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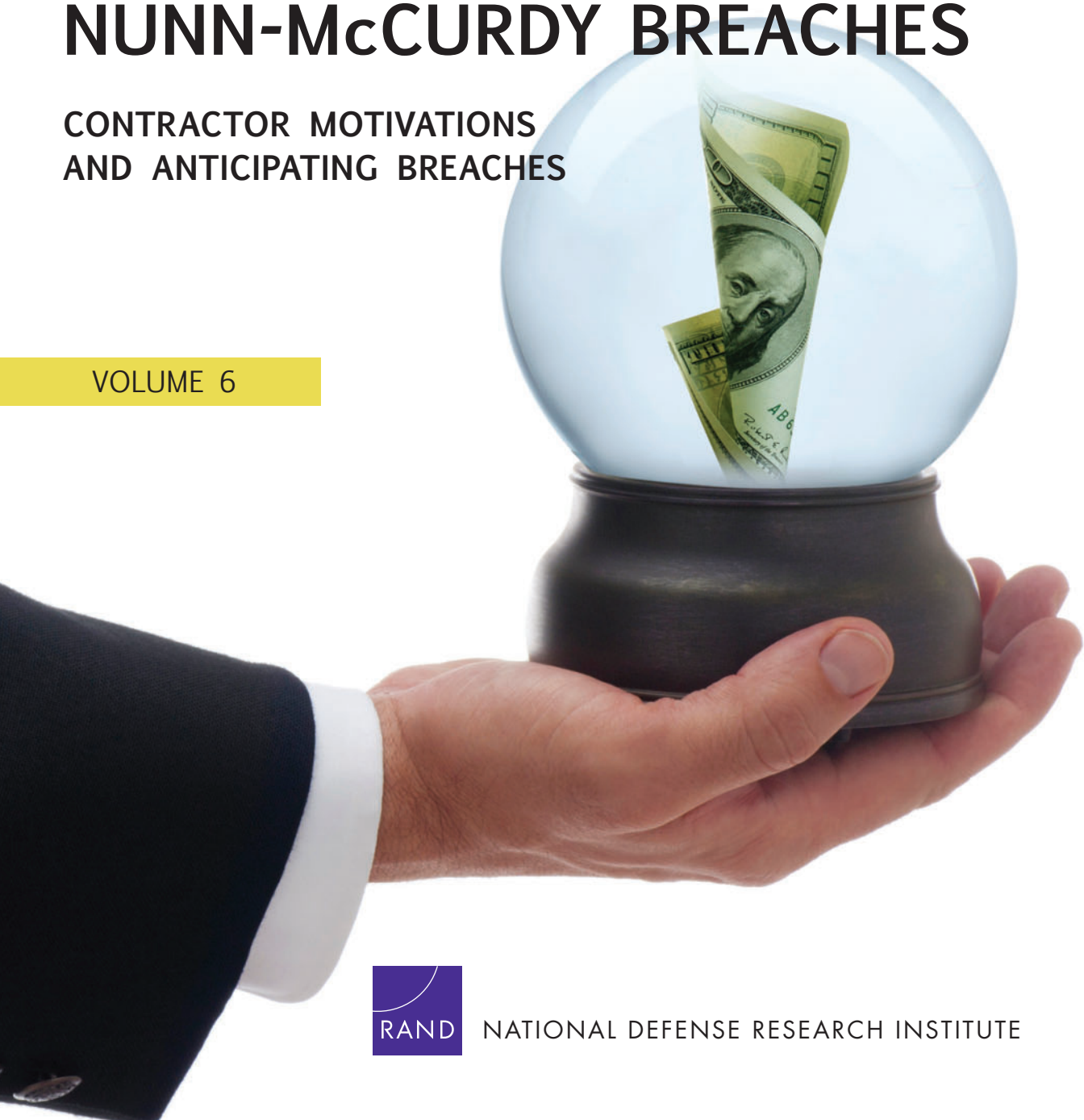
CONTRACTOR MOTIVATIONS AND ANTICIPATING BREACHES

VOLUME 6



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Prepared for the Office of the Secretary of Defense

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Preface

Continuing concern about large cost overruns in a broad range of major defense programs led Congress to pass new laws extending the ambit of the existing Nunn-McCurdy Act, stipulating that the U.S. Department of Defense (DoD) review and report on the factors affecting program costs. In accordance with the revised Nunn-McCurdy Act, the office of Performance Assessments and Root Cause Analysis (PARCA) must provide its root cause explanation as part of a 60-day program review triggered when the applicable military department secretary reports a breach.

In March 2010, in view of staffing limitations, the newly created PARCA within the Office of the Secretary of Defense (OSD) elected to rely on federally funded research and development center support in discharging its new responsibilities. Since then, PARCA engaged the RAND Corporation to conduct multiple studies on the root causes of Nunn-McCurdy breaches or other large cost increases in nine major defense acquisition programs: the Wideband Global Satellite, Longbow Apache, the *Zumwalt*-class destroyer (DDG-1000), the Joint Strike Fighter, Excalibur, the Joint Tactical Radio System Ground Mobile Radio, the Navy Enterprise Resource Planning, Global Hawk, and the P-8A Poseidon.[1] In addition to reports on major defense acquisition programs, RAND, at the request of the sponsor, has researched topics related to the management of defense acquisition. These topics include program manager tenure, oversight of acquisition category II programs, framing assumptions, pro-

[1] 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 Reilly, 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; Irv Blickstein, Jeffrey A. Drezner, Martin C. Libicki, Brian McInnis, Megan McKernan, Charles Nemfakos, Jerry M. Sollinger, and Carolyn Wong, *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*, Santa Monica, Calif.: RAND Corporation, MG-1171/2-OSD, 2012; and Irv Blickstein, Chelsea Kaihoi Duran, Daniel Gonzales, Jennifer Lamping Lewis, Charles Nemfakos, Jesse Riposo, Rena Rudavsky, Jerry M. Sollinger, Daniel Tremblay, and Erin York, *Root Cause Analyses of Nunn-McCurdy Breaches, Volume 3: Joint Tactical Radio System, P-8A Poseidon, and Global Hawk Modifications*, Santa Monica, Calif.: RAND Corporation, MG-1171/3-OSD, 2013. Not available to the general public.

grams with multiple Nunn-McCurdy breaches, and an analysis of the Joint Tactical Radio System Wideband Networking Waveform and Long Term Evolution Waveform developments.[2]

This report considers two topics in an attempt to enable DoD to be more proactive in avoiding Nunn-McCurdy breaches. The first topic explores the incentives in defense contracts, seeking to determine whether better alternatives exist to the ones presently used. The second topic involves analyzing major defense acquisition programs to determine whether it is possible to anticipate which programs might incur a Nunn-McCurdy breach.

This report should interest DoD staff and military personnel who are involved in the acquisition of defense systems.

This research was sponsored by OSD PARCA and conducted within the Acquisition and Technology Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

For more information on the RAND Acquisition and Technology Policy Center, see http://www.rand.org/nsrd/ndri/centers/atp.html or contact the director (contact information is provided on the web page).

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[2] Mark V. Arena, Irv Blickstein, Abby Doll, Jeffrey A. Drezner, James G. Kalimani, Jennifer Kavanagh, Daniel F. McCaffrey, Megan McKernan, Charles Nemfakos, Rena Rudavsky, Jerry M. Sollinger, Daniel Tremblay, and Carolyn Wong, *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*, Santa Monica, Calif.: RAND Corporation, MG-1171/4, 2013.

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Summary

Background and Purpose

In an effort to control the cost of acquiring military systems, Congress has enacted various pieces of legislation, often refining the provisions of the original Nunn-McCurdy Act. A recent iteration, the Weapons Systems Acquisition Reform Act of 2009, created a Performance Assessments and Root Cause Analysis (PARCA) group in the Department of Defense (DoD) to conduct root cause analyses of programs that had breached a Nunn-McCurdy threshold. PARCA is a relatively small organization and lacks the staff to carry out a root cause analysis across the wide range of systems, and it has engaged outside organizations to perform these analyses. The RAND National Defense Research Institute (NDRI) has analyzed the root causes of Nunn-McCurdy breaches in nine major defense acquisition programs. PARCA has also asked RAND NDRI to research various other topics related to the acquisition process.

This report contains the results of research into two such topics. One analyzes the motivations of defense contractors and identifies mechanisms that might more closely align the incentives that drive contractors with the goals of DoD. The concept undergirding this research is that ensuring closer correspondence between contractor incentives and DoD goals will likely yield a more cost-effective contracting process. Discussion of this topic reflects the views of the members of a Concept of Operations Group (COG) consisting of knowledgeable current or former senior DoD executives. It does not reflect the result of independent technical analysis by RAND, nor does the publication of this report imply endorsement of the views expressed on this topic.

The second topic explores the possibility of anticipating a Nunn-McCurdy breach in a defense acquisition program. It reviews a number of acquisition programs that have incurred a Nunn-McCurdy breach and analyzes them for common characteristics. The goal is to determine whether it is possible to isolate a set of characteristics that would warn policymakers that a given program might be more likely than other programs to breach a Nunn-McCurdy threshold. An early warning might allow policymakers to give additional management oversight to the program and potentially avoid a breach.

This summary presents the highlights of the two research projects.

Contractor Incentives

Contractor incentives are a key mechanism that government has to align its objectives with the motivations of industry. This analysis is informed by a combination of a literature search and discussions with government and industry experts on contracting. To conduct our discussions with experts systematically, we employed a research technique developed at RAND known as a COG. COGs are small groups of planners, technologists, and experienced military operators who work together to identify options, strategies, and ideas. COGs, whose membership is composed of creative thinkers, have no preconceived solutions and no idea is too outrageous to entertain during the discussions. The ideas presented are vetted over multiple meetings to arrive at evolved ideas that are feasible. For this particular COG exercise, we focused on trying to understand industry motivation on government contracts to better inform government program teams and to help identify areas where incentives could be better applied. The COG participants all have government and industry experience, so they are able to provide a balanced view of the issues. The COG formed for this project included experts from several fields, including the following:

- retired Army, Air Force, and Navy flag officers and those with Senior Executive Service experience overseeing program acquisition and contracting strategies in both the public and private sectors
- experienced civilian DoD acquisition executives
- senior analysts and planners from academic institutions.

The COG met several times, sometimes in multiday sessions.

What Drives Corporations?

COG participants concluded that to achieve optimal schedule, cost, and performance from contractors, DoD's contractor incentive "tools" must align as much as possible with what actually motivates contractors. These motivations largely center on the financial aspects of running enterprises.

- **Maintain Preeminence and Preservation Within Respective Sectors:** A powerful motivation for industry is a desire to establish dominance or presence in a sector or segment as a way to stabilize and maintain a business line.
- **Cash/Credit Rating:** These two financial motivations are linked. Cash flow is important to a firm, as it allows timely payment of bills, minimizing short-term borrowing costs to finance activities. A steadier, more predictable cash flow means a better credit rating (and lower costs to borrow).
- **Owner Value:** Senior executives at companies often have corporate mandates to increase owner values (e.g., increasing stock price and paying dividends). More-

over, they can have personal incentives in terms of stock price level, so that increasing share price personally benefits them.

- **Manage Financial Risk:** A key corporate requirement for success is to manage and mitigate risk. In so doing, a firm reduces its exposure to loss (and erosion of profit).
- **Returns:** The main goal of any business is to make a profit.
- **Profitable Growth:** Beyond profit, firms seek to grow their businesses as a way to achieve economies of scale and move into new business areas.
- **Program Stability:** Contractors wish to reduce program uncertainty in quantities, cash flow, requirements, supplier base health, and other factors whose alteration may affect future profitability.

COG members noted that in addition to the corporate motivations listed above, individuals also have personal motivations that affect the contracting process. For example, the prospect of rewards from winning a particularly attractive contract might drive an individual to bid more aggressively on a contract than he or she would on a less-significant contract. Individual motivations tend to be more varied than those of the corporation, but they can have a strong influence on contract negotiations.

