/A-22 and F/A-18 E/F Development Programs
Obaid Younossi, David E. Stem, Mark A. Lorell, Frances M. Lussier
2005, MG-276-AF, https://www.rand.org/pubs/monographs/MG276.html

How can the Air Force and the other services profit from the experience of the F/A-22 and F/A-18 E/F—two very different development programs? As of 2005, the F/A-18E/F was a new platform, but it incorporated some of the key components of the legacy platform. The F/A-22, on the other hand, was completely new, but the authors believe that the divergent histories of the two—the F/A-22 was delayed 52 months and experienced cost overruns, while the F/A-18E/F was developed on time and on budget—have lessons to teach future acquisition decisionmakers.

In this report, the authors present a detailed history of the two programs and conclude that these decisionmakers can take several steps to reduce risk and improve the acquisition process, including setting realistic schedule and cost estimates, establishing a stable and experienced development team, being aware of the risks entailed in concurrent development of new technology, and carefully monitoring airframe weight.

An Acquisition Strategy, Process, and Organization for Innovative Systems
John Birkler, Giles K. Smith, Glenn A. Kent, Robert V. Johnson
2000, MR-1098-OSD, https://www.rand.org/pubs/monograph_reports/MR1098.html

The length of time required to move a weapon system through the acquisition cycle has long been a source of concern and frustration to government and industry officials responsible for equipping the U.S. armed forces. The notion of somehow shortening the cycle duration has been a recurring theme in studies of acquisition and DoD management performed by various panels and commissions. In this report, the authors argue that force modernization should put considerable emphasis on the introduction of some unconventional or novel system concepts. They also argue that the acquisition process is poorly adapted to the timely definition and development of such systems. The characteristics of novel systems differ from those of the systems for which the present acquisition process was designed. They are so different that the authors believe that merely tinkering with the process will be an inadequate solution.

To provide guidance in the formulation of new procedures, the authors identify a few major elements of acquisition strategy that would enable the process to deal with the special features of such systems and the expected environment of urgency that might attend their development. The five such strategy elements are as follows: (1) Provide an environment that fosters new concepts for systems and new concepts of operations. (2) Conduct accelerated development and demonstration of new concepts at the subsystem and system level, without commitment to full procurement and fielding. (3) Upon successful demonstration of a new system, permit early, provisional fielding and operation before completion of full maturation development and associated testing. (4) Encourage timely and visionary decisions on such programs by enabling programs to be approved and guided by a few senior officials, without the demand for extensive staff support and documentation. (5) Provide a new and separate organization to oversee the development and demonstration of novel systems and operational concepts. To be effective, the officials who operate under such a new system must be in an environment that views an occasional unsuccessful project as an acceptable price for building a menu of new projects that can be used as a base for rapidly responding to new technological opportunities and new operational needs.

Cheaper, Faster, Better? Commercial Approaches to Weapons Acquisition
Mark A. Lorell, Julia Lowell, Michael Kennedy, Hugh P. Levaux
2000, MR-1147-AF, https://www.rand.org/pubs/monograph_reports/MR1147.html

As of 2000, civil-military integration lay at the core of DoD efforts to reduce the costs of procuring and maintaining modern weapon systems. After analyzing the commercial aerospace industry and the experiences of various acquisition reform pilot programs, the authors conclude that a commercial-like acquisition approach could benefit major Air force acquisition programs. The authors note that the Joint Strike Fighter was an excellent candidate pilot program for application of acquisition reform measures during engineering and manufacturing development. The authors further recommend that future programs be structured to include greater risk-sharing between contractors and the government. The principal benefits of civil-military integration for the acquisition reform pilot programs have come from the structuring and management of these programs to make them more like complex commercial product markets in which buyers and sellers establish and achieve price and performance targets in a cooperative environment. The real promise of civil-military integration is to help insert the incentives for price discipline and high performance prevalent in the commercial marketplace into military R&D production.

The Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process
Michael R. Thirtle, Robert V. Johnson, John Birkler
1997, MR-899-OSD, https://www.rand.org/pubs/monograph_reports/MR899.html

In June 1995, a new endurance unmanned aerial vehicle flew over Bosnia to surveil and provide all-weather reconnaissance and image-gathering in an operational (i.e., conflict) environment. Representing a new capability for DoD, this unmanned aerial vehicle also represented a departure from DoD's usual way of doing acquisition business. The study documented in this report was completed in support of RAND research on ACTD programs for the Office of the Secretary of Defense. The effort was conducted from July until December 1996 and documents research on the Medium Altitude Endurance Unmanned Aerial Vehicle ACTD program (also known as the Predator). Specifically, RAND researchers were tasked to examine two questions: (1) What were the overarching lessons learned from the Predator ACTD program, and (2) which lessons can be generalized and applied to other ACTD programs? In this analysis, the authors closely detail the Predator ACTD program and document the important demonstration and transition issues from the project that can be applied to other ACTD programs. The intent of this work is to improve the ACTD process and the transition of ACTD programs to formal acquisition programs. This report should be of interest to those involved in acquisition, program offices, and ACTD programs.

Improving the Military Acquisition Process: Lessons from Rand Research
Michael Rich, Edmund Dews, C. L. Batten, Jr.
1986, R-3373-AF/RC, https://www.rand.org/pubs/reports/R3373.html

This report, drawing on more than 30 years of RAND research, evaluates past experience with defense development and production, identifies trends that will affect future acquisition activity, and recommends improvements in the acquisition process to meet future challenges. The findings indicate that, in terms of the three most generally accepted measures for judging the acquisition process—cost growth, schedule slippage, and functional performance shortfalls—there has been steady improvement in program outcomes over time. The authors present an integrated strategy for meeting the future force-modernization challenges: Improve the requirement-formulation process, make early development more austere, separate critical subsystem development from platform development, encourage austere prototyping, improve the transition from full-scale development to production, focus more attention on upgrading fielded systems, and stimulate plant modernization and production flexibility.

Joint Acquisition

Most defense acquisition programs are carried out by a specific service, and one service receives the capabilities of the program. However, joint programs have been carried out through a collaboration of multiple services, and multiple services reap the military capabilities. With multiple services, complexity and uncertainty can increase. The reports in this section discuss joint program management challenges and opportunities.

Enhancing Management of the Joint Future Vertical Lift Initiative
Jeffrey A. Drezner, Parisa Roshan, Thomas Whitmore
2017, RR-2010-OSD/JS, https://www.rand.org/pubs/research_reports/RR2010.html

The history of joint acquisition programs in DoD reveals varied outcomes—some positive, some negative. Joint program management is intended to reduce management costs and spread risks across participating services. Increased commonality theoretically yields economies of scale and savings that can be realized during the development, production, and support phases. However, joint management introduces significant complexity, while commonality also introduces significant technical challenges. Some joint programs have proved to be successful (e.g., the Joint Direct Attack Munition), yet the complexity of joint requirements might have contributed to cost growth and schedule delays in other programs (e.g., F-35 Joint Strike Fighter), detracting from the benefits expected from commonality. The joint Future Vertical Lift initiative asked RAND to examine joint management constructs and recommend strategies for improving both the program's internal organizational structure and alignment with key external bodies. The authors draw a distinction between joint program management and commonality and argue that it is possible to achieve some degree of commonality without joint program

management. After conducting a review of historical joint initiatives, as well as a review of relevant business management literature, the authors identify some of the factors affecting joint program success and recommend ways to apply those lessons to the management of the Future Vertical Lift program.

Do Joint Fighter Programs Save Money?
Mark A. Lorell, Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An, Robert A. Guffey
2013, MG-1225-AF, https://www.rand.org/pubs/monographs/MG1225.html

In the past several decades, DoD has pursued numerous joint aircraft programs, the largest and most recent of which is the F-35 Joint Strike Fighter. Joint aircraft programs are thought to reduce life-cycle cost by eliminating duplicate RDT&E efforts and by realizing economies of scale in procurement, operations, and support. But the need to accommodate different service requirements in a single design or common design family can lead to greater program complexity, increased technical risk, and common functionality or increased weight in excess of that needed for some variants, potentially leading to higher overall cost, despite these efficiencies. To help Air Force leaders (and acquisition decisionmakers in general) select an appropriate acquisition strategy for future combat aircraft, the authors of this report analyze the costs and savings of joint aircraft acquisition programs. The project team examines whether historical joint aircraft programs have saved life-cycle costs compared with the costs of single-service programs. In addition, the project team assesses whether the Joint Strike Fighter is on track to achieving the joint savings originally anticipated at the beginning of full-scale development. Also examined are the implications of joint fighter programs for the health of the industrial base and for operational and strategic risk.

Space and Cyber Acquisition

Space and cyberspace are emerging warfighting domains with specific acquisition challenges. Confronting Russia or China will likely demand different investments with a stronger emphasis in both areas. The following reports explore the unique challenges the DoD has faced and provides recommendations for the future across space and cyberspace domains.

Improving Acquisition to Support the Space Enterprise Vision
Yool Kim, Guy Weichenberg, Frank Camm, Brian Dougherty, Thomas C. Whitmore, Nicholas Martin, Badreddine Ahtchi
2020, RR-2626-AF, https://www.rand.org/pubs/research_reports/RR2626.html

The Space Enterprise Vision, developed jointly by Air Force Space Command and the National Reconnaissance Office in 2015, describes an integrated approach to building a force across all space mission areas. Given that the vision requires a departure from the way space

systems are currently acquired, Air Force Space Command headquarters and Space and Missile Systems Center asked RAND Project AIR FORCE to assess key barriers to realizing the Space Enterprise Vision and recommend ways to overcome those barriers to help achieve the vision's goals. In this report, the research team examines a variety of potential approaches to support the goals, based on a literature review and semi-structured interviews with acquisition subject-matter experts and sponsor guidance. The researchers identify several promising alternative acquisition approaches that merit in-depth examination in this project: MOSA, agile acquisition, and rapid prototyping.

A Need for Speed? Identifying the Effects of Space Acquisition Timelines on Space Deterrence and Conflict Outcomes

Benjamin Goirigolzarri

2019, RGSD-432, https://www.rand.org/pubs/rgs_dissertations/RGSD432.html

DoD leaders have asserted that slow space acquisition timelines may threaten U.S. space superiority, but the link between acquisition timelines and space conflict has not been rigorously investigated in prior research. This dissertation questions that assertion through a mixed-methods approach of game-theoretic modeling and case study analysis. The author finds primarily that acquisition timelines drive underlying strategies but not necessarily the outcomes of space conflict and deterrence. If an actor is at a disadvantage, it can mitigate that disadvantage by investing in relatively simple redundancies and resiliencies supporting its space architecture and remain reserved through conflict. In the case of parity, the author finds that the appropriate strategy is to invest in complex systems and to take an assertive posture in conflict. Given leadership's statements and this dissertation's conclusions on U.S. space acquisition timelines, the United States should focus its investments on relatively simple investments that support its resilience in space. This does not, however, suggest that the United States should abandon its space acquisition reform efforts, as those may improve broader conflict dynamics and space acquisition efficiencies.

Acquisition of Space Systems, Volume 7: Past Problems and Future Challenges

Yool Kim, Elliot Axelband, Abby Doll, Mel Eisman, Myron Hura, Edward G. Keating, Martin C. Libicki, Bradley Martin, Michael E. Mcmahon, Jerry M. Sollinger, Erin York, Mark V. Arena, Irv Blickstein, William Shelton

2015, MG-1171/7-OSD, https://www.rand.org/pubs/monographs/MG1171z7.html

Acquiring and deploying space systems in a timely, affordable manner is important to U.S. national security, but, for years, DoD space programs have experienced large cost growth, schedule delays, and technical problems. Although these issues have been mostly resolved, DoD should apply lessons learned from past experience as it plans for the next-generation space systems, especially in the current fiscal environment. The authors analyze the performance of selected DoD space programs in terms of cost growth, schedule delays, and on-orbit performance

over the course of their program histories spanning from 1996 to 2012; identify key factors that contributed to cost growth, schedule overruns, and technical problems; characterize the current status of these programs; and identify future acquisition challenges that next-generation space systems might face.

Rapid Acquisition and Fielding for Information Assurance and Cyber Security in the Navy
Isaac R. Porche III, Shawn McKay, Megan McKernan, Robert W. Button, Bob Murphy, Kate Giglio, Elliot Axelband
2012, TR-1294-NAVY, https://www.rand.org/pubs/technical_reports/TR1294.html

Identifying an agile and adaptable acquisition process that can field new IT capabilities and services in relatively short and responsive time frames is a pressing issue for the U.S. Navy. Damaging malware can mutate within hours or days, requiring a defense that is sufficiently responsive to mitigate each variant. The Navy's Program Manager, Warfare 130, an office in the Navy's Program Executive Office for Command, Control, Communications, Computers, and Intelligence, is focused on rapidly and proactively fielding innovative capabilities to stay ahead of cyber threats. It requires an acquisition and fielding cycle that can deliver hardware security products within 12 to 18 months, software security products within six to 12 months, and incremental development for both hardware and software every three months. These time frames are far shorter than the Navy's traditional acquisition cycle, which can be 36 months from concept approval to initial operational capability or eight to ten years for full operational capability. With a focus on these goals, RAND researchers sought to identify ways to accelerate or bypass the traditional acquisition process in response to the unique demands of Program Manager, Warfare 130 IT and cyber programs, with lessons derived from and recommendations applicable to programs across DoD.

Space Capabilities Development Implications of Past and Current Efforts for Future Programs
Myron Hura, Gary McLeod, Lara Schmidt, Manuel Cohen, Mel Eisman, Elliot Axelband
2007, Not available to the general public

In 2007, the space-acquisition community needed to manage a large number of major military satellite programs: Legacy programs had satellites still to be maintained, launched, and operated to end of life; their follow-on programs were acquiring satellites with enhanced capabilities; and new programs were developing completely new space capabilities. The combination of a large workload, concerns about space-acquisition capabilities (e.g., government and contractor processes, procedures, and expertise to manage, design, manufacture, and integrate subcomponents into systems, and systems into system-of-systems enterprises), indicators of potential decreases in on-orbit reliability of recently built space vehicles, and a constrained budget environment raised the issue of the capability of the space-acquisition

community to execute space programs while minimizing the probability of future gaps in existing operational capabilities.

The authors of this study examine space programs to identify positive and negative factors that affected their development and develop suggested actions to help the Air Force and DoD improve the development of future space capabilities and reduce the probability of operational gaps. The report begins with a review of U.S. government policy documents and a variety of DoD, federally funded research and development center, and contractor studies highlighting geopolitical and economic factors that shaped the development and acquisition of national security space capabilities during the Cold War era and the post–Cold War era. The authors examine four mission areas supported by space capabilities: imagery intelligence, missile warning, weather, and military satellite communications. The authors develop four overarching recommendations: Hedge for unanticipated failures, return system performance to preeminence, enable acquisition space program directors and hold them accountable for program outcomes, and examine the capabilities of the space-acquisition community (both government and industry) to carry out the large workload.

Evolutionary Acquisition: Implementation Challenges for Defense Space Programs
Mark A. Lorell, Julia F. Lowell, Obaid Younossi
2006, MG-431-AF, https://www.rand.org/pubs/monographs/MG431.html

This monograph presents findings of a RAND Project AIR FORCE research project documenting lessons learned by the U.S. Air Force and other DoD cost analysis and acquisition community members from the implementation of evolutionary acquisition strategies for major Air Force defense space acquisition programs. In May 2003, DoD mandated evolutionary acquisition strategies relying on spiral development as the preferred approach to satisfying operational needs. However, these strategies vary considerably in their implementation. The authors of this research effort adopt a three-pronged approach. First, they comprehensively review literature on evolutionary acquisition theory and implementation. Second, they conduct interviews with senior DoD and Air Force acquisition management officials regarding these strategies. Finally, they review five major space acquisition programs that have been restructured in accordance with evolutionary acquisition concepts. The authors conclude that the implementation of this approach on military space programs so far has produced mixed results. The capabilities and requirements definition and management processes are major challenges in all associated programs. Appropriate structuring of evolutionary acquisition phases with operationally useful threshold requirements and mapping the path to overall objective capability are demanding tasks on most programs. The use of spiral development for implementing evolutionary acquisition on major space hardware acquisition programs greatly increases the level of program uncertainties, raising serious challenges for program managers in the current acquisition environment. The authors further conclude that evolutionary acquisition programs

require an evolutionary costing approach; most cost analysts interviewed expressed generally positive views about evolutionary acquisition.