Turning to the other side of the negotiating table, the COG identified the areas of influence or levers that the government has to influence the contracting process. These include the following:

- **Competition:** The defense market is far from being an ideal situation for competition because in the United States there is one buyer and very few sellers, and competition works best when there are many buyers and sellers of identical (or nearly so) products, the so-called "ideal" market. Nonetheless, competition is sometimes one of the most important mechanisms in achieving value for DoD.
- **Contract Length:** Longer contracts are more desirable to industry because such contracts provide a more assured cash flow and opportunities to invest for efficiencies.
- **Foreign Military Sales:** Foreign sales (either FMS or direct buys) are potentially lucrative to industry because they increase quantities sold and get higher margins than do sales to the U.S. government alone.
- **Risk Sharing:** Who carries the risk and how it can be mitigated are central issues in early program planning. Incentive contracts seek to balance the financial risk-reward of contracts between industry and government. Depending on the share line (the formula for distributing contract cost overruns and underruns between government and industry), industry has the opportunity to benefit from any realized savings but is also penalized for overrunning.
- **Profit:** The government can use a variable fee on a defense contract to motivate certain outcomes, such as unit cost or schedule.

- **Timely Cash Flow:** One particular advantage of defense contracts is that they typically generate greater, free cash flows than other sectors.
- **Production Rate:** The government has some flexibility (budgets allowing) in how quickly it procures an item. Higher production rates for a given quantity result in increased cash flow and earlier profits for a company than lower ones.
- **Provisions to Protect Intellectual Property:** Intellectual property—through unique or proprietary technology or processes—can give a competitive advantage to a firm (i.e., it can offer goods and services at a lower price or it can offer a unique capability that no other firm can). Retaining rights can dampen industry enthusiasm for a project, and ceding them to industry can limit DoD's ability to support systems that rely on intellectual property.
- **Oversight:** Most companies that do business with DoD see the oversight as too burdensome, and subcontractors even more so.

COG members noted that DoD processes were another factor in the contracting equation. This was especially true of a perceived government trend toward increased auditing, which has a tendency to turn government-industry relationships into adversarial ones. This tends to inhibit cooperation, which is normally what characterizes relationships among firms in the commercial world. Also, the DoD culture tends to operate counter to that of industry in that DoD personnel are driven by the need to please their supervisors and industry personnel focus on program success.

Matching Incentives with Government Levers

Having identified both industry incentives and government levers, the COG then arrayed them against each other in different scenarios. An example appears in Figure S.1, which shows how the two align in the acquisition of large, complex systems. The COG used nine of the government levers and eight of the industry motivators discussed above to identify 34 combinations, which we also call mechanisms, that could motivate defense contractors involved in providing these complex systems. Of these 34 mechanisms, nearly half were connected with two government levers: contract length and foreign military sales. The COG judged that the longer the contract offered to a contractor, the greater the contractor's motivation to produce complex systems that are on time and within cost and achieve performance goals. On the other end of the spectrum, the two industry motivators over which the government has the least influence—helping a company to maintain preeminence in an industry or to bolster its reputation—are among the most important to the contractors, in the COG's judgment. This raises a key point: The government's influence over some industry motivators is quite limited.

The points where government can influence contract negotiations will differ by area. For example, a contract involving information technologies will have different incentives than one for a large, complex system or a service contract.

Figure S.1
Industry Motivators Most Influenced by Government Contract Mechanisms on Large, Complex System Acquisition Programs

		Industry motivators							
		Maintain Preeminence	Cash/ Credit Rating	Owner Value	Manage Financial Risk	Returns	Profitable Growth	Program Stability	Reputation/ Customer Satisfaction
Government contract mechanisms and policies	Competition	✓			✓		✓	✓	✓
	Contract length		✓	✓	✓	✓	✓	✓	✓
	Foreign military sales	✓		✓	✓	✓	✓	✓	✓
	Risk sharing		✓	✓	✓	✓		✓	
	Profit		✓	✓		✓			
	Timely cash flow		✓			✓			
	Production rate						✓	✓	
	Provisions to protect IP	✓			✓		✓		
	Oversight								

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Recommendations

The history of examining contract type effectiveness and also many alternative treatments of contract mechanisms is long. For major systems acquisition, the phase of the program factors into appropriate contract type. Moreover, the nature of the goods or services being acquired influences the incentives for both parties and therefore has implications for contracts. Overall, the singular, obvious conclusion is that contracts' form, type, and incentives must be tailored to each situation. A "one-size-fits-all" approach to defense contracting will not work.

The COG discussions also echoed this perspective—tailoring is critically important to effective incentives. Beyond that, the COG members made the following general observations on improving contractor incentives for DoD:

- **Do Your Homework:** An important aspect to contractor incentives is understanding the motivations of the people and firms with which the government negotiates. Understanding these motivations can help both the government and industry come to more beneficial terms. To arrive at more effective incentives, the government must determine the incentive levers, before negotiations begin. These

levers are varied and depend on circumstances. Such an explicit assessment might be part of the documentation for contract award reviews.

- **Expand the Incentive Mechanisms:** The government has limited levers with which to motivate certain contractor incentives. Two of these levers seem to be infrequently used and need more consideration: foreign sales and payment terms. Making an early determination of whether a system or service would be open to foreign sales could be used as leverage in negotiating other contract terms. Cash flow is critical to certain firms, so using cash flow as an incentive could be an effective motivation technique. The government has considered beginning pilot efforts under the Superior Supplier Incentive program. This program, in part, aims to allow contracting officers to set more favorable progress payments and withhold progress payments to firms that qualify. Regrettably, the government has not yet implemented this program.
- **People Matter:** One feature of contracts and negotiations that COG members felt was important is the fact that deals are made between people. Much of the contract guidance is about form and structure, but little deals with negotiation and strategy. The group recommended that this personal dimension to contracting be addressed in acquisition training.
- **Review the Cost Benefit of Oversight and Auditing:** Several COG members noted that the level of oversight and auditing on defense contracts seemed excessive in some cases and drawn out in others. They questioned whether such oversight resulted in any savings to the government. Although these audits did find some problems, these were few and did not balance the level of effort spent by both the government and contractor. The recommendations of the group is twofold: First, take a critical look at the current oversight process and assess whether it is generating value to the government; second, with regard to expeditionary contracts, examine whether personnel levels and processes support surge operations.
- **Systematically Review the Effectiveness of Incentives on Programs:** One area noted by the COG is that there does not appear to be any systematic review of the effectiveness of various contractor incentives on program outcomes. Although the Government Accountability Office and others have reviewed the cost (and sometimes schedule) performance for various contract types, DoD could do more to retrospectively review how various incentives influence other areas, such as responsiveness and quality.

Anticipating Nunn-McCurdy Breaches

Framework and Results

One specific objective of this research was to develop an analytical framework that enables oversight officials to identify programs with a greater likelihood of incurring critical unit cost breaches. Using information readily available, the framework facilitates generation of a relatively short list of major defense acquisition programs (MDAPs), based on factors inherent in program execution as well as possible external factors that warrant more thorough monitoring. This process potentially allows DoD to prepare for, and perhaps even avert or at least mitigate, a critical unit cost breach.

The general approach of the project was to develop a methodology that identifies programs likely to breach and then applies it to determine whether the methodology successfully identified programs that breached. The methodology involved the following three steps:

Step 1 begins with the official MDAP list. Each program is then independently assessed against a set of criteria, e.g., the program had a recent Nunn-McCurdy breach, one unit cost metric exceeds 5 percent, and more than half of the funds remain to be spent.

Step 2 involves two distinct analytic tasks. One task analyzes the historical record of breaches for the programs of potential interest identified in Step 1, paying particular attention to recent breaches. The second—acceleration curve analysis—uses historical cost and quantity data to identify patterns and significant discrepancies that may indicate current or future cost growth.

Step 3 is the root cause analysis (RCA). It is the most analytically intensive step and requires some knowledge of the history of each program on the "Programs at Risk" list from Step 2. This step is very much like a "mini RCA" in the sense that program-related materials are searched for indications that one or more factors known to be associated with cost increases are present.

The initial model demonstration predicted only five of the nine programs in breach in 2010, but it did allow proof of concept and provided lessons for refining the model, which has been done. It is also important to recognize that we are not trying to predict which programs will breach but rather identify a set of programs at a relatively higher risk of a near-term breach. The research identified 39 programs to be put on a watch list of programs with a higher risk of breach.

Conclusions

This exploratory analysis demonstrates that readily available information can be used to identify a set of programs that appear to be at a relatively higher risk of a future breach. Although we cannot yet accurately predict which programs will incur a Nunn-McCurdy breach in the near term, we can sort through the complete MDAP list and identify programs that are at higher risk than other programs using criteria derived

from readily available information. Application of the framework results in a shorter and more manageable list of programs to monitor and also provides hypotheses about what exactly to look for in each program.

Acknowledgments

We gratefully acknowledge the contribution of the members of the Concept of Operations Group, whose experience and willingness to devote substantial time to this effort were indispensable to the this research. The group consisted of Millard Firebaugh, Michael Hammes, Paul Kern, George Muellner, and Eleanor Spector. The COG members spent several days discussing and debating the issues. Their insights were highly valuable, and many of their thoughts and ideas are reflected in this document. This research would be far less rich without their contributions. Any inaccuracies or omissions are the responsibility the authors and not the COG members. We also thank our two reviewers—Frank Camm and Robert E. Murphy—for their thoughtful and insightful comments. Their efforts made this a better report.

Abbreviations

AARGM	advanced anti-radiation guided missile
ACWA	Assembled Chemical Weapons Alternative
ADM	Acquisition Decision Memorandum
AEHF	Advanced Extremely High Frequency
AHE	Advanced Hawkeye
AIP	Acquisition Improvement Program
AMF	airborne and maritime/fixed
AMP	Avionics Modernization Program
AMRAAM	Advanced Medium-Range Air-to-Air Missile
APUC	average procurement unit cost
AS	Acquisition Strategy
AT&L	Acquisition, Technology, and Logistics
ATIRCM	Advanced Threat Infrared Countermeasure
BAMS	broad area maritime surveillance
BBP	Better Buying Power
B/L	baseline
BMDS	Ballistic Missile Defense System
BY	base year
CAGR	compound annual growth rate
CBO	Congressional Budget Office

CE	current estimate
CEC	cooperative engagement capability
CIC	cost improvement curve
CGF	cost growth factor
CMA	Chemical Materials Agency
CMWS	Common Missile Warning System
COG	Concept of Operations Group
CPAF	cost-plus-award-fee
CPFF	cost-plus-fixed-fee
CPIF	cost-plus-incentive-fee
CRS	Congressional Research Service
CSIS	Center for Strategic and International Studies
DAES	Defense Acquisition Executive Summary
DAG	*Defense Acquisition Guidebook*
DAMIR	Defense Acquisition Management Information Retrieval
DAU	Defense Acquisition University
DCAA	Defense Contract Audit Agency
DCMA	Defense Contract Management Agency
DEPSECDEF	Deputy Secretary of Defense
DFAR	Defense Federal Acquisition Regulation
DFARS	Defense Federal Acquisition Regulation Supplement
DoD	Department of Defense
DSB	Defense Science Board
EBIT	earnings before interest and taxes
EFV	Expeditionary Fighting Vehicle
EHF	extremely high frequency

EMD	engineering, manufacturing, and development
EOQ	economic order quantity
ESSM	Evolved Sea Sparrow Missile
FAR	Federal Acquisition Regulation
FFP	firm fixed price
FMS	foreign military sales
FMTV	family of medium tactical vehicles
FP	fixed price
FPI	fixed-price incentive
FPIF	fixed-price incentive, firm target
FY	fiscal year
FYDP	Five-Year Defense Plan
GAO	Government Accountability Office
GMLRS	Guided Multiple Launch Rocket System
GMR	Ground Mobile Radio
GPS	Global Positioning System
HIMARS	High Mobility Artillery Rocket System
HMS	handheld manpack and small force
IAMD	Integrated Air and Missile Defense
ICH	Improved Cargo Helicopter
IDA	Institute for Defense Analyses
IDECM	Integrated Defensive Electronic Countermeasure
IDIQ	indefinite delivery/indefinite quantity
IOC	initial operational capability
IP	intellectual property
IT	information technology

JASSM	Joint Air-to-Surface Standoff Missile
JCA	Joint Cargo Aircraft
JDAM	Joint Direct Attack Munition
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System
JROC	Joint Requirements Oversight Council
JSF	Joint Strike Fighter
JSOW	Joint Standoff Weapon
JTRS	Joint Tactical Radio System
KPP	key performance parameter
LCS	littoral combat ship
LRIP	low rate initial production
MAIS	Major Automated Information System
MDA	Missile Defense Agency
MDAP	major defense acquisition program
MRAP	Mine Resistant Ambush Protected
MRL	manufacturing readiness level
MYP	multiyear procurement
NAS	National Airspace System
NAVSTAR	Navigation Satellite Timing and Ranging
NDAA	National Defense Authorization Act
NDRI	National Defense Research Institute
NED	Network Enterprise Domain
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense

PARCA	Performance Assessments and Root Cause Analysis
PAUC	program acquisition unit cost
PD	production and development
PDRR	Prototype Development Risk Reduction
PM	program manager
PUC	program unit code
R&D	research and development
RCA	root cause analysis
RDT&E	research, development, test, and evaluation
RMP	Radar Modernization Program
RMS	remote mine hunting system
ROIC	return on investment capital
SAE	Service Acquisition Executive
SAR	Selected Acquisition Report
SBIRS	Space-Based Infrared System
SBSS	Space-Based Space Surveillance
SECDEF	Secretary of Defense
SM-3	Standard Missile 3
SYP	single-year procurement
T&M	test and measurement
TOW	tube-launched, optically tracked, wire guided
TPP	Total Package Procurement
TRIM	Truth Revealing Incentive Mechanism
TRL	technology readiness level
TSPR	Total Systems Performance Responsibility
TWS	thermal weapon sight

UAS	unmanned aircraft system
U.S.C.	U.S. Code
VTUAV	VTOL Tactical Unmanned Aerial Vehicle
WGS	Wideband Global SATCOM
WSARA	Weapon Systems Acquisition Reform Act

CHAPTER ONE

Introduction

Background and Purpose

Congress has long been interested in reducing the cost of acquiring materiel for the Department of Defense (DoD). To that end, it directed establishment of the office of Performance Assessments and Root Cause Analysis (PARCA), with the primary purpose of providing explanations for Nunn-McCurdy breaches as part of a 60-day program review triggered when the applicable military department secretary reports a breach. The RAND National Defense Research Institute (NDRI) has been assisting PARCA with preparing these explanations. However, the director of PARCA has also asked NDRI to research various other topics related to defense acquisition.

This report, one of a series studying the management issues associated with defense acquisition programs, considers two topics. One probes the motivations of defense contractors in an effort to achieve better alignment between DoD officials and those who work for the companies that contract with DoD to provide it with goods and services. Such alignment will result in more efficient acquisition, which, in turn, will lower the cost of goods and services purchased by DoD.

The second explores the issue of determining the feasibility of anticipating programs that could incur a Nunn-McCurdy breach. The purpose is to determine whether programs that breach the Nunn-McCurdy ceilings display common characteristics that could signal program managers to take action to forestall a breach

How This Report Is Organized

The next chapter provides an overview of these issues with respect to contract incentives and draws out new areas for DoD to explore in terms of incentives. The focus is incentives on major defense acquisition programs (MDAPs), although the chapter also briefly discusses service contracts and Major Automated Information Systems (MAIS). Chapter Three describes the analytical framework and methodology that RAND developed to anticipate MDAP Nunn-McCurdy breaches.

The report has several appendixes. Appendix A lists the members of the Concept of Operations Group (COG). Appendix B provides an example of the Truth Revealing Incentive Mechanism (TRIM). Appendix C discusses executive compensation, and Appendix D examines the possible benefits of multiyear procurement (MYP) contracts as applied to systems in which contract length is less commonly used as an incentive. The final appendix presents a brief history of the evolution of Nunn-McCurdy legislation.

CHAPTER TWO

Contractor Incentives

Introduction

Contract incentives are a key mechanism that government uses to align its objectives with the motivations of industry. Over the decades of weapon systems procurement, there have been many different views on the efficacy and appropriateness of certain contract forms and incentives. In this chapter, we provide an overview of these issues as they relate to contract incentives and draw out new areas for DoD to explore in terms of incentives. Our focus is incentives on major acquisition programs (although we briefly discuss service contracts and MAIS in the next chapter).

This analysis is informed by a combination of a literature search[1] and discussions with government and industry experts on contracting. To conduct our discussions with experts systematically, we employed a research technique developed at RAND known as a COG. COGs are small groups of planners, technologists, and experienced military operators who work together to identify options, strategies, and ideas. COGs, whose membership is composed of creative thinkers, have no preconceived solutions and no idea is too outrageous to entertain during the discussions. The ideas presented are vetted over multiple meetings to arrive at evolved ideas that are feasible. For this particular COG exercise, we focused on an understanding of industry motivation on government contracts to better inform government program teams and to help identify areas where incentives could be better applied. The COG participants all have government and industry experience, so they are able to provide a balanced view of the issues.

[1] For the literature review, we examined official guidance on contracting incentives and mechanisms from the Office of the Secretary of Defense (OSD), the Services, and the Office of Management and Budget. We also examined the Federal Acquisition Regulation (FAR)/Defense Federal Acquisition Regulation (DFAR). In addition, we reviewed official acquisition program documentation and decisions. We examined congressional testimony and Congressional Research Service (CRS) reports along with Defense Acquisition University (DAU) tutorials, training, and magazines. Other DoD documentation we reviewed included briefings from conferences. We examined some additional research from the following institutions: the Air Force Institute of Technology, the U.S. Government Accountability Office (GAO), the Naval Postgraduate School, the Institute for Defense Analyses (IDA), and RAND. Finally, we explored the economic literature for models that might be relevant to this analysis.

RAND developed and used COGs to good effect in past research projects, in which they were instrumental in helping policymakers explore and identify new and emerging acquisition approaches, organization structures, mission needs, technologies, and operational concepts.[2] COGs engage in iterative and sequential structured discussions that produce insights that the RAND analytical team can assemble, collate, and merge into independent assessments of potential policy options.

In this effort, RAND organized a COG consisting of a broad cross-section of members from inside and outside RAND. The group, whose membership is detailed in Appendix A, included the following:

- retired Army, Air Force, and Navy flag officers and those with Senior Executive Service experience in overseeing program acquisition and contracting strategies in both the public and private sectors
- experienced civilian DoD acquisition executives
- senior analysts and planners from RAND and academic institutions.

The COG convened for several sessions, each lasting two days during February and April 2013. The group circulated notes and ideas after each session to fuel discussions in subsequent meetings.

The goal of the COG sessions and the overall project has been to provide a preliminary look at incentives and disincentives created by government acquisition policies and practices. It is meant to inform ongoing discussions on how to better align incentives and achieve better program outcomes. From DoD's point of view, it is revisiting contract incentives and length issues as part of a broader effort to achieve the outcomes listed below:

- improved program execution through enhanced program office capabilities and performance assessments
- realistic baseline cost and schedule estimates and the identification and validation of the estimates' framing assumptions
- maintenance of the industrial base's critical skills
- enhanced acquisition workforce performance and skills through the Human Capital Initiative, a program to improve the skills of the workforce

[2] See John Birkler, C. Richard Neu, and Glenn Kent, *Gaining New Military Capability: An Experiment in Concept Development*, Santa Monica, Calif.: RAND Corporation, MR-912-OSD, 1998; and John Gordon IV, Peter A. Wilson, John Birkler, Steven Boraz, and Gordon T. Lee, *Leveraging America's Aircraft Capabilities: Exploring New Combat and Noncombat Roles and Missions for the U.S. Carrier Fleet*, Santa Monica, Calif.: RAND Corporation, MG-448-NAVY, 2006.

- improvement of the systems engineering practice
- better affordability across acquisition products and services.

The next section provides background for this research—including an overview of policy and guidance documents and prior research into the effectiveness of contract forms (and incentives), explores the motivations of industry and their alignment (or lack thereof) with government, and reviews examples of other contract forms used in the commercial world and their potential to be used on DoD programs. The third section of the chapter reviews the results and discussions from a series of COG meetings held by RAND with industry and government experts familiar with defense contracting. The next section identifies those actions that, in the judgment of the COG members, will have the strongest stimulant effect on industry. We do so by marrying the government levers with the industry motivators that we discuss in the preceding section, using matrix tables to display the results of the COG's consensus evaluations. This section also discusses the advantages and disadvantages of these alternatives as well as appropriate circumstances for their implementation. Finally, the chapter concludes with a summary of our observations.

Background

This section provides background information relative to contract incentives on defense programs. It provides

- highlights from regulation, guidance, and policy documents related to contract types and incentives
- selected prior research into the effectiveness of contract incentives and an examination of contract incentive issues discussed in acquisition decisions
- an exploration of the incentives for industry as discussed in other research and financial documents.

The use of competition in defense acquisition is widely advocated in policy statements and widely reflected in requirements issued by Congress, the Office of Management and Budget, DoD, and the military Services.[3] This emphasis stems from the conviction that competition will drive down the unit cost of a product or service and reduce overall cost to the government. Other arguments for having more than one sup-

[3] For example, see Ashton Carter, *Directive-Type Memorandum (DTM) 09-027—Implementation of the Weapon Systems Acquisition Reform Act of 2009*, Washington, D.C.: Department of Defense, Acquisition, Technology and Logistics, December 4, 2009; Shay Assad, *Memorandum: Improving Competition in Defense Procurements*, November 24, 2010; and Shay Assad *Memorandum: Improving Competition in Defense Procurements—Amplifying Guidance*, April 27, 2011.

plier exist (e.g., providing a surge capability should the Services need to expand production quickly), but the crux of the competition issue is procurement cost (or, more accurately, price).

The complexity and uniqueness of major defense acquisition make it difficult for DoD to follow traditional competitive approaches. In the typical commercial marketplace, a buyer examines the available products, requests competitive bids for production from a number of contractors, selects a bid based on a fixed price, and signs a one-step contract for delivery on a specified date. Such a market depends on having complete information about a customer's needs; a standardized, off-the-shelf product; a predictable budget; certainty about the number of items to be purchased; and little reason for concern about the future viability of the losing firm. Major defense acquisitions lack these characteristics. The track record of the effectiveness of competition has been unclear.[4] Nonetheless, the defense acquisition system has sought ways to preserve or implement competitive-like mechanisms in defense acquisition.[5]

In addition, in some cases (especially in the procurement of major systems where the nonrecurring cost is large), it may be less costly for the government to forgo competition and to rely on a single supplier.[6]

This section presents highlights from prior research and is not meant to be an all-encompassing review.

Regulations, Policy, and Guidance

Regulations

Any discussion of contract types (and their related incentives) must begin with the FAR and the Defense Federal Acquisition Regulation Supplement (DFARS). Defense acquisition contracts generally fall into one of two types: fixed-price or cost-

[4] For example, see, J. L. Birkler, John C. Graser, Mark V. Arena, Cynthia R. Cook, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, F. S. Timson, Obaid Younossi, and Jonathan Gary Grossman, *Assessing Competitive Strategies for the Joint Strike Fighter: Opportunities and Options*, Santa Monica, Calif.: RAND Corporation, MR-1362-OSD/JSF, 2011.

[5] For example, see, J. L. Birkler, Mark V. Arena, Irv Blickstein, Jeffrey A. Drezner, Susan M. Gates, Meilinda Huang, Robert Murphy, Charles Panagiotis Nemfakos, and Susan K. Woodward, *From Marginal Adjustments to Meaningful Change: Rethinking Weapon System Acquisition*, Santa Monica, Calif.: RAND Corporation, MG-1020-OSD, 2010; and William P. Rogerson, *Profit Regulation of Defense Contractors and Prizes for Innovation*, Santa Monica, Calif.: RAND Corporation, R-3635-PAE, 1992.

[6] For example, see Mark V. Arena and J. L. Birkler, *Determining When Competition Is a Reasonable Strategy for the Production Phase of Defense Acquisition*, Santa Monica, Calif.: RAND Corporation, OP 263-OSD, 2010.

reimbursement.[7] The FAR and DFARS provide specific guidance for these contracting types that Martin (2011)[8] summarizes as follows:

> Fixed-Price (FAR Subpart 16.2)—Under a fixed-price contract, the contractor agrees to deliver the product or service required at a price not in excess of the agreed-to maximum. Fixed-price contracts should be used when the contract risk is relatively low, or defined within acceptable limits, and the contractor and the Government can reasonably agree on a maximum price. [underlining in original]
>
> Cost-Reimbursement (FAR Subpart 16.3)—Under a cost-reimbursement contract, the contractor agrees to provide its best effort to complete the required contract effort. Cost-reimbursement contracts provide for payment of allowable incurred costs, to the extent prescribed in the contract. These contracts include an estimate of total cost for the purpose of obligating funds and establishing a ceiling that the contractor cannot exceed (except at its own risk) without the approval of the contracting officer. [underlining in original]

The important difference between these two types has to do with the amount of risk each party assumes and the obligation of the contractor to provide a good or service. This issue of risk transfer is central to any discussion of contract incentives or contract form for defense acquisitions.