Data in Defense Acquisition

In the information age, the acquisition community can arm decisionmakers with data to make more-informed acquisition decisions. RAND research suggests that tailoring acquisition approaches and engaging a broader industrial base will be necessary to improve acquisition outcomes. Implicit in those recommendations is a need to better leverage program and workforce data. This section describes RAND reports that discuss challenges related to acquisition data and opportunities that those data can provide.

Assessing Department of Defense Use of Data Analytics and Enabling Data Management to Improve Acquisition Outcomes
Philip S. Anton, Megan McKernan, Ken Munson, James G. Kallimani, Alexis Levedahl, Irv Blickstein, Jeffrey A. Drezner, Sydne Newberry
2019, RR-3136-OSD, https://www.rand.org/pubs/research_reports/RR3136.html

In the conference report accompanying the National Defense Authorization Act for FY 2017, Congress expressed concern that DoD "does not sufficiently incorporate data into its acquisition-related learning and decision-making" and asked six questions about "the use of data analysis, measurement, and other evaluation-related methods in DoD acquisition programs." In this report, the authors decompose and measure acquisition functions, data governance, and training to assess how data and associated analytics support DoD acquisition decisionmaking. Advancement should include developing a data analytics strategy across acquisition domains, expanding data governance and data-sharing, and continuing to expand and mature data collection, access, and analytic layers. Also, mechanisms are needed to authorize and ensure protected access to data for both DoD and external analysts. Improved incentives and understanding of data analytics could encourage decisionmakers to make better use of capabilities.

Issues with Access to Acquisition Data and Information in the Department of Defense: Considerations for Implementing the Controlled Unclassified Information Reform Program
Megan McKernan, Jessie Riposo, Geoffrey McGovern, Douglas Shontz, Badreddine Ahtchi
2018, RR-2221-OSD, https://www.rand.org/pubs/research_reports/RR2221.html

Acquisition data play a critical role in the management of DoD's portfolio of weapon systems. Along with appropriate information security, Controlled Unclassified Information (CUI) labels are one of the key methods for protecting sensitive information from disclosure. Mandatory U.S. government–wide policies governing the handling of unclassified acquisition information exist because of concerns about exploitation by sophisticated adversaries. Executive

Order 13556, signed by then–President Barack Obama on November 4, 2010, established a government-wide program for managing CUI, which includes personally identifiable information, proprietary business information, and law enforcement investigation information, among others. As the CUI executive agent, the National Archives and Records Administration is responsible for addressing more than 100 ways of characterizing CUI, which it has done in the September 2016 CUI *Federal Register*. The rules in this register came into effect on November 14, 2016. This report provides a closer look at the current state of the CUI program, as well as how the new CUI rules might affect DoD acquisition data management. RAND researchers find a high degree of overlap in the content, if not the nomenclature, of past and present CUI labels used for acquisition data, but the problem going forward is translating policy into practice.

Issues with Access to Acquisition Data and Information in the Department of Defense: Doing Data Right in Weapon System Acquisition

Megan McKernan, Nancy Y. Moore, Kathryn Connor, Mary E. Chenoweth, Jeffrey A. Drezner, James Dryden, Clifford A. Grammich, Judith D. Mele, Walter Nelson, Rebeca Orrie, Douglas Shontz, Anita Szafran

2017, RR-1534-OSD, https://www.rand.org/pubs/research_reports/RR1534.html

Acquisition data and information are the foundation for decisionmaking, management, and oversight of weapon-system acquisition programs. They are critical to initiatives to improve defense acquisition, such as Better Buying Power. DoD gathers a wide variety of acquisition information and stores it in multiple, sometimes incompatible systems, most of which are built for reporting, not analysis. Large businesses have similar problems, and the concept of master data management may have lessons for both. In this report, the authors review 21 key acquisition-related data information systems and their origins and uses and identify how acquisition data might be improved. They also summarize background on acquisition data; review commercial practices in data management; and offer findings and recommendations to further improve acquisition data quality, access, and use.

International Acquisition

In addition to its primary acquisition work for DoD, RAND has also contributed work to the acquisition and industrial base problems in allied nations. The focus on industrial base, acquisition workforce, and major decisions underscores the unique challenges that these countries face in developing and fielding state-of-the-art military equipment.

Contestability Frameworks: An International Horizon Scan
Cynthia R. Cook, Emma Westerman, Megan McKernan, Badreddine Ahtchi, Gordon T. Lee, Jenny Oberholtzer, Douglas Shontz, Jerry M. Sollinger
2016, RR-1372-AUS, https://www.rand.org/pubs/research_reports/RR1372.html

The Australian Department of Defence is undergoing a fundamental restructure, one aspect of which aims to ensure that it has a robust military capability acquisition process. A key component of this restructuring is the establishment of an internal contestability capability to review the department's requirements, acquisition, and budget decisions internally before they are passed to other elements in the government. The role of this contestability function is to help ensure that the requirements and the resultant capabilities delivered to the Australian Defence Force are aligned with articulated strategy and available resources. To help develop this capability, the Australian Department of Defence engaged the RAND Corporation to identify and review international contestability practices.

This report details the study's findings. It describes key contestability functions and the primary aspects of those functions, as described in the literature. The report also provides the results of case studies of contestability functions in a variety of public and private organizations. RAND researchers find that different organizations take a wide variety of approaches to implementing and conducting contestability functions. Still, there was a pervasive understanding that contestability could be linked to better outcomes and that a structured review of decisions could help reduce or avoid problems.

Australia's Naval Shipbuilding Enterprise: Preparing for the 21st Century
John Birkler, John F. Schank, Mark V. Arena, Edward G. Keating, Joel B. Predd, James Black, Irina Elena Danescu, Dan Jenkins, James G. Kallimani, Gordon T. Lee, Roger Lough, Robert Murphy, David Nicholls, Giacomo Persi Paoli, Deborah Peetz, Brian Perkinson, Jerry M. Sollinger, Shane Tierney, Obaid Younossi
2015, RR-1093-AUS, https://www.rand.org/pubs/research_reports/RR1093.html

In 2015, the Australian government was set to produce a new Defence White Paper to outline revised and refined defense objectives. As the time, a basic question facing the government was whether Australia should buy ships from foreign shipbuilders or support a domestic naval shipbuilding industry. This question is complex, containing many facets and issues that often center on cost trade-offs and economic considerations but that also touch upon important national and strategic concerns.

At the request of the Australian Department of Defence's 2015 White Paper Enterprise Management team, the RAND Corporation analyzed the capability of the shipbuilding and ship repair industrial bases in Australia to meet the demands of current and future naval surface ship programs. The analysis in this report aims to help Australia's defense policymakers in three ways: first, to gain an understanding of the capacity and associated costs of Australia's naval

shipbuilding industrial base to successfully implement the country's current acquisition plan; second, to gauge how alternative acquisition requirements, programs, build strategies, quantities, and related costs and schedules might affect the capacity of that industrial base; and third, to measure the economic effects of the industry throughout Australia. RAND researchers provide detailed findings from both public and proprietary data and from surveys of industry representatives, and they offer recommendations to Australian policymakers.