Historical Trends in Contract Policy

Over the decades of weapon system procurement, the forms of contracting and incentives that are in vogue (and believed to be most effective in aligning industry's goals with government's objectives) have gone through many cycles. In the discussion below, we review highlights in the trends in contracting since the 1950s by decade, drawing heavily from Fox's (2011) excellent prior analysis and from some other supplemental documents.[9]

In the 1950s, heavy reliance was placed on sole-source procurement, and more than 40 percent of contracts were cost-plus-fixed-fee. Both development and production were carried out under cost-reimbursement contracts.

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[7] Edward C. Martin, "Incentive Contracting," PowerPoint file, SAF/AQC Field Support Team, April 25, 2011, p. 7.

[8] Martin, 2011, p. 7.

[9] J. Ronald Fox, *Defense Acquisition Reform, 1960–2009: An Elusive Goal*, Washington, D.C.: Center for Military History, U.S. Army, 2011; GAO, *Small Business: Trends in Federal Procurement in the 1990s*, GAO-01-119, Washington, D.C., January 2001; William Lucyshyn, *Fixed-Price Development Contracts: A Historical Perspective*, College Park, Md.: University of Maryland, Center for Public Policy and Private Enterprise, May 16, 2012; James Gill, "Incentive Arrangements for Space Acquisitions," *6th Annual Acquisition Research Symposium of the Naval Postgraduate School: Vol. II: Defense Acquisition in Transition*, Monterey, Calif.: Naval Postgraduate School, No. NPS-AM-09-029, April 2009.

In the 1960s, OSD discouraged the use of cost-plus-fixed-fee contracts in favor of fixed-price and incentive contracts because of cost overruns in the 1950s. Secretary of Defense Robert McNamara's acquisition improvement tool, Total Package Procurement (TPP), required that firms contract, on a fixed-price basis, for both the acquisition program development and production stages at the same time, to prevent a winning contractor (for the development program) from increasing its prices when there was no competition on the subsequent production stage. TPP was unsuccessful because optimism in the early competition, combined with the inclusion of no pricing contingencies for unpredicted developmental difficulties, caused companies who had won the TPP contracts to lose substantial amounts of money, thus jeopardizing contract performance. TPP was discontinued in 1966.

In the following decade, Deputy Secretary of Defense (DEPSECDEF) David Packard expected the services to tailor system contracts to the risks involved. He favored cost-reimbursement contracts for the development stages of major systems, with subcontracts that maximized competition for vital system components. DoD had recognized the need to tailor contract types to the perceived risk of a specific acquisition program, relying on cost-plus-incentive contracts for the development of major systems. DoD Directive 5000.1 directed that cost-type contracts be used on high-risk development programs, whereas the military departments could use fixed-price agreements once development had solved major problems. The 1972 congressionally mandated Procurement Commission recommended the use of cost-reimbursable contracts for research and development (R&D) projects.[10] The subsequent use of cost-reimbursable contracts did not eliminate cost growth on complex weapon system development programs, but it did assure that the government customer would underwrite the cost risk of development of the state-of-the-art systems it required.

In reaction to cost growth on large weapon development programs, in 1981 President Ronald Reagan's defense secretary, Caspar W. Weinberger, and DEPSECDEF, Frank C. Carlucci, created the Acquisition Improvement Program (AIP) to reform the acquisition process. The result was a repeated call for more fixed-price contracts. AIP sought to energize the defense industrial base by using more flexible contracting procedures and second-sourcing production of major weapon systems to enhance competition to reduce costs.

From 1990 through 2005, there was a rise in the use of award-fee, fixed-price development contracts and of Total Systems Performance Responsibility (TSPR), which placed system development responsibility on contractors.

To make manageable source selections among the dozens of companies that would compete for smaller information technology (IT) and service contracts, the Federal Acquisition Streamlining Act of 1994 codified the authority of agencies to enter

[10] Congress appointed the Congressional Commission on Government Procurement or "Procurement Commission" in 1972. The commission was asked to identify the causes and solutions for weapon cost overruns.

into task- or delivery-order contracts with a prequalified reduced number of firms for the same or similar products, known as multiple award contracts. The IT acquisition reforms of the Clinger-Cohen Act of 1996 provided for the use of multiagency contracts and what have become known as government-wide agency contracts for federal agencies to access each other's IT contracts.

A GAO report in 2005 precipitated a major shift in acquisition contract incentive policy.[11] Up to that point, award-fee contracts types had been prevalent for complex development contracts. The GAO report concluded, "the power of monetary incentives to motivate excellent contractor performance and improve acquisition outcomes is diluted by the way DOD structures and implements incentives."[12] Looking at 93 incentive- or award-fee contracts active between 1999 and 2003, GAO found that the median percentage of available award fee was 90 percent, often regardless of cost and schedule outcomes. In fact, the GAO asserted that

> Rather than focusing on acquisition outcomes, such as delivering a fielded capability within established cost and schedule baselines, DOD often places emphasis on such things as the responsiveness of contractor management to feedback from DOD officials, quality of contractor proposals, or timeliness of contract data requirements.[13]

Instead of explaining to GAO that lengthy, complex development programs never meet all specifications, schedules, and cost baselines because of the unpredictable nature of new weapon system technology, and that award fees enable the department to redirect development when the achievement of an initial goal proves too costly, DoD largely agreed with GAO's overall observations and recommendations and subsequently issued policy and guidance that severely limited the use of award fee contracts.[14] DoD's first guidance was a March 2006 memorandum requiring that "award fees be tied to identifiable interim outcomes, discrete events or milestones, as much as possible,"[15] notwithstanding that the FAR says that award fee contracts are to be used "when the work to be performed is such that it is neither feasible nor effective to devise predetermined objective incentive targets applicable to cost, schedule, and technical performance" (FAR 16.401 (e)(1)(i). The memorandum provided direction on contrac-

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[11] U.S. Government Accountability Office, *Defense Acquisitions: DOD Has Paid Billions in Award and Incentive Fees Regardless of Acquisition Outcomes*, Report to the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate, GAO-06-66, Washington, D.C., December 2005.

[12] GAO, 2005, p. 1.

[13] GAO, 2005, p. 4.

[14] GAO, 2005.

[15] OUSD (AT&L), "Award Fee Contracts (FAR 16, DFARS 215, DFARS 216)," Memorandum for Secretaries of the Military Departments (Attn: Acquisition Executives), Directors of the Defense Agencies, Washington, D.C., March 29, 2006, p. 1.

tor performance awards and rollover award fees and established an "Award and Incentive Fees" Community of Practice through the DAU. Following that guidance, the National Defense Authorization Act for Fiscal Year 2007 directed DoD to ensure that no award fee be paid for unsatisfactory acquisition performance outcomes.

As a result, in April 2007, a separate DoD memorandum enumerated specific ratings for award-fee provisions but stressed, "it is the policy of the Department that objective criteria will be utilized, whenever possible, to measure contract performance."[16] Many of the military departments and centers also altered their guidance and directly referenced the 2005 GAO report.[17] A follow-up GAO report in 2009 applauded that new DoD guidance followed the 2005 GAO recommendations; however, it found that these practices were being implemented inconsistently across DoD programs.[18] In addition to policy changes that resulted from the GAO study, Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L) Ken Krieg directed that the DAU investigate reasons behind the success of certain award and incentive fee strategies and compile these observations into best practices.[19] From 2005 to the present, there has been an increasing preference for incentive fee type contracts away from award-fee contracts.

More recently, Under Secretary of Defense (AT&L) Carter's Better Buying Power (BBP) guidance stressed an increase in the use of fixed-price incentive, firm target (FPIF) contracts where appropriate (specifically, FPIF contracts with a 50/50 share line[20] and 120 percent ceiling "as a point of departure").[21] Fixed-price contracts were viewed as appropriate when (1) the government knows what it wants and does not change its mind, and (2) industry has good control of its processes and costs and can, thus, set a price. FPIF was seen as appropriate early in production and in single-source

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16 OUSD (AT&L), "Proper Use of Award Fee Contracts and Award Fee Provisions," Memorandum for Secretaries of the Military Departments (Attn: Acquisition Executives), Directors of the Defense Agencies, Washington, D.C., April 24, 2007a, p. 1.

17 See, for example, David Block, Greg Brown, Timothy Brown, Linda Drum, Melissa Duong, James Gill, Robert Graham, Ann Justice, Kristy Kuhlman, and Tanya Schoon, *Space and Missile Systems Center (SMC) Incentives Guide*, Los Angeles Air Force Base, Calif.: Space and Missile Systems Center, March 7, 2007. DoD also made efforts to collect data on the implementation of contract awards and incentives (OUSD [AT&L], "Award and Incentive Fees—Data Collection," Memorandum for Secretaries of the Military Departments (Attn: Procurement Executives), Directors of the Defense Agencies, Washington, D.C., April 24, 2007b).

18 GAO, *Federal Contracting: Guidance on Award Fees Has Led to Better Practices But Is Not Consistently Applied*, GAO-09-630, Washington, D.C., May 2009, p. 3.

19 Alan S. Gilbreth and Sylvester Hubbard, "How to Make Incentive and Award Fees Work," *Defense Acquisition Review Journal*, Vol. 16, No. 2, July 2008, pp. 132–149.

20 Share line is the formula by which overruns and underruns on contracts are distributed between the government and contractor.

21 Ashton Carter, "Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending," Memorandum for Acquisition Professionals, Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics, Washington, D.C., September 10, 2010, p. 6.

situations where year-on-year price improvement can be rewarded. In regard to the acquisition of services, the use of time and materials and award fee contracts should be limited.[22] A clarification was made in 2012 as part of an update to BBP (known as BBP 2.0):

> **Employ Appropriate Contract Types:** The original BBP emphasized the use of Fixed Price Incentive (FPI) contracts. In BBP 2.0, we are refining our guidance to emphasize the use of the appropriate contract vehicle for the product or services being acquired. The DFAR and FAR provide for a range of contract types for a reason: one size does not fit all. This initiative will focus on improving the training of management and contracting personnel in the appropriate use of all contract types.
>
> **Increase use of Fixed Price Incentive contracts in Low Rate Initial Production:** One phase of acquisition where FPI contracts are particularly appropriate is during the early stages of transition from development to production, low rate initial production (LRIP), particularly the earlier lots of LRIP. We will continue to emphasize the use of FPI during this phase.[23]

Guidance

Guidance on contracting incentives is abundant and has existed for decades. However, no contract type can eliminate cost growth in the development of complex weapon systems. Examples of contract pricing and incentive guidance include the following:

- *Department of Defense COR Handbook* (OUSD [AT&L], 2012)
- *Incentive Contracting Guide* (DoD and National Aeronautics and Space Administration, 1969)
- *Space & Missile System Center (SMC) Incentives Guide* (Block et al., 2007)
- *Incentives Guidebook* (U.S. Army and Massachusetts Institute of Technology, 2001)
- *Contract Pricing Reference Guides: Advanced Issues in Contract Pricing, Volume 4* (Office of the Deputy Director of Defense Procurement and Acquisition Policy for Cost, Pricing, and Finance, 2012)
- *Defense Acquisition Guidebook* (DAU, 2012).

The level of detail in this guidance differs. For example the *Defense Acquisition Guidebook* (DAG) lays out the broad contract incentive issues and who and what influences the choice of contract type and incentives. The other incentive guides are more

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[22] Carter, 2010, p. 12.

[23] Frank Kendall, "Better Buying Power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending," Memorandum for Acquisition Professionals, Washington, D.C., November 13, 2012, p. 3.