Keeping Major Naval Ship Acquisitions on Course: Key Considerations for Managing Australia's SEA 5000 Future Frigate Program
John F. Schank, Mark V. Arena, Kristy N. Kamarck, Gordon T. Lee, John Birkler, Robert Murphy, Roger Lough
2014, RR-767-AUS, https://www.rand.org/pubs/research_reports/RR767.html

This report provides a program overview of acquisition options available for the Commonwealth of Australia's next-generation naval surface combatant and identifies internal and external factors that can influence a major ship acquisition program. The authors address questions relating to available ship design and build options; various phases, options, and decisions; and aspects that can contribute to the success of an acquisition program. Three broad options for designing and building the new ship include a new design, tailor-made to Royal Australian Navy specifications and requirements; a military off-the-shelf design, which would involve making only minor modifications to an existing ship design; and an evolved military off-the-shelf design, which would involve making more-significant modifications to an existing ship design. The authors discuss lessons learned as they apply to different phases of a shipbuilding program and highlight the lessons most applicable to the acquisition strategy selected.

Sustaining Key Skills in the UK Military Aircraft Industry
Matt Bassford, Hans Pung, Nigel Edgington, Tony G. Thompson-Starkey, Kristin Weed, Mark V. Arena, James G. Kallimani, Gordon T. Lee, Obaid Younossi
2010, MG-1023-MOD, https://www.rand.org/pubs/monographs/MG1023.html

In December 2005, the United Kingdom's Ministry of Defence published its first Defence Industrial Strategy, containing a specific reference to the military fixed-wing aircraft sector and a requirement to retain domestic design and engineering capabilities, as well as other skills, to perform through-life activities. In 2009, the House of Commons Defence Committee urged the Ministry of Defence to "set out what assessment it has made of the health of the UK defense industry and, in particular, those parts of the defense industry where the [Ministry of Defence] wishes to retain industrial capability in the UK." The research reported in this monograph was commissioned by the Ministry of Defence's Fixed Wing Sector Strategy Board to assist the organization in its development of a strategy and sustainment plan for the military fixed-wing sector. This monograph describes the qualitative and quantitative methodologies that the RAND team followed and summarizes its findings and recommendations.

Differences Between Military and Commercial Shipbuilding: Implications for the United Kingdom's Ministry of Defence

John Birkler, Denis Rushworth, James Chiesa, Hans Pung, Mark V. Arena, John F. Schank

2005, MG-236-MOD, https://www.rand.org/pubs/monographs/MG236.html

In the United Kingdom, the shipbuilding industry is sustained largely by the government's purchases of naval and naval auxiliary vessels. The desire for a continuing efficient and robust shipbuilding industry has prompted the United Kingdom's Ministry of Defence to ask whether the United Kingdom's shipbuilding industry can compete more broadly in commercial or foreign military markets. The prospects for broadening UK shipyards' customer base appear to be poor. The United Kingdom would face strong competitors in attempting to re-enter the commercial shipbuilding market. Japan and South Korea dominate the market for ships of low and moderate complexity, mostly cargo ships and tankers of varying types. European Union shipyards dominate the market for more-complex ships, such as passenger vessels, although that market segment is also under pressure from Asian shipbuilders. The United Kingdom certainly has a stronger industrial base to support military sales than it does in the commercial arena, but the match between most current UK military ship products and global demand is not a close one. The military export market is largely a market for modestly priced frigates and small conventionally powered attack submarines. It is not clear that a UK shipyard could build a conventional submarine at a competitive price; UK warships are, in general, too sophisticated and expensive to make them interesting to potential importers. Furthermore, export contracts often require that most ships in an order be built in the importing country, thus limiting the benefit that such sales may have for the exporter's construction workforce.

Assembling and Supporting the Joint Strike Fighter in the UK: Issues and Costs

Cynthia R. Cook, Mark V. Arena, John C. Graser, Hans Pung, Jerry M. Sollinger, Obaid Younossi

2003, MR-1771-MOD, https://www.rand.org/pubs/monograph_reports/MR1771.html

The United Kingdom's Ministry of Defence has selected the Joint Strike Fighter as a replacement for its Harrier aircraft and may buy up to 150 Joint Strike Fighter aircraft. This report seeks to inform the Ministry of Defence about the overlap of final assembly and repair, assess the suitability of four UK aerospace companies as potential sites for final assembly of its Joint Strike Fighter aircraft, identify the costs associated with such an undertaking, and look at any potential concomitant technology transfer implications. The authors indicate significant overlap in the two tasks in question, and their analysis allow them to estimate the costs of various options. They determine that three of the UK sites would be suitable after additional investments and capability development, varying according to site. The authors conclude by asserting that the technology-transfer issues need to be addressed as soon as possible.

The Royal Navy's New-Generation Type 45 Destroyer: Acquisition Options and Implications

John Birkler, John F. Schank, Mark V. Arena, Giles K. Smith, Gordon T. Lee

2002, MR-1486-MOD, https://www.rand.org/pubs/monograph_reports/MR1486.html

In 2001, RAND researchers helped the United Kingdom's Ministry of Defence evaluate different acquisition strategies that it might use to acquire the new-generation Type 45 *Daring*-class destroyer. RAND's analyses helped determine whether the Ministry of Defence should have the Type 45 built by one company or two, whether the ministry should compete the 12 ships in the class or directly allocate work to specific shipbuilders, and whether companies producing the Type 45 should construct the destroyer in its entirety in one shipyard or from blocks produced in several shipyards.

Abbreviations

AcqDemo	Civilian Acquisition Workforce Personnel Demonstration Project
ACTD	Advanced Concept Technology Demonstration
CUI	Controlled Unclassified Information
DoD	U.S. Department of Defense
FY	fiscal year
HAE UAV	High Altitude Endurance Unmanned Aerial Vehicle
IT	information technology
MDAP	major defense acquisition program
MOSA	Modular Open Systems Approach
O&S	operations and support
OT	other transaction
PBA	price-based acquisition
R&D	research and development
RDT&E	research, development, test, and evaluation
SBIR	Small Business Innovation Research

References

Alkire, Brien, Sherrill Lingel, Caroline Baxter, Christopher M. Carson, Christine Chen, David Gordon, Lawrence M. Hanser, Lance Menthe, and Daniel M. Romano, *Command and Control of Joint Air Operations in the Pacific: Methods for Comparing and Contrasting Alternative Concepts*, Santa Monica, Calif.: RAND Corporation, RR-1865-AF, 2018. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1865.html

Anton, Philip S., Brynn Tannehill, Jake McKeon, Benjamin Goirigolzarri, Maynard A. Holliday, Mark A. Lorell, and Obaid Younossi, *Strategies for Acquisition Agility: Approaches for Speeding Delivery of Defense Capabilities*, Santa Monica, Calif.: RAND Corporation, RR-4193-AF, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR4193.html

Arena, Mark V., Irv Blickstein, Daniel Gonzales, Sarah Harting, Jennifer Lamping Lewis, Michael McGee, Megan McKernan, Charles Nemfakos, Jan Osburg, Rena Rudavsky, and Jerry M. Sollinger, *DoD and Commercial Advanced Waveform Developments and Programs with Multiple Nunn-McCurdy Breaches, Volume 5*, Santa Monica, Calif.: RAND Corporation, MG-1171/5-OSD, 2014. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1171z5.html

Arena, Mark V., Irv Blickstein, Obaid Younossi, and Clifford A. Grammich, *Why Has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs over the Past Several Decades*, Santa Monica, Calif.: RAND Corporation, MG-484-NAVY, 2006. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG484.html

Arena, Mark V., John C. Graser, and Paul DeLuca, *Implications of an Air Force Budget Downturn on the Aircraft Industrial Base: An Exploratory Analysis*, Santa Monica, Calif.: RAND Corporation, RR-248-AF, 2013. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR248.html

Arena, Mark V., Obaid Younossi, Kevin Brancato, Irv Blickstein, and Clifford A. Grammich, *Why Has the Cost of Fixed-Wing Aircraft Risen? A Macroscopic Examination of the Trends in U.S. Military Aircraft Costs over the Past Several Decades*, Santa Monica, Calif.: RAND Corporation, MG-696-NAVY/AF, 2008. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG696.html

Arena, Mark V., Obaid Younossi, Lionel A. Galway, Bernard Fox, John C. Graser, Jerry M. Sollinger, Felicia Wu, and Carolyn Wong, *Impossible Certainty: Cost Risk Analysis for Air Force Systems*, Santa Monica, Calif.: RAND Corporation, MG-415-AF, 2006. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG415.html

Asch, Beth J., "The Economic Complexities of Incentive Reforms," in Robert Klitgaard and Paul C. Light, eds., *High-Performance Government: Structure, Leadership, Incentives*, Santa Monica, Calif.: RAND Corporation, MG-256-PRGS, 2005, pp. 309–342. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG256.html

Asch, Beth J., and John T. Warner, *A Theory of Military Compensation and Personnel Policy*, Santa Monica, Calif.: RAND Corporation, MR-439-OSD, 1994. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR439.html

Barnett, Jackson, "DOD Nudges Innovative Startups Toward 'Trusted Capital' with New Digital Marketplace," *FedScoop*, January 23, 2021.

Bartels, Elizabeth M., Jeffrey A. Drezner, and Joel B. Predd, *Building a Broader Evidence Base for Defense Acquisition Policymaking*, Santa Monica, Calif.: RAND Corporation, RR-A202-1, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RRA202-1.html

Bassford, Matt, Hans Pung, Nigel Edgington, Tony G. Thompson-Starkey, Kristin Weed, Mark V. Arena, James G. Kallimani, Gordon T. Lee, and Obaid Younossi, *Sustaining Key Skills in the UK Military Aircraft Industry*, Santa Monica, Calif.: RAND Corporation, MG-1023-MOD, 2010. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1023.html

Bellasio, Jacopo, and Erik Silfversten, "The Impact of New and Emerging Technologies on the Cyber Threat Landscape and Their Implications for NATO," in A. Ertan, K. Floyd, P. Pernik, and Tim Stevens, eds., *Cyber Threats and NATO 2030: Horizon Scanning and Analysis*, Tallinn: North Atlantic Treaty Organization, Cooperative Cyber Defence Centre of Excellence, 2020, pp. 88–107.

Birkler, John, Mark V. Arena, Irv Blickstein, Jeffrey A. Drezner, Susan M. Gates, Melinda Huang, Robert Murphy, Charles Nemfakos, and Susan K. Woodward, *From Marginal Adjustments to Meaningful Change: Rethinking Weapon System Acquisition*, Santa Monica, Calif.: RAND Corporation, MG-1020-OSD, 2010. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1020.html

Birkler, John, Anthony G. Bower, Jeffrey A. Drezner, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, Fred Timson, William P. G. Trimble, and Obaid Younossi, *Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry*, Santa Monica, Calif.: RAND Corporation, MR-1656-OSD, 2003. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR1656.html

Birkler, John, Paul Bracken, Gordon T. Lee, Mark A. Lorell, Soumen Saha, and Shane Tierney, *Keeping a Competitive U.S. Military Aircraft Industry Aloft: Findings from an Analysis of the Industrial Base*, Santa Monica, Calif.: RAND Corporation, MG-1133-OSD, 2011. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1133.html

Birkler, John, John F. Schank, Mark V. Arena, Edward G. Keating, Joel B. Predd, James Black, Irina Danescu, Dan Jenkins, James G. Kallimani, Gordon T. Lee, Roger Lough, Robert Murphy, David Nicholls, Giacomo Persi Paoli, Deborah Peetz, Brian Perkinson, Jerry M. Sollinger, Shane Tierney, and Obaid Younossi, *Australia's Naval Shipbuilding Enterprise: Preparing for the 21st Century*, Santa Monica, Calif.: RAND Corporation, RR-1093-AUS, 2015. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1093.html

Birkler, John, Giles Smith, Glenn A. Kent, and Robert V. Johnson, *An Acquisition Strategy, Process, and Organization for Innovative Systems*, Santa Monica, Calif.: RAND Corporation, MR-1098-OSD, 2000. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR1098.html

Blickstein, Irv, Michael Boito, Jeffrey A. Drezner, James Dryden, Kenneth Horn, James G. Kallimani, Martin C. Libicki, Megan McKernan, Roger C. Molander, Charles Nemfakos, Chad J. R. Ohlandt, Caroline R. Milne, Rena Rudavsky, Jerry M. Sollinger, Katharine Watkins Webb, and Carolyn Wong, *Root Cause Analyses of Nunn-McCurdy Breaches, Volume 1:* Zumwalt-*Class Destroyer, Joint Strike Fighter, Longbow Apache, and Wideband Global Satellite*, Santa Monica, Calif.: RAND Corporation, MG-1171/1-OSD, 2011. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1171z1.html

Bolten, Joseph G., Robert S. Leonard, Mark V. Arena, Obaid Younossi, and Jerry M. Sollinger, *Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, MG-670-AF, 2008. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG670.html

Bonds, Timothy M., Joel B. Predd, Timothy R. Heath, Michael S. Chase, Michael Johnson, Michael J. Lostumbo, James Bonomo, Muharrem Mane, and Paul S. Steinberg, *What Role Can Land-Based, Multi-Domain Anti-Access/Area Denial Forces Play in Deterring or Defeating Aggression?* Santa Monica, Calif.: RAND Corporation, RR-1820-A, 2017. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1820.html

Braun, William G., III, and Charles D. Allen, "Shaping a 21st-Century Defense Strategy: Reconciling Military Roles," *Joint Force Quarterly*, Vol. 73, April 2014, pp. 52–59.

Brose, Christian, *The Kill Chain: Defending America in the Future of High-Tech Warfare*, New York: Hachette Books, April 21, 2020.

Brown, Michael, and Pavneet Singh, *China's Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable a Strategic Competitor to Access the Crown Jewels of U.S. Innovation*, Silicon Valley, Calif.: Defense Innovation Unit Experimental, January 2018.

Chang, Ike, Steven Galing, Carolyn Wong, Howell Yee, Elliot Axelband, Mark Onesi, and Kenneth Horn, *Use of Public-Private Partnerships to Meet Future Army Needs*, Santa Monica, Calif.: RAND Corporation, MR-997-A, 1999. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR997.html

Chen, Shuxen, and Charles Wolf, Jr., *China, the United States, and the Global Economy*, Santa Monica, Calif.: RAND Corporation, MR-1300-RC, 2001. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR1300.html

Chenoweth, Mary E., Jeremy Arkes, and Nancy Y. Moore, *Best Practices in Developing Proactive Supply Strategies for Air Force Low-Demand Service Parts*, Santa Monica, Calif.: RAND Corporation, MG-858-AF, 2010. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG858.html

Chou, Yen-Chou, *The Impact of Technology Refreshment on the Defense Acquisition Life Cycle*, dissertation, Aberdeen Proving Ground, Md.: Defense Acquisition University, May 2013.

Cohen, Raphael S., Nathan Chandler, Shira Efron, Bryan Frederick, Eugeniu Han, Kurt Klein, Forrest E. Morgan, Ashley L. Rhoades, Howard J. Shatz, and Yuliya Shokh, *The Future of Warfare in 2030: Project Overview and Conclusions*, Santa Monica, Calif.: RAND Corporation, RR-2849/1-AF, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR2849z1.html

Congressional Budget Office, *Long-Term Implications of the 2020 Future Years Defense Program*, Washington, D.C., August 2019.

Connor, Kathryn, and James Dryden, *New Approaches to Defense Inflation and Discounting*, Santa Monica, Calif.: RAND Corporation, RR-237-OSD, 2013. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR237.html

Cook, Cynthia R., Emma Westerman, Megan McKernan, Badreddine Ahtchi, Gordon T. Lee, Jenny Oberholtzer, Douglas Shontz, and Jerry M. Sollinger, *Contestability Frameworks: An International Horizon Scan*, Santa Monica, Calif.: RAND Corporation, RR-1372-AUS, 2016. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1372.html

Cox, Amy G., Nancy Y. Moore, and Clifford A. Grammich, *Identifying and Eliminating Barriers Faced by Nontraditional Department of Defense Suppliers*, Santa Monica, Calif.: RAND Corporation, RR-267-OSD, 2014. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR267.html

Danzig, Richard, *Driving in the Dark: Ten Propositions About Prediction and National Security*, Washington, D.C.: Center for a New American Security, October 2011.