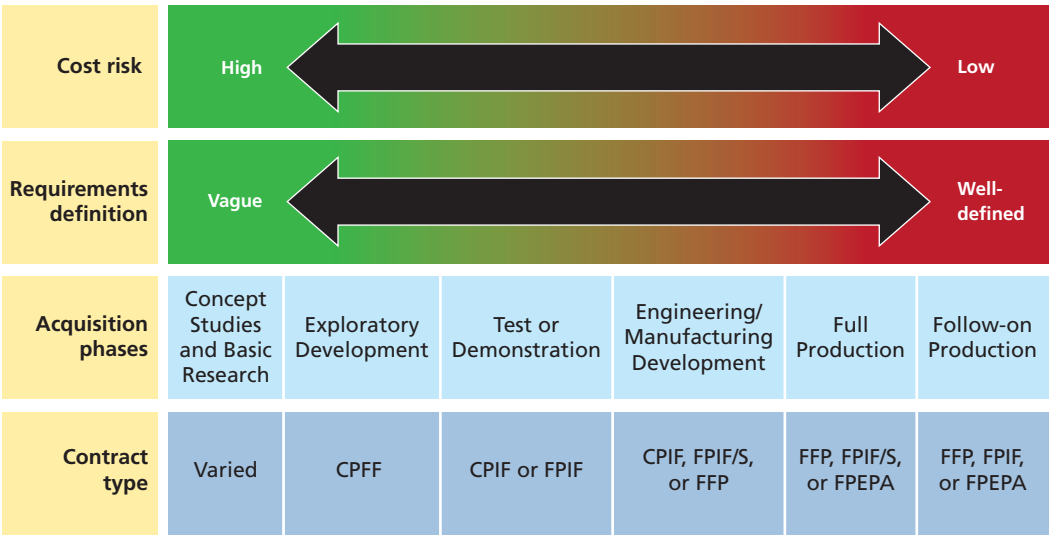
specific to contract form and implementation. They describe the different types of contracts and the various incentive methods. Several of the documents work through the mechanics of "share lines" (that is, how much risk the government is willing to assume compared with the contractor) and sliding-scale incentive contracts. Overall, the guidance documents discuss the central issue of programmatic and technical risk and note that determining which party—government or industry—can better manage that risk is a key factor in the selection of contract type and incentives. Figure 2.1 (from Martin, 2011) summarizes the differences and broad preferences of contract incentives during acquisition. More uncertainty and risk favor cost-type contracts over fixed-price. All demonstrate a preference for cost-type contracts in system development.

The DAU offers a similar view (Figure 2.2) to Martin's spectrum in Figure 2.1.

Service Contracts

The acquisition of services by DoD represents more than 50 percent of total contract spending.[24] Secretary Carter stated that "Buying services is fundamentally different than buying weapon systems, yet most current acquisition regulations, laws, policies, processes, standards, training, education, and management structures are focused on optimizing the characteristics of products."[25]

Figure 2.1
Spectrum of Contract Types and Cost Risk

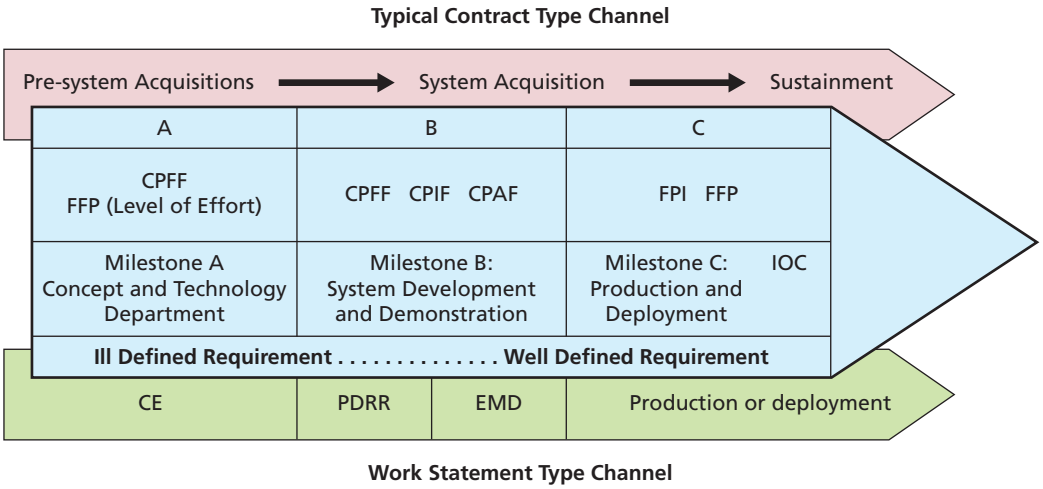


SOURCE: Martin, 2011, p. 9.
RAND *MG1171/6-2.1*

[24] Carter, 2010.

[25] Carter, 2010, p. 11.

Figure 2.2
DAU Contract Spectrum by Program Phase



SOURCE: Defense Acquisition University, "Acquisition Community Connection—Contract Types," web page, June 18, 2006.
RAND *MG1171/6-2.2*

Another important reason for examining service contracts is that they behave very differently from acquisition/procurement contracts. According to the Defense Science Board (DSB), service contract incentive strategies must consider not only the outcome of the service but also the process of service delivery. Progress is not necessarily linear and is therefore difficult to track and incentivize effectively. Contract length and re-competition time lines can heavily influence the efficacy of performance incentives. DoD lacks an effective taxonomy and guidance for creating and overseeing service contracts.[26]

The difficulty in developing a comprehensive taxonomy and guidance lies in the wide spectrum of service categories, illustrated in Figure 2.3.

Along this spectrum, services can range from easily quantifiable and observable performance, such as facility construction or maintenance of equipment, to services with limited measurable progress, such as R&D and knowledge-based services. Qualitative, performance-based measures require higher expertise and more complex, subjective metrics (such as award fee). Many services overlap into the definitions of commodities and weapon systems, such as information technology.[27] The application of contract incentives is complex when the contract straddles both production and con-

[26] OUSD (AT&L), *Report of the Defense Science Board Task Force on Improvements to Services Contracting*, Washington, D.C., March 2011, p. 7.

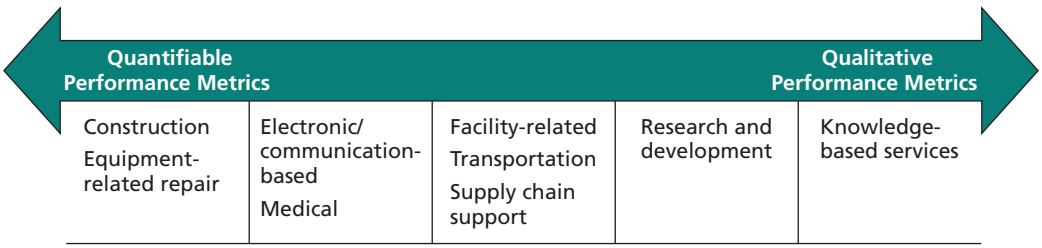
[27] IT services, for example, blur the lines of distinction between service, commodity, and weapons system contracts, encompassing MAIS, communications services, and hardware.

sumption of the service. Services toward the left side of the spectrum in Figure 2.3 generally permit the use of fixed-price contracts, and contracts for services toward the right side require more flexibly priced contracts.

In addition to contract fees, competition provides a strong motivation for good performance on service contracts. Although it is assumed that competition promotes the lowest possible cost, frequent re-competition for the same service can discourage incumbents from implementing cost and schedule reduction initiatives because uncertainty with future contracts increases the risk that investments will not be recovered.[28]

As stressed in the 2011 DSB report, DoD has to overcome many hurdles before it can optimize its service contracting.[29] For example, a 2008 GAO report discussing service contracts states, ". . . incentive and award fees are often based on contractor attitudes and efforts versus positive results (i.e., cost, quality, schedule)."[30] GAO has also been critical of DoD's overreliance on time and materials contracts and on ill-defined contract actions for its services, which provide "no profit incentive to the contractor for cost control or labor efficiency" and appear to have been implemented solely "for expediency."[31] The same report also highlights the lack of manpower and expertise within the DoD contracting community to construct and assess appropriate contract incentives and performance requirements.

Figure 2.3
Spectrum of Services Contracts



RAND *MG1171/6-2.3*

[28] Scot A. Arnold, Bruce R. Harmon, Karen W. Tyson, Kenton G. Fasana, and Christopher S. Wait, *Defense Department Profit and Contract Finance Policies and Their Effects on Contract and Contractor Performance*, Alexandria, Va.: Institute for Defense Analyses, IDA Paper P-4284, February 2009.

[29] OUSD (AT&L), 2011.

[30] David M. Walker, *Defense Acquisitions: DOD's Increased Reliance on Service Contractors Exacerbates Long-Standing Challenges*, Testimony Before the Subcommittee on Defense, Committee on Appropriations, House of Representatives, GAO-08-621T, Washington, D.C.: U.S. Government Accountability Office, January 23, 2008, p. 16.

[31] John Hutton and William Solis, *Defense Acquisitions: Actions Needed to Ensure Value for Service Contracts*, Testimony Before the Before the Defense Acquisition Reform Panel, Committee on Armed Services, U.S. House of Representatives, GAO-09-643T, Washington, D.C.: U.S. Government Accountability Office, April 23, 2009, p. 1.

Managing and assessing postaward performance entail various activities to ensure that the delivery of services meets the terms of the contract, including adequate surveillance resources, proper incentives, and a capable workforce for overseeing contracting activities. If surveillance is not conducted, is insufficient, or is not well documented, DoD risks being unable to identify and correct poor contractor performance in a timely manner.[32]

Effectiveness and Recent Implementation of Contract Strategies

Prior Research

The February 2009 IDA report on profit policy and contract incentives provided an overview of several key and thorough studies on incentive contracts.[33] These studies compared cost growth with the contract share line to see whether the basic assumption of incentive theories held true—that higher ratios led to lower cost growth. In Table 2.1, we show IDA's summary of these studies along with its more recent analysis.

The results varied, most likely because of differing data samples. The IDA results align with what was expected: that fixed-price and other contracts that transfer more risk to industry tend to have lower cost growth. However, the report cautions that this result may not be directly caused by the contract selection. IDA postulates that contract selection bias also leads to lower cost growth through "matching the right level of contract requirements accuracy to the appropriate level of contract risk."[34] Also, contractors will try to reduce uncertainty and the risk of overruns through higher targets and base prices. In essence, it is possible to achieve lower cost growth through the contract but not obtain the product at the best or lowest price. Isolating and determining the influence of several features—the incentives themselves, contract selection bias, and cost growth versus best price—increases the complexity of identifying which incentives actually work. Also, if fixed-price contracts are used correctly, they are employed when specifications are well defined and there is cost history for the same or similar products, so the risk of cost growth is inherently reduced, but not necessarily by the type of contract applied.

The Center for Strategic and International Studies (CSIS) monitors major contracting mechanisms used in defense spending. From 1999 through 2010, fixed-price contracting mechanisms clearly dominated spending within DoD. In 2010, these contracts accounted for 65 percent of the total, and cost-reimbursable contracts accounted for only 28 percent. Figure 2.4 reproduces a figure from a CSIS report on the distri-

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[32] Hutton and Solis, 2009, p. 8.

[33] Scot A. Arnold, David L. McNicol, and Kenton G. Fasana, *Can Profit Policy and Contract Incentives Improve Defense Contract Outcomes?* Institute for Defense Analyses, IDA Paper P-4391 (Revised), February 2009.

[34] Arnold, McNicol, and Fasana, 2009, p. 17.

Table 2.1
Summary of Prior Analyses on Contract Type and Incentive Effectiveness

Study	Year	Contract Data Used	Key Results
IDA (Cross)	1966	93 CPFF/43 FPIF contracts	Incentives yielded lower cost growth (6.3%) that more than offset their higher average fee rate (2.8%; net savings 3.5%); however, cost growth reduction was not related to share ratio
RAND (Fischer)	1968	1,007 Air Force contracts	Incentives yielded lower cost growth (FPIF vs. CPFF: 5.1%) that more than offset their higher average fee rate (3%; net savings, 2.1%); however, cost growth reduction was not related to share ratio.
U.S. Army (Launer)	1974	53 CPIF contracts (1964–1971)	Share ratio drove underruns but not overruns.
GAO	1987	62 FPIF contracts (1976–1981)	The final contract costs were normally distributed around the target cost (average cost growth, 0.2%); however, cost growth reduction was not related to share ratio.
IDA (Frazier, Cloos, and Kimko)	2001	7 CPIF/19 FPIF contracts (1992–1999)	Lower cost growth was related to higher share ratio; average cost growth for the sample was –6%.
IDA (Arnold, McNicol, and Fasana)	2009	31 CPFF, 83 CPIF, 5 FPIF, 72 FFP, and 47 unknown contracts (1969–2007)	Cost growth appears to decline as more cost risk is transferred to the contractor. FFP and FPIF had lowest cost growth variance as well.