Defense Science Board, *2008 Summer Study on Capability Surprise*, Vol. 1: *Main Report*, Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, September 2009.

———, *Design and Acquisition of Software for Defense Systems*, Washington, D.C.: Office of the Under Secretary of Defense for Research and Engineering, February 2018.

Defense Science Board Task Force on Defense Industrial Structure for Transformation, *Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to Address the Coming Crisis*, Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, July 2008.

DoD—*See* U.S. Department of Defense.

Drezner, Jeffrey A., and Robert S. Leonard, *Innovative Development: Global Hawk and DarkStar—Transitions Within and Out of the HAE UAV ACTD Program*, Santa Monica, Calif.: RAND Corporation, MR-1476-AF, 2002. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR1476.html

Drezner, Jeffrey A., Parisa Roshan, and Thomas Whitmore, *Enhancing Management of the Joint Future Vertical Lift Initiative*, Santa Monica, Calif.: RAND Corporation, RR-2010-OSD/JS, 2017. As of February 6, 2021: https://www.rand.org/pubs/research_reports/RR2010.html

Drezner, Jeffrey A., and Michael Simpson, *Exploring Parallel Development in the Context of Agile Acquisition: Analytical Support to the Air Superiority 2030 Enterprise Capability Collaboration Team*, Santa Monica, Calif.: RAND Corporation, RR-1808-AF, 2017. As of February 6, 2021: https://www.rand.org/pubs/research_reports/RR1808.html

Egel, Daniel, Howard J. Shatz, Krishna B. Kumar, and Ted Harshberger, "Defense Budget Implications of the COVID-19 Pandemic," *Real Clear Defense*, April 7, 2020.

Firesmith, Donald, "Open System Architectures: When and Where to Be Closed," SEI Insights Blog, Software Engineering Institute, October 2015.

Fox, J. Ronald, *Defense Acquisition Reform, 1960–2009: An Elusive Goal*, Washington, D.C.: U.S. Army Center of Military History, 2011.

Garamone, Jim, "Transformational Change Comes to DOD Acquisition Policy," U.S. Department of Defense, October 21, 2019.

Gates, Susan M., *Shining a Spotlight on the Defense Acquisition Workforce—Again*, Santa Monica, Calif.: RAND Corporation, OP-266-OSD, 2009. As of October 1, 2021: https://www.rand.org/pubs/occasional_papers/OP266.html

Gates, Susan M., Edward Keating, Adria Jewell, Lindsay Daugherty, Bryan Tysinger, Albert A. Robbert, and Ralph Masi, *The Defense Acquisition Workforce: An Analysis of Personnel Trends Relevant to Policy, 1993–2006*, Santa Monica, Calif.: RAND Corporation, TR-572-OSD, 2008. As of October 4, 2021: https://www.rand.org/pubs/technical_reports/TR572.html

Gilman, Derek, *Foreign Military Sales*, Washington, D.C.: Defense Security Cooperation Agency, September 30, 2014.

Greenwalt, William, and Dan Patt, *Competing in Time: Ensuring Capability Advantage and Mission Success Through Adaptable Resource Allocation*, Washington, D.C.: Hudson Institute, February 2021.

Gonzales, Daniel, Sarah Harting, Mary Kate Adgie, Julia Brackup, Lindsey Polley, and Karlyn D. Stanley, *Unclassified and Secure: A Defense Industrial Base Cyber Protection Program for Unclassified Defense Networks*, Santa Monica, Calif.: RAND Corporation, RR-4227-RC, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR4227.html

Guo, Christopher, Philip Hall-Partyka, and Susan M. Gates, *Retention and Promotion of High-Quality Civil Service Workers in the Department of Defense Acquisition Workforce*, Santa Monica, Calif.: RAND Corporation, RR-748-OSD, 2014. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR748.html

Haines, Linda, "Technology Refreshment Within DoD," *Program Manager*, March–April 2001, pp. 22–27.

Held, Bruce, and Ike Chang, *Using Venture Capital to Improve Army Research and Development*, Santa Monica, Calif.: RAND Corporation, IP-199, 2001. As of October 1, 2021: https://www.rand.org/pubs/issue_papers/IP199.html

Held, Bruce, Thomas Edison, Shari Lawrence Pfleeger, Philip S. Antón, and John Clancy, *Evaluation and Recommendations for Improvement of the Department of Defense Small Business Innovation Research (SBIR) Program*, Santa Monica, Calif.: RAND Corporation, DB-490-OSD, 2006. As of October 1, 2021: https://www.rand.org/pubs/documented_briefings/DB490.html

Hicks, Kathleen H., Andrew P. Hunter, Mark F. Cancian, Todd Harrison, and Seamus P. Daniels, *What to Look for in the FY 2020 Defense Budget Request*, Washington, D.C.: Center for Strategic and International Studies, January 31, 2019.

Hoehn, John, *Joint All-Domain Command and Control: Background and Issues for Congress*, Washington, D.C.: Congressional Research Service, R46725, March 18, 2021.

Horn, Kenneth P., Elliott I. Axelband, Ike Yi Chang, Paul S. Steinberg, Carolyn Wong, and Howell Yee, *Performing Collaborative Research with Nontraditional Military Suppliers*, Santa Monica, Calif.: RAND Corporation, MR-830-A, 1997. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR830.html

Hura, Myron, Gary McLeod, Lara Schmidt, Manuel Cohen, Mel Eisman, and Elliot Axelband, *Space Capabilities Development Implications of Past and Current Efforts for Future Programs*, Santa Monica, Calif.: RAND Corporation, 2007, Not available to the general public.

International Monetary Fund, *World Economic Outlook—Globalization: Opportunities and Challenges*, Washington, D.C., May 1997.

Jenkins, Brian Michael, and John Paul Godges, eds., *The Long Shadow of 9/11: America's Response to Terrorism*, Santa Monica, Calif.: RAND Corporation, MG-1107-RC, 2011. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1107.html

Joint Chiefs of Staff, *Joint Vision 2020*, Washington, D.C.: U.S. Government Printing Office, June 2000.

Kim, Yool, Guy Weichenberg, Frank Camm, Brian Dougherty, Thomas C. Whitmore, Nicholas Martin, and Badreddine Ahtchi, *Improving Acquisition to Support the Space Enterprise Vision*, Santa Monica, Calif.: RAND Corporation, RR-2626-AF, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR2626.html

Klitgaard, Robert, and Paul C. Light, eds., *High-Performance Government: Structure, Leadership, Incentives*, Santa Monica, Calif.: RAND Corporation, MG-256-PRGS, 2005. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG256.html

Larson, Eric, Gustav Lindstrom, Myron Hura, Ken Gardiner, Jim Keffer, and Bill Little, *Interoperability of U.S. and NATO Allied Air Forces: Supporting Data and Case Studies*, Santa Monica, Calif.: RAND Corporation, MR-1603-AF, 2004. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR1603.html

Lewis, Jennifer Lamping, Laura Werber, Cameron Wright, Irina Danescu, Jessica Hwang, and Lindsay Daugherty, *2016 Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project*, Santa Monica, Calif.: RAND Corporation, RR-1783-OSD, 2016. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1783z1.html

Lingel, Sherrill, Jeff Hagen, Eric Hastings, Mary Lee, Matthew Sargent, Matthew Walsh, Li Ang Zhang, and David Blancett, *Joint All-Domain Command and Control for Modern Warfare: An Analytic Framework for Identifying and Developing Artificial Intelligence Applications*, Santa Monica, Calif.: RAND Corporation, RR-4408/1-AF, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR4408z1.html

Locher, James R., III, *Victory on the Potomac: The Goldwater-Nichols Act Unifies the Pentagon*, College Station, Tex.: Texas A&M University Press, 2002.