SOURCES: Arnold, McNicol, and Fasana, 2009; Cross, 1966; Fischer, 1968; Launer, 1974; GAO, 1987; and Frazier, Cloos, and Kimko, 2001.

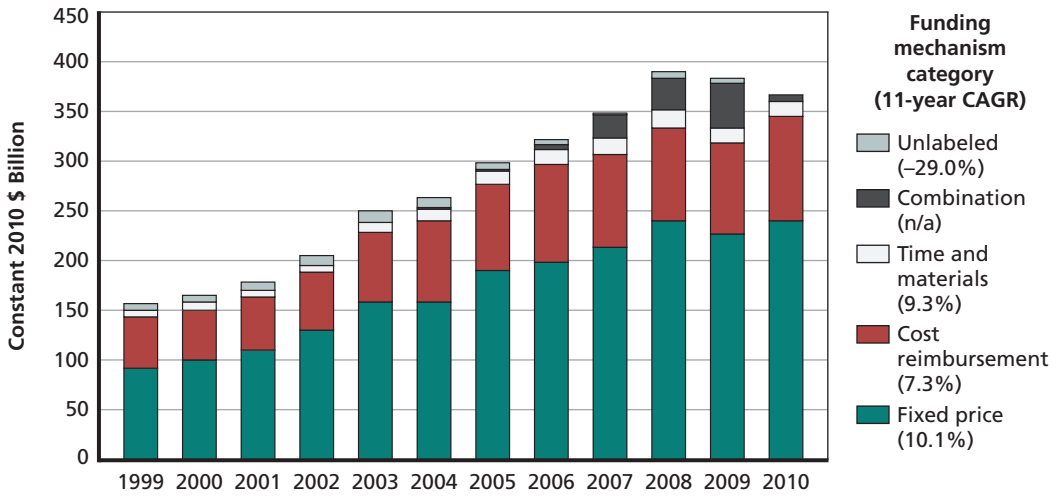
bution of contract types.[35] Over the period that CSIS examined, the number of fixed-price contracts has been growing faster than any other type.

Acquisition Documentation History

To understand how official acquisition documents discussed contract incentives, we reviewed Acquisition Decisions Memoranda (ADMs) and acquisition strategies available in the Defense Acquisition Management Information Retrieval (DAMIR) database and OUSD (AT&L)'s ADM repository. Out of the available 919 ADMs in the repository and DAMIR, only 34 discussed contractor incentives or justification for contract type. Of these 34 ADMs, the majority focused on assessing or enhancing contractor incentives just before or during the production phase. ADMs for Air Force or

[35] David Berteau, Guy Ben-Ari, Jesse Ellman, Reed Livergood, David Morrow, and Gregory Sanders, *Defense Contract Trends: U.S. Department of Defense Contract Spending and the Supporting Industrial Base, An Annotated Brief by the CSIS Defense-Industrial Initiatives Group,* Washington, D.C.: Center for Strategic and International Studies, May 2011, p. 25.

Figure 2.4
Defense Contract Types, 1999–2010



SOURCE: Berteau et al., 2011.
RAND *MG1171/6-2.4*

Navy programs constituted the largest number of the 34 ADMs. Below, we summarize the characteristics of the programs:

- number of ADMs per acquisition stage
  - program development: 1
  - research, development, test, and evaluation (RDT&E): 1
  - engineering, manufacturing, and development (EMD): 9
  - production: 23
- number of ADMs per service
  - Air Force: 10
  - Air Force–Navy: 2
  - Army: 5
  - joint: 6
  - Navy: 11.

Overall, the majority of the identified ADMs merely mentioned vague recommendations for a contract type, typically following rule-of-thumb guidelines. Only two provided a detailed discussion of incentive and award fees by either giving specific guidance as to how they should be executed in light of the program's unique characteristics or detailing the risk involved in pursuing such a contract.

In addition to reviewing ADMs for historical use of contracting incentives, we also looked at a sample of acquisition strategies from 32 MDAPs that were available

in DAMIR. From 32 acquisition strategies, we extracted contract incentive information for 36 major contracts. We found that the level of detail on incentives varies from program to program and contract to contract within programs. Depending on the acquisition phase, different incentives are specified. Cost, schedule, and performance incentives are weighted based on what is most critical to achieve at a particular program phase.

Acquisition strategies modified award-fee plans in response to cost growth and schedule slips, and the pool of award fees shifted over time. Acquisition strategies discussed why one incentive is chosen over another, but this was not observed in all acquisition strategies. Programs sometimes use multiple incentives and negative incentives to achieve the desired program outcomes.[36]

Figure 2.5 shows the type of contracts actually used overlaid with the DAU contract type guidance for the phase of the contract.

Industry Incentives

The incentives for industry are much broader than any share-line or fee structure on a single contract. Industry considers its own longer-term, corporate strategies and how the contract enhances its portfolio and shareholder value. More than profit or fee incentives could be used to reduce cost growth and achieve schedule and technical requirements. Beyond maximizing profit and cash flow on the current contract, companies are motivated by the imperative for organizational survival, growth of the company in terms of employment and sales, and a desire to advance science and technology for national defense.[37] Contracts offer an opportunity to enhance corporate reputation through good performance, thus increasing the possibility for follow-on work. Contractors are motivated to win new contracts to obtain mechanisms that increase their competitive advantage, such as access to new technology, market penetration, or narrowing competitors' opportunities with the customer. The timing and length of the contract are motivational factors because they provide predictability in the company's future business and contribute to the maintenance of its critical skill supplier and workforce base.[38]

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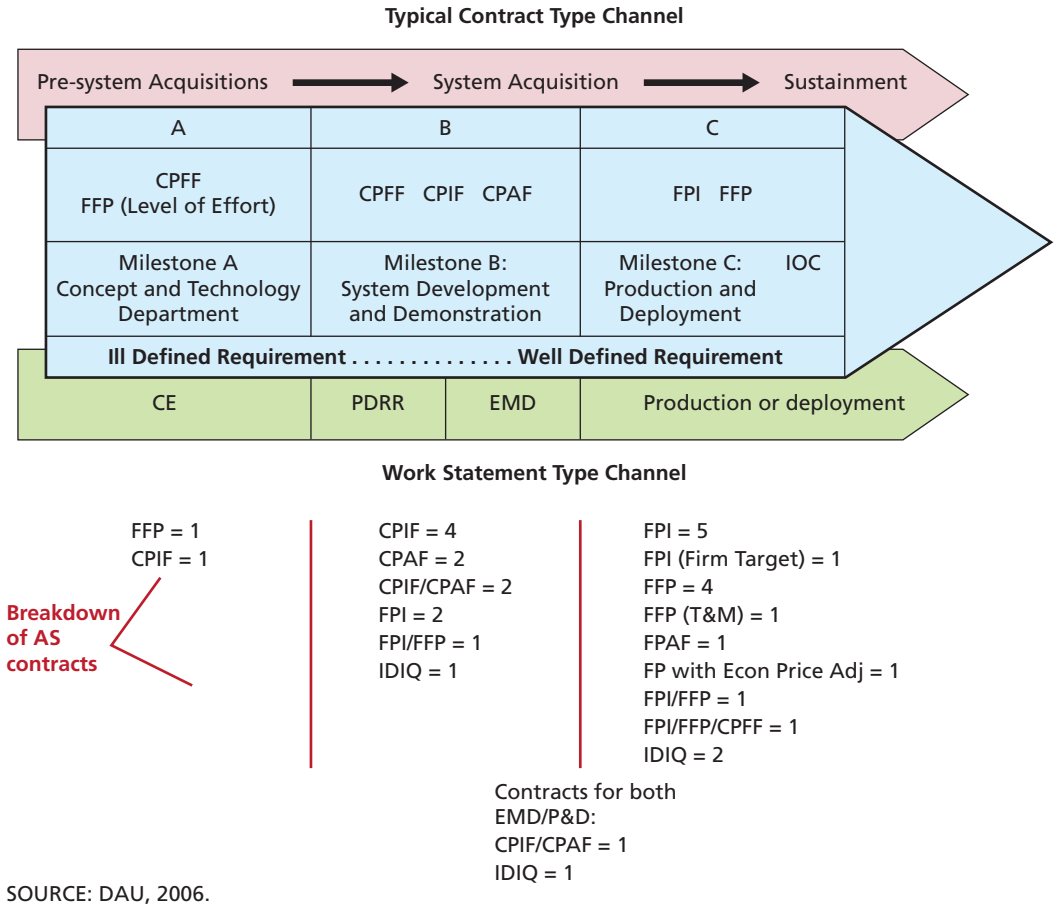
[36] Negative incentives mean that if an outcome is not achieved, the contractor has to return the fee to the government.

[37] David Leigh Belden, *Defense Procurement Outcomes in the Incentive Contract Environment*, dissertation, Stanford, Calif.: Stanford University, May 1969, pp. 36–37.

[38] A variety of ways exist to align contractor incentives with those of the government. For one example, see Appendix B.

Figure 2.5
Actual Acquisition Strategy Contracts Largely Reflect DAU Guidance in Practice



SOURCE: DAU, 2006.

RAND *MG1171/6-2.5*

Multiyear Contracting

Contract length is a key incentive for industry. Although annual contracts require less foresight and provide the government with maximum decisionmaking and budgeting flexibility, a contractor with a one-year time horizon may lack the incentive to make up-front investments in cost-saving initiatives or process improvements, thereby reducing cost savings. Multiyear contracts can be employed to achieve stable procurement and significant savings. GAO notes several prospective benefits and sources of savings from longer contracts, including allowing contractor purchase of parts and materials in larger economic order quantities (that is, bulk buys of spare parts at discounted per-unit costs), better facility use, and cost avoidance for the government and the con-

tractor by reducing the burden of constructing and administering annual contracts.[39] Congress is often reluctant to authorize MYP, because it loses its ability to influence the program (see Table 2.2).

In this section, we examine regulations governing the use of multiyear contracts and examples of their recent implementation.

Multiyear, Multiple Year, and Block Buy Contracting

Although multiyear contracts are the primary focus of this analysis, it is useful to consider multiple year and block buy contracts for contextual reference. The three types of contracts can be characterized as follows:

- *A multiyear contract* is a contract for the purchase of property or services for more than one but not more than five program years. Multiyear agreements typically bind the government for the period of performance; should the contract be canceled before expiration, the government might be required to pay a cancellation penalty to the contractor for certain recurring and nonrecurring costs amortized over the contract's remaining years.

Table 2.2
Multiyear Procurement Contracts Listing in the FY 2013 Appropriations Act

Service	Program	Length (years)	Fiscal Years	Renewed?
Air Force	C-17A	5	2003–2007	N/A
	CV-22	5	2008–2012	Yes, FY 2013–2017
	F-22	3	2007–2009	N/A
Navy	DDG-51	5	2013–2017	N/A
	ESSM	3	2013–2015	N/A
	F/A-18 + EA-18G	5	2010–2014	N/A
	MH-60R	5	2007–2011	Yes, FY 2012–2016
	Virginia	5	2009–2013	Planned renewal in FY 2014
	V-22	5	2008–2012	Yes, FY 2013–2017
Army	TOW missiles	5	2012–2016	N/A
	UH-60	5	2007–2011	Yes, FY 2012–2016
	CH-47	5	2008–2012	Yes, FY 2013–2017

[39] GAO, *Defense Acquisitions: DOD's Practices and Processes for Multiyear Procurement Should Be Improved*, GAO-08-298, Washington, D.C., February 2008.

- *A multiple year* contract is a sequence of one-year contracts with options to extend. There is no financial commitment in a multiple year contract beyond the current fiscal year.
- *Block buy contracts*[40] are an infrequently used option that permits the government to use a single contract for more than a single year's worth of procurement of an item without having to exercise a contract option for each additional year. Block buy contracts require individual congressional authorization but are not governed by any permanent statutes and are therefore unlimited in length and criteria.[41]

Block buy contracting is of particular interest because of its similarities to multiyear agreements. As with multiyear agreements, block buy contracts cover more than a single year's worth of procurement and require congressional authorization to implement; however, because they are not regulated by any existing statutes, there are no limits on the number of years a block buy contract can cover, and there are no legal criteria that a program must satisfy to be eligible. According to a CRS report, they are less likely than multiyear agreements to include cancellation penalties, but it is unclear whether there is a defined explanation for this fact or if it is simply an observation based on the limited historical experience with this type of contract.

Block buy contracting was initiated in 1998 through section 121(b) of the fiscal year (FY) 1998 National Defense Authorization Act to allow the Navy to procure the *Virginia*-class submarine over a period of five years: At that time, the *Virginia* was not eligible for a multiyear procurement contract because 1998 was the first year of procurement and there was no ability to demonstrate a stable design. Block buy contracting has apparently been used quite rarely since this first instance; the only other example included in the CRS report is for two block buy contracts covering the purchase of the littoral combat ship (LCS) between FY 2010 and 2015. Because of the unusual nature of this type of contract, it is not a major focus of this study and is not proffered as a broadly applicable incentive, but it is helpful to understand its past usage as an alternative to the more common and more regulated traditional multiyear agreements.

Regulations Governing Multiyear Contracts

There are two primary types of multiyear contracts. Multiyear contracts for the acquisition of property, i.e., procurement contracts, are covered by 10 U.S. Code (U.S.C.) 2306c and FAR subpart 17.1. Multiyear contracts for the acquisition of services, i.e., sustainment contracts, are covered by 10 U.S.C. 2306c and DFARS subparts 217.170

[40] Block buy contracting is not to be confused with a block buy, which generally refers to funding the procurement of more than one copy of an item in a single year, particularly when that exceeds the amount that would normally be funded in a year.

[41] Ronald O'Rourke and Moshe Schwartz, *Multi-Year Procurement and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, Washington, D.C.: Congressional Research Service, June 27, 2012.

through 217.174. Multiyear contracts require congressional approval if the program costs exceed a certain threshold:

- Congressional *authorization* is needed if the contract amount is equal to or greater than $500 million.
- Congressional *notification* is required if any of the following conditions apply:
  - The contract employs economic order quantities (EOQs) in excess of $20 million in any given year.
  - The contract will involve advanced procurement leading to a multiyear contract that employs EOQ procurement in excess of $20 million in any given year.
  - The contract includes an unfunded contingent liability in excess of $20 million.
  - The contract cancellation ceiling exceeds $100 million.

Contracts put forth for multiyear authorization must also satisfy certain criteria to be eligible. These requirements have changed since the inception of the multiyear contract and are currently set forth in FAR subpart 17.105. Procurement contracts are subject to the following six criteria:

- The contract will result in substantial savings relative to carrying out the program through annual contracts.
- The minimum need for the property to be purchased is expected to remain substantially unchanged during the contemplated contract period.
- There is a reasonable expectation that the agency will request funding for the contract at the level required to avoid contract cancellation.
- There is a stable design for the property to be acquired, and the technical risks associated with the property are not excessive.
- The estimates of both the cost of the contract and the anticipated cost avoidance through the use of a multiyear contract are realistic.
- The use of such a contract will promote the national security of the United States.

The congressional limit on a single multiyear contract is five years. However, although requirements and limitations on multiyear contracts are clearly spelled out in federal regulations, it is important to note that because each DoD Appropriations Act is a separate congressionally approved piece of legislation, the requirements may be ignored and limitations exceeded in specific instances. In this sense, the criteria listed in the FAR may be viewed as guidelines rather than hard requirements, and, indeed, the current criterion of "substantial savings" is more flexible than the previous one,

which included expectations of 10 percent savings or more.[42] Even the five-year length restriction has been exceeded in specific instances: In 1996, Congress approved a contract to procure 80 C-17 aircraft over a period of seven years, despite a GAO recommendation that the contract be reevaluated given the costs and risks involved.[43]

Benefits of Using Multiyear Contracts

The theory behind the use of multiyear contracts is that they provide contractors incentives to make up-front investments that enable long-term savings. These investments would not be justified from the contractor's perspective over a series of single-year contracts that annually face risk of cancellation or funding instability. These investments could include benefits associated with EOQs, process changes, facility investments, equipment upgrades, and labor training. A share of the savings associated with these investments is passed on to the government, resulting in lower costs than with annual contracts. Multiyear contracts may also have reduced contract administration costs, since they do not need to be renegotiated annually.

Further, these realized cost savings become part of the cost basis for any contracts negotiated after the multiyear contract. Assuming that the contractor has to disclose realized costs during multiyear contract performance, the government, rather than the contractor, will be the primary beneficiary of cost savings after the expiration of the multiyear contract. However, these benefits will be realized only if acquisitions continue; there is no government benefit or projected reduced costs if the multiyear contract ends a weapon system's procurement or sustainment. For example, the DDG program used MYP to control costs during low-rate production.[44]

Other analyses have confirmed the savings associated with multiyear contracts in some cases. A 2008 GAO report evaluated the use of multiyear contracts with programs that had not demonstrated stable design or requirements but acknowledged that when used with the F117 engine, "a commercially available engine with a stable design and manufacturing process," the price breaks expected were realized.[45] Prior RAND reports have also identified real savings in multiyear procurement and sustainment

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[42] GAO, 2008.

[43] GAO, *Congressional Testimony: Comments on Air Force Request for Approval of Multiyear Procurement Authority*, GAO/T-NSIAD-96-136, Washington, D.C., March 28, 1996.

[44] The Program Executive Office/program manager (PM) initially resisted Assistant Secretary of the Navy/Deputy Assistant Secretary of the Navy efforts to structure a MYP. They were concerned about losing near-term flexibility at their management level for incentivizing the contractors in areas of quality, supply chain/spare parts, safety, improved earned value management, incorporation of upgrades, and motivation of the contractor team in the near term. Congress was also concerned about lack of flexibility. These concerns were resolved by restructuring the proposed 12 percent FPIF with a 50/50 share line to an 8 percent FPIF, 50/50 and 4 percent award fee contract. The award fee was to be determined quarterly, with the PM having the flexibility to change fee criteria based on contract performance issues.

[45] GAO, 2008.

contracts: An assessment of the F-22 cost savings found that the multiyear contract saved about $411 million in comparison with three single year contracts.[46] The same report examined the Navy F/A-18E/F program and reported savings there as well:

> According to the F/A-18E/F program office, the most important source of savings on the main airframe MYP contract with Boeing was the $200 million in EOQ and [cost reduction initiative] funding and annual [advance procurement] funding. . . . The analyses we were able to perform using the available data for the F/A-18E/F MYP I support the conclusion that savings were realized and the magnitude was probably in the neighborhood of the original justification estimate.[47]

Finally, a RAND study examining a possible F-22 multiyear sustainment contract found the potential for significant savings, defining savings by the criterion that the contractor would not have been motivated to pursue the same cost-reducing investments without the opportunity to recover its expenditures during the five-year contract term.[48] In Appendix D, we explore the experience with multiyear on some more recent, smaller procurements. We examine the possible benefits of MYP contracts as applied to systems in which contract length is less commonly used as an incentive and explore the possibility that missile/munitions and communications and electronics programs may actually be better suited to multiyear agreements than some of the larger programs with which multiyear agreements are used regularly.

Summary of the COG Discussions

This section discusses elements of the business and government contracting environments that enable firms and government to achieve their objectives. Although defense firms have different business personalities, most are spurred by a set of core and common motivations, such as the desire to be preeminent in their industrial sector, to generate high returns, and to enjoy a solid reputation. Government, too, has a variety of measures that it can take to motivate or change industry behavior or business outcomes.

This report presents these views without any effort to assess them analytically. Readers should understand them as statements made by knowledgeable current or former senior DoD executives and not as statements based on independent, technical RAND analysis. RAND does not in any way endorse these views.

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[46] Obaid Younossi, Mark V. Arena, Kevin Brancato, John C. Graser, Benjamin Goldsmith, Mark A. Lorell, F. S Timson, and Jerry M. Sollinger, *F-22A Multiyear Procurement Program: An Assessment of Cost Savings*, Santa Monica, Calif.: RAND Corporation, MG-664-OSD, 2007.

[47] Younossi et al., 2007, pp. 61, 72.

[48] Guy Weichenberg et al., *Multiyear Contracting for F-22/F119 Sustainment*, Santa Monica, Calif.: RAND Corporation, 2012, p. xi. Not available to the general public.

All that said, using the COG, RAND did identify a new and innovative way to think about and identify motivators that are common across large U.S. defense system producers, information and communication technology suppliers, and support service contractors. We also came up with a new approach to identifying tools that government can use to improve contracting results. Key to this new RAND approach is an understanding of elements that can actually channel industry executives' behavior and specific government actions that motivate industry.

It should be noted at the outset that industry motivations differ from those of the government. At the same time, motivations can also differ within each sector and each company, depending on its circumstances, such as the need for cash flow at a particular time or for development leading to foreign sales.

Setting the Stage: COG Meetings

The first set of COG meetings occurred in February 2013. During these meetings, we sought to engage planners, technologists, and experienced defense acquisition and contract experts who have both government and industry contracting experience, in exploring nontraditional incentive and contract length strategies. The first meeting presented the following questions:

- What motivates industry in terms of cost and schedule performance?
- Are important incentives being overlooked or underused (i.e., contract length, incentive share lines, variable cash flow, risk sharing, flexibility)?
- How can DoD better align its incentives with those of industry?
- How do incentive structures differ between acquisition and support/service contracts?
- What is the best way to measure performance?

The second set of COG meetings occurred in April 2013. At these meetings, we revisited many of the topics discussed in the first meeting, as well as some more focused topics inspired by the first discussion in February. The questions presented to the group included the following:

- What are the key challenges in improving the acquisitions process?
- What specific incentives pertain to acquisition of large, complex programs?
- What specific incentives pertain to acquisition of electronics or communications programs?
- What specific incentives pertain to support/service contracts?
- How do we best consider the relative importance of different incentive options to different industries?

Major Points of the COG Discussions

During the two-day discussions, COG participants focused on the following themes:

- the alignment between contractor motivations and contractor incentive tools and how DoD can use this alignment in contracts and interactions
- determining when certain contract types and lengths are appropriate across the acquisition product spectrum
- identifying DoD-unique business aspects (process and behaviors) that act as enablers or barriers to incentivizing contractor performance.

Contractor/Firm Motivations and Incentives

One central observation of the COG, over the several days of discussions, was that the government needs to understand the incentive environment in which the contractor works as well as the nature and stage of the acquisition program. In general, the group felt that government negotiators do not understand contractor motivations; they focus primarily on contract terms, not the external environment or the expected results. During contract negotiations, DoD must understand the market environment and the contractor's desire to position itself to gain future work. In fact, many motivations lie outside the single contract in question. Industry works in a different environment from DoD because it does not focus on a single contract; instead, it focuses on the longer-term implications of its business strategy; firms have a longevity beyond a specific contract. Therefore, they make decisions to optimize their long-term value.

Across acquisition product types and acquisition phases, contractor motivations may be consistent in some areas and not in others. For example, during the contract proposal process, the contractor mostly desires to "get into the game"—i.e., win the award—to further entrench the firm as the leader in the market. In such a case, the contractor will then "propose to win" in the early phase of a program (potentially making little to no profit in the R&D stage). At the opposite end of the spectrum, during the support phase, the contractor might focus more on cash flow and the level of effort involved in supporting the capability. The COG also observed that the development phase is always going to have problems (costs will grow, schedules will slip, and not all initial technical goals will be achievable for a reasonable cost). Government expectations must be set accordingly. A key challenge for DoD is recognizing the various motivations and how they change with program phases and that it must tailor contracting approaches accordingly.

The COG made several other, general observations with respect to incentives and contracting. DoD does not systematically ascertain, retrospectively, whether contract incentives were effective in promoting desired outcomes. Better historical data

on effectiveness would help to evaluate various contract strategies.[49] Another important observation is that contractor interaction is, first, a business relationship between people. Often, the personal interactions can be more important in the success or failure of any given contract. Thus, experience and knowledge on both sides of the negotiation and management table is a key attribute. However, the COG noted government reluctance to create appropriate contract incentives beyond prescribed guidance because of risk aversion (not wanting to have to justify incentives outside those advocated in current policy direction). Importantly, the COG noted that tailoring the contract terms is one of the most difficult and important activities on the government side; there are no magic contracting terms that universally produce desired outcomes.