Lorell, Mark A., Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An, and Robert A. Guffey, *Do Joint Fighter Programs Save Money?* Santa Monica, Calif.: RAND Corporation, MG-1225-AF, 2013. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1225.html

Lorell, Mark A., Robert S. Leonard, and Abby Doll, *Extreme Cost Growth: Themes from Six U.S. Air Force Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, RR-630-AF, 2015. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR630.html

Mayer, Lauren A., Mark V. Arena, Frank Camm, Jonathan P. Wong, Gabriel Lesnick, Sarah Soliman, Edward Fernandez, Phillip Carter, and Gordon T. Lee, *Prototyping Using Other Transactions: Case Studies for the Acquisition Community*, Santa Monica, Calif.: RAND Corporation, RR-4417-AF, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR4417.html

McCollester, Maria, Michelle E. Miro, and Kristin Van Abel, *Building Resilience Together: Military and Local Government Collaboration for Climate Adaptation*, Santa Monica, Calif.: RAND Corporation, RR-3014-RC, 2020. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR3014.html

McKernan, Megan P., Jeffrey A. Drezner, and Jerry M. Sollinger, *Tailoring the Acquisition Process in the U.S. Department of Defense*, Santa Monica, Calif.: RAND Corporation, RR-966-OSD, 2015. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR966.html

Meyers, John Speed, and Jonathan P. Wong, "In Defense of Defense Analysis," *War on the Rocks*, September 2, 2016.

Myers, Meghann, "Officials Extend F/A-18 Hornet Service Lives," *Navy Times*, March 7, 2015.

Nemfakos, Charles, Irv Blickstein, Aine Seitz McCarthy, and Jerry M. Sollinger, *The Perfect Storm: The Goldwater-Nichols Act and Its Effect on Navy Acquisition*, Santa Monica, Calif.: RAND Corporation, OP-308-NAVY, 2010. As of October 1, 2021: https://www.rand.org/pubs/occasional_papers/OP308.html

Ochmanek, David, Peter A. Wilson, Brenna Allen, John Speed Meyers, and Carter C. Price, *U.S. Military Capabilities and Forces for a Dangerous World: Rethinking the U.S. Approach to Force Planning*, Santa Monica, Calif.: RAND Corporation, RR-1782-1-RC, 2017. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1782-1.html

O'Connell, Caolionn, Elizabeth Hastings Roer, Rick Eden, Spencer Pfeifer, Yuliya Shokh, Lauren A. Mayer, Jake McKeon, Jared Mondschein, Phillip Carter, Victoria A. Greenfield, and Mark Ashby, *Managing Risk in Globalized Supply Chains*, Santa Monica, Calif.: RAND Corporation, RR-A425-1, 2021. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RRA425-1.html

Office of Management and Budget, "Historical Tables," webpage, White House, undated. As of November 3, 2021: https://www.whitehouse.gov/omb/historical-tables/

Office of the Under Secretary of Defense (Comptroller), *Financial Management Regulation*, U.S. Department of Defense Instruction 7000.14-R, Washington, D.C.: U.S. Department of Defense, May 2019.

Office of the Under Secretary of Defense for Acquisition and Sustainment, *Operation of the Adaptive Acquisition Framework*, U.S. Department of Defense Instruction 5000.02, Washington, D.C., January 23, 2020.

Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Performance of the Defense Acquisition System: 2016 Annual Report*, Washington, D.C.: U.S. Department of Defense, October 2016.

Office of the Under Secretary of Defense for Defense Procurement and Acquisition Policy, *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment*, Washington, D.C.: U.S. Department of Defense, January 31, 2003.

Office of the Under Secretary of Defense for Research and Engineering, "Modernization Priorities," webpage, undated. As of November 15, 2020: https://www.cto.mil/modernization-priorities/

Ohlandt, Chad J. R., Lyle J. Morris, Julia A. Thompson, Arthur Chan, and Andrew Scobell, *Chinese Investment in U.S. Aviation*, Santa Monica, Calif.: RAND Corporation, RR-1755-USCC, 2017. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1755.html

Pandes, Henry P., *A Quest for Efficiencies: Total System Performance Responsibility*, thesis, Maxwell Air Force Base, Ala.: Air Command and Staff College, 2001.

Parmentola, John A., and Robert S. Rohde, "Army Venture Capital Initiative," *Army AL&T*, November–December 2003, pp. 28–29, 43.

Paul, Christopher, Isaac R. Porche III, and Elliot Axelband, *The Other Quiet Professionals: Lessons for Future Cyber Forces from the Evolution of Special Forces*, Santa Monica, Calif.: RAND Corporation, RR-780-A, 2014. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR780.html

Pernin, Christopher G., Elliot Axelband, Jeffrey A. Drezner, Brian B. Dille, John Gordon IV, Bruce J. Held, K. Scott McMahon, Walter L. Perry, Christopher Rizzi, Akhil R. Shah, Peter A. Wilson, and Jerry M. Sollinger, *Lessons from the Army's Future Combat Systems Program*, Santa Monica, Calif.: RAND Corporation, MG-1206-A, 2012. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1206.html

Perry, Walter L., and John Gordon IV, *Analytic Support to Intelligence in Counterinsurgencies*, Santa Monica, Calif.: RAND Corporation, MG-682-OSD, 2008. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG682.html

Porche, Isaac R., III, James Dryden, Kathryn Connor, Bradley Wilson, Shawn McKay, Kate Giglio, and Juan Montelibano, *Finding Services for an Open Architecture: A Review of Existing Applications and Programs in PEO C4I*, Santa Monica, Calif.: RAND Corporation, MG-1071-NAVY, 2011. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1071.html

Rich, Michael, Edmund Dews, and C. L. Batten, Jr., *Improving the Military Acquisition Process: Lessons from Rand Research*, Santa Monica, Calif.: RAND Corporation, R-3373-AF/RC, 1986. As of October 1, 2021: https://www.rand.org/pubs/reports/R3373.html

Ronald Reagan Presidential Foundation and Institute, "Harnessing and Securing American Innovation: How Venture Capital Impacts National Defense," 2019 Reagan National Defense Forum, Panel 5, Simi Valley, Calif., 2019. As of November 13, 2020: https://www.youtube.com/watch?v=y-w2vCIUr6M

Roper, Will, *There Is No Spoon: The New Digital Acquisition Reality*, Washington, D.C.: Department of the Air Force, October 7, 2020.

Rostker, Bernard, *Right-Sizing the Force: Lessons for the Current Drawdown of American Military Personnel*, Washington, D.C.: Center for a New American Security, June 2013.

Ryseff, James, "How to (Actually) Recruit Talent for the AI Challenge," *War on the Rocks*, February 5, 2020.

Savych, Bogdan, *Toward Incentives for Military Transformation: A Review of Economic Models of Compensation*, Santa Monica, Calif.: RAND Corporation, TR-194-OSD, 2005. As of October 1, 2021: https://www.rand.org/pubs/technical_reports/TR194.html

Sayler, Kelley M., *Hypersonic Weapons: Background and Issues for Congress*, Washington, D.C.: Congressional Revenue Service, R45811, November 6, 2020.

Schank, John F., Cesse Ip, Frank W. Lacroix, Robert E. Murphy, Mark V. Arena, Kristy N. Kamarck, and Gordon T. Lee, *Learning from Experience*, Vol. II: *Lessons from the U.S. Navy's* Ohio*,* Seawolf*, and* Virginia *Submarine Programs*, Santa Monica, Calif.: RAND Corporation, MG-1128/2-NAVY, 2011. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1128z2.html

Schank, John F., Scott Savitz, Ken Munson, Brian Perkinson, James McGee, and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs*, Santa Monica, Calif.: RAND Corporation, RR-696-NAVY, 2016. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR696.html

Schwartz, Moshe, *Defense Acquisition Reform: Background, Analysis, and Issues for Congress*, Washington, D.C.: Congressional Research Service, R43566, May 23, 2014a.

———, *Defense Acquisitions: How DOD Acquires Weapon Systems and Recent Efforts to Reform the Process*, Washington, D.C.: Congressional Research Service Report, RL34026, May 23, 2014b.

Schwartz, Moshe, Kathryn A. Francis, and Charles V. O'Connor, *The Department of Defense Acquisition Workforce: Background, Analysis, and Questions for Congress*, Washington, D.C.: Congressional Research Service, R44578, July 29, 2016.