Corporate Motivations

The COG participants concluded that to achieve optimal schedule, cost, and performance from contractors, DoD's contractor incentive "tools" must align as much as possible with what actually is motivating contractors. These motivations largely center on the financial aspects of running enterprises. Here are the motivators that the COG identified:

- **Maintain Preeminence and Preservation Within Respective Sectors:** One powerful motivation for industry is the desire to establish dominance or presence in a sector or segment as a way to stabilize and maintain a business line. This motivation can take two forms: preeminence versus remaining viable for the specific capability—staying in the game. The first form is to be the dominant firm as a provider for a specific capability. This can be done through having the majority of business in an area or through unique intellectual property or capabilities. Once established, the firm can have a greater likelihood of future business in this area. This strategy is particularly effective where there are high barriers to entry, which is typical on major defense programs. Once established as the dominant firm, the business line will have less competitive pressure (and potentially will earn greater revenues). The other side of this motivation is "staying in the game," which means that the firm will act to preserve a business line or activity. This is more typical when there are multiple competing firms or a product line with diminishing demand. In such cases, a firm might be willing to propose aggressively to maintain a business line (e.g., Boeing's aggressive proposal for the development of the next-generation tanker).
- **Cash/Credit Rating:** These two financial motivations are linked. Cash flow is important to a firm as it allows timely payment of bills, minimizing short-term borrowing costs to finance activities. A steadier, more predictable cash flow means

[49] Since this report was written, OSD has published two reports that have attempted to collect data and information on the incentive structure of DoD. These reports provide a much more authoritative source of information than other reports published by external organizations.

a better credit rating (and lower costs to borrow). This is particularly significant on DoD contracts where interest on borrowing is an unallowable cost. Cash flow is one of several metrics that external groups use to value companies. Credit rating is the flip side of the financial equation. Being able to pay bills on time and having an established cash flow means better credit terms. Overall, both factors result in a lower cost to do business that can lead to being more competitive, and more profitable

- **Owner Value:** Senior executives at companies often have corporate mandates to increase owner values (e.g., increasing stock price and paying dividends). Moreover, they can have personal incentives in terms of stock price level, so that increasing share price personally benefits them. Many factors can be used to determine owner value: Among these are cash flow, revenue/earnings, margin, employed capital, and cost of capital.[50]
- **Manage Financial Risk:** A key corporate requirement for success is to manage and mitigate risk. In so doing, a firm reduces its exposure to loss (and erosion of profit). This does not mean avoiding risk, because often programs with higher risk can yield greater returns if managed appropriately.
- **Returns:** The main goal of any business—to make a profit—is a central motivating factor in the defense business. Hence, opportunities that offer more profit potential will be sought out by industry. However, profit margins on defense business are often lower than in other industries and do not vary over a wide range.[51]
- **Profitable Growth:** Beyond profit, firms seek to grow their businesses as a way to achieve economies of scale and move into new business areas. Growth and diversification can minimize business fluctuations. Growing firms also can attract talent more easily when applicants perceive the opportunity for doing creative work and for promotion. Company growth becomes a competitive advantage. Financial markets also value profitable growth. Growth in profits and revenue translate into greater company value. It is also important to recognize that not all firms are focused on returns on investment. Some see value in revenue growth, particularly large diversified firms. Negotiators need to appreciate which type of firm they are dealing with.
- **Program Stability:** Contractors wish to reduce program uncertainty in quantities, cash flow, requirements, supplier base health, and other factors whose alteration that may affect future profitability. Increases or decreases in planned production rates will almost always incur increased costs. Typically, initial production rates are not achieved, causing higher overhead rates because of excess manning and facility investment. Other external factors can affect program stability, such

[50] Those seeking more information should consult, for example, Ruth Bender and Keith Ward, *Corporate Financial Strategy*, 3rd edition, 2008.

[51] See Arnold et al., 2009.

as warfighter's demands, technology advancements, and enemy threats, which need to be accommodated. Larger programs are often viewed as "cash cows" with funding taken away to "fix" other programs. When this occurs, considerable reprograming needs to take place and can be quite disruptive especially in the latter states of EMD and LRIP.

- **Reputation:** Motivation to maintain or improve reputation can work at both a firm and product level. The reputation of a firm has intangible benefits unlike the other financial motivations. Being recognized as a leader or highly competent firm can translate into more business opportunities and greater competitiveness. Firms want to succeed on programs. A product with a reputation for high quality can translate into more sales and revenue over the long term. Another aspect of reputation is workforce/employment stability at the firm, i.e., the workers know that there will be a place for talented people.

Personal Motivations

Beyond these corporate motivations, some COG participants noted that although all major proposals are reviewed in detail by senior leaders, corporate finance, and the board of directors, the personal motivations of the industry players are also important. Government can benefit from a broad understanding of these personal motivations. Contracting with businesses to provide military hardware or to perform services comes down to individuals in the government interacting with individuals who work for the contractors. The motivations of the individuals who are involved in the contracting process, both government employees and contractor employees, play a significant role in determining the outcomes of these government-contractor interactions.

Although COG members had different perspectives on motivations, several participants felt that, in general, the government and contractor entities involved in programs are structured, disciplined organizations in which it is reasonable to expect that the actions of individuals will be governed by organizational priorities, plans, standards, directives, and policies. Individual motivations and preferences will be constrained to align with the interests of the organizations that the individuals serve. However, the organizational motivations of both the government and the contractors are interpreted through individuals; so the government is well advised not only to assess what motivates the contractors but to also appreciate that the individuals involved may have personal interests that also carry weight in determining outcomes. For example, an individual's personal ambition for a plum promotion that depends on winning a contract could cause a contractor to bid more aggressively than is warranted by the scope of work and the contractor's capability to perform. Likewise, personal animosity based on some difference of opinion over even a small matter can color the decision to award a contract. Deals are made between people. The institutional form of the deal is a contract between organizations made through structured organizational processes, but they are also handshakes between individuals.

In thinking about incentives, the government needs to recognize that the importance of incentives may vary with different individuals within a company. What motivates the chief executive officer may differ a lot from what motivates the prospective program manager or the head of contracts. The message is that the government decisionmakers for a potential contract action need to invest some time in studying the potential offerors not just as a business entity but also as key individuals.

There are many sources of relevant information about a company's needs and motivations. The annual reports (10-Ks) of publicly traded corporations and share price trends contain clues.[52] Performance of individuals on other contracts can be determined through discussions among government peers. News stories in local newspapers often reveal insight into relationships, and straightforward discussion with key contractor individuals can be illuminating. Not only do all of these kinds of research reveal important insight into the future expectations for a contractor's behavior as an organization, they can also shed some light on the finer-grained element of what may be expected from the individuals involved and how their interests may affect outcomes. Understanding the incentives of those it is bargaining with might provide additional leverage to the government in the negotiating process. For instance, knowing that an executive has revenue targets to meet at the end of the fiscal year might give the official an incentive to close the contract before the year's end.

Government Influence Mechanisms: Levers That Government Can Pull

The COG participants then enhanced the list of mechanisms and tools available to the government to influence the contractor:

- **Competition:** In the commercial marketplace, competition is an economic mechanism by which consumers have access to products and services that are lower in price and technically up-to-date. Competition works when there are many buyers and sellers of identical (or nearly so) products, the so-called "ideal" market. The defense market is far from being an ideal area for competition because there is (in the United States) one buyer and very few sellers. So, competitive forces are harder to implement and do not always achieve the same benefits as seen in the commercial market.[53] Nonetheless, competition is sometimes one of the most important mechanisms in achieving value for DoD.[54] An actual competition between suppliers does not need to take place. The threat of competition where there is a

[52] Examples from these reports are found in Appendix C.

[53] See, for example, Birkler et al., 2010.

[54] See, for example, J. S. Gansler, W. Lucyshyn, and M. Arendt, *Competition in Defense Acquisitions*, College Park, Md.: Center for Public Policy and Private Enterprise, School of Public Policy, University of Maryland, February 2004.

plausible substitute good or provider of a service can sometimes achieve some of the benefits of actual competition.

- **Contract Length:** Longer contracts are more desirable to industry because such contracts provide a more assured cash flow and opportunities to invest for efficiencies. Multiyear contracting (discussed above) is one example of an extended contract. The term length for service contracts can also be an important motivation to a firm's performance.
- **Foreign Military Sales:** Foreign sales (either FMS or direct buys) are potentially lucrative to industry because they increase quantities sold and get higher margins than do sales to the U.S. government alone. Structuring programs so that there is a possibly of foreign sales could be a potentially effective incentive for industry. For example, the government could make more systems available to close allies than they currently do. The ability for a system to be sold to allies could be a negotiation point during negotiations. Moreover, making the choice early enough in the design phase could allow adaptability for foreign sales. The F-22 program serves as an example where the Air Force attempted to generate an export version as a way to keep the production line going and make the U.S. version more affordable. Such efforts were blocked by Congress.[55]
- **Risk Sharing:** The importance of addressing risk early on is critical to a program's success. Who carries the risk and how it can be mitigated are central issues in early program planning. Incentive contracts seek to balance the financial risk-reward of contracts between industry and government. Depending on the share line, industry has the opportunity to benefit from any realized savings but is also penalized for overrunning. In theory, both sides should be incentivized to manage risk. As we discussed above, the results are mixed as to the effectiveness of incentive contracts and share lines.
- **Profit:** The government can use a variable fee on a defense contract to motivate certain outcomes, such as unit cost or schedule. For example, on incentive contracts, underrunning the target cost means that the contractor can share some of the savings with the government through an increased fee. The fee should be directly related to the profit the company earns on a contract; a higher fee should mean higher profit, other things being equal. On award-fee contracts, the fee varies based on preagreed conditions. This type of contract allows the government more flexibility in incentivizing contractor behavior beyond price. However, award-fee contracts can be more difficult to implement and, as has been discussed above, are not always seen to be effective.

[55] Sam LaGrone, "AF Ready for F-22 Export Version," *Air Force Times*, June 14, 2009; Jim Wolf, "Senate Panel Seeks End to F-22 Export Ban," web article, Reuters.com, September 10, 2009.

- **Timely Cash Flow:** One particular advantage of defense contracts is that they typically generate greater, free cash flows than other sectors.[56] This cash flow arises, in part, from the government's ability to promptly pay costs incurred (in contrast with payment on delivery, which is common in the commercial world). Moreover, the government covers all development costs and can make advanced payments for long-lead items. From DFARS (232.501-1), "The customary progress payment rates for DoD contracts, including contracts that contain foreign military sales (FMS) requirements, are 80 percent for large business concerns, 90 percent for small business concerns, and 95 percent for small disadvantaged business concerns." One possible potential incentive that the COG noted was to vary the progress payment rate based on prior performance. Better-performing firms could get up to the maximum customary rate, whereas lower-performing firms could get lower rates. Another important aspect of cash flow is that it ties to executive compensation (see Appendix C).
- **Production Rate:** The government has some flexibility (budgets allowing) in how quickly it procures an item. Higher production rates (for a given quantity) result in increased cash flow and earlier profits for a company than lower production rates. Because of the time value of money, companies prefer anything that moves cash flow earlier. Thus, the government could potentially spur higher production rates on programs that meet its goals and objectives. An example of such a strategy is the *Virginia* attack submarine program, where industry was challenged to reduce the unit cost of the submarine below a certain threshold. If achieved, the government would buy two submarines per year rather than one.
- **Provisions to Protect Intellectual Property:** Intellectual property (IP)—through unique or proprietary technology or processes—can give a competitive advantage to a firm (i.e., it can offer goods and services at a lower price or a unique capability that no other firm can). The granting to the government of unlimited rights in IP (including the right to give the IP to a competitor), for IP created on a development contract, dampens corporate enthusiasm for participating in such government-sponsored projects. On the flip side, the government's not obtaining unlimited rights in IP can adversely affect DoD's ability to support systems that rely on that IP. These are serious concerns that should be addressed before and during contract deliberations.
- **Oversight:** Most defense-dependent contractors consider DoD's business processes as burdensome. Firms that depend less on DoD contracts find the processes, and the accompanying constraints imposed on their subcontractors, even more off-putting, with the result that they shy away from directly participating in acquisition programs. Of particular concern to contractors are cost-

[56] See Arnold et al., 2009.

accounting standards and processes, requirements for competition, lack of use of performance-based specifications, and IP rights (see above).

COG participants then identified alignments between DoD's contractor tools and contractor motivations to understand which strategies would benefit