Seong, Somi, Obaid Younossi, Benjamin W. Goldsmith, Thomas Lang, and Michael Neumann, *Titanium: Industrial Base, Price Trends, and Technology Initiatives*, Santa Monica, Calif.: RAND Corporation, MG-789-AF, 2009. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG789.html

Serena, Chad C., *A Revolution in Military Adaptation: The US Army in the Iraq War*, Washington, D.C.: Georgetown University Press, September 2011.

Silberglitt, Richard, James T. Bartis, Brian G. Chow, David L. An, and Kyle Brady, *Critical Materials: Present Danger to U.S. Manufacturing*, Santa Monica, Calif.: RAND Corporation, RR-133-NIC, 2013. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR133.html

Snyder, Don, James D. Powers, Elizabeth Bodine-Baron, Bernard Fox, Lauren Kendrick, and Michael H. Powell, *Improving the Cybersecurity of U.S. Air Force Military Systems Throughout Their Life Cycles*, Santa Monica, Calif.: RAND Corporation, RR-1007-AF, 2015. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR1007.html

Stecher, Brian M., Frank Camm, Cheryl L. Damberg, Laura S. Hamilton, Kathleen J. Mullen, Christopher Nelson, Paul Sorensen, Martin Wachs, Allison Yoh, Gail L. Zellman, and Kristin J. Leuschner, *Toward a Culture of Consequences: Performance-Based Accountability Systems for Public Services*, Santa Monica, Calif.: RAND Corporation, MG-1019/1, 2010. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG1019z1.html

Steipp, Chadwick M., "Funding Cyberspace: The Case for an Air Force Venture Capital Initiative," *Air and Space Power Journal*, Vol. 27, No. 4, July–August 2013, pp. 119–128.

Tarraf, Danielle C., William Shelton, Edward Parker, Brien Alkire, Diana Gehlhaus, Justin Grana, Alexis Levedahl, Jasmin Léveillé, Jared Mondschein, James Ryseff, Ali Wyne, Dan Elinoff, Edward Geist, Benjamin N. Harris, Eric Hui, Cedric Kenney, Sydne Newberry, Chandler Sachs, Peter Schirmer, Danielle Schlang, Victoria Smith, Abbie Tingstad, Padmaja Vedula, and Kristin Warren, *The Department of Defense Posture for Artificial Intelligence: Assessment and Recommendations*, Santa Monica, Calif.: RAND Corporation, RR-4229-OSD, 2019. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR4229.html

Tate, David M., *Software Productivity Trends and Issues*, Alexandria, Va.: Institute for Defense Analysis, conference paper, March 2017.

Thirtle, Michael R., Robert V. Johnson, and John L. Birkler, *The Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process*, Santa Monica, Calif.: RAND Corporation, MR-899-OSD, 1997. As of October 1, 2021: https://www.rand.org/pubs/monograph_reports/MR899.html

Tingstad, Abbie, *Climate Change and U.S. Security in the Arctic*, Santa Monica, Calif.: RAND Corporation, CT-517, 2019. As of October 1, 2021: https://www.rand.org/pubs/testimonies/CT517.html

U.S. Code, Title 10, Section 2306b, Multiyear Contracts: Acquisition of Property.

U.S. Department of Defense, *DoD Dictionary of Military and Associated Terms*, Joint Publication 1-02, Washington, D.C., April 6, 1999.

———, *Report to Congress: Restructuring the Department of Defense Acquisition, Technology and Logistics Organization and Chief Management Officer Organization*, Washington, D.C., August 2017.

———, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, Washington, D.C., 2018.

———, "Defense Acquisition Workforce: Key Information, OVERALL, as of FY20Q4," briefing slides, September 30, 2020. As of October 1, 2021: https://www.hci.mil/docs/Workforce_Metrics/FY20Q4/FY20(Q4)OVERALLDefenseAcquisitionWorkforce(DAW)InformationSummary.pdf

U.S. Government Accountability Office, *Defense Acquisition Workforce: Actions Needed to Guide Planning Efforts and Improve Workforce Capability*, Washington, D.C., GAO-16-80, December 2015.

U.S. Senate Permanent Subcommittee on Investigations of the Committee on Homeland Security and Governmental Affairs, *Defense Acquisition Reform: Where Do We Go from Here? A Compendium of Views by Leading Experts*, Washington, D.C.: U.S. Government Printing Office, October 2014.

Van Atta, Richard H., R. Royce Kneece, Jr., and Michael J. Lippitz, *Assessment of Accelerated Acquisition of Defense Programs*, Alexandria, Va.: Institute for Defense Analyses, September 2016.

Walt, Stephen M., "Alliances in a Unipolar World," *World Politics*, Vol. 61, No. 1, January 2009, pp. 86–120.

Webb, Tim, Christopher Guo, Jennifer Lamping Lewis, and Daniel Egel, *Venture Capital and Strategic Investment for Developing Government Mission Capabilities*, Santa Monica, Calif.: RAND Corporation, RR-176-OSD, 2014. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR176.html

Werber, Laura, John A. Ausink, Lindsay Daugherty, Brian Phillips, Felix Knutson, and Ryan Haberman, *An Assessment of Gaps in Business Acumen and Knowledge of Industry Within the Defense Acquisition Workforce: A Report Prepared for the U.S. Department of Defense in Compliance with Section 843(c) of the Fiscal Year 2018 National Defense Authorization Act*, Santa Monica, Calif.: RAND Corporation, RR-2825-OSD, 2019. As of November 22, 2021: https://www.rand.org/pubs/research_reports/RR2825.html

Werber, Laura, Lindsay Daugherty, Edward G. Keating, and Matthew Hoover, *An Assessment of the Civilian Acquisition Workforce Personnel Demonstration Project*, Santa Monica, Calif.: RAND Corporation, TR-1286-OSD, 2012. As of October 1, 2021: https://www.rand.org/pubs/technical_reports/TR1286.html

Wong, Jonathan P., *Balancing Immediate and Long-Term Defense Investments*, Santa Monica, Calif.: RAND Corporation, RGSD-378, 2016. As of October 1, 2021: https://www.rand.org/pubs/rgs_dissertations/RGSD378.html

———, "Why You Can't Call In an Air Strike with an iPhone," *War on the Rocks*, July 2, 2020a.

———, "Bad Idea: Overly Focusing on Speed in Development and Acquisition," Center for Strategic and International Studies, December 15, 2020b.

Work, Robert, "The Third U.S. Offset Strategy and Its Implications for Partners and Allies," speech at the Willard InterContinental Hotel, Washington, D.C., January 28, 2015.

Young, Stephanie, and J. Michael Gilmore, *Operating Under a Continuing Resolution: A Limited Assessment of Effects on Defense Procurement Contract Awards*, Santa Monica, Calif.: RAND Corporation, RR-2263-OSD, 2019. As of October 1, 2021: https://www.rand.org/pubs/research_reports/RR2263.html

Younossi, Obaid, Mark V. Arena, Robert S. Leonard, Charles Robert Roll, Jr., Arvind Jain, and Jerry M. Sollinger, *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs*, Santa Monica, Calif.: RAND Corporation, MG-588-AF, 2007. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG588.html

Younossi, Obaid, Kevin Brancato, John C. Graser, Thomas Light, Rena Rudavsky, and Jerry M. Sollinger, *Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options*, Santa Monica, Calif.: RAND Corporation, MG-797-AF, 2010. As of October 1, 2021: https://www.rand.org/pubs/monographs/MG797.html

PROJECT AIR FORCE

Improving the U.S. Department of Defense (DoD) acquisition system—the management and development processes by which the department acquires, develops, and sustains weapon systems, automated information systems, and services—has been an issue of sustained interest to policymakers since the beginning of the military establishment. Numerous actions have been initiated and implemented over decades to rein in the increasing life-cycle costs and to ensure a timely delivery of these systems to meet U.S. security needs. In this report, researchers describe overarching trends that affect the defense acquisition system, outline challenges in DoD's defense acquisition process, and suggest improvements that might help address those challenges. The study is informed by open-source documents and insights from publicly available RAND Corporation research on defense acquisition, especially reports published since 1986, when a similar review of RAND research was published.

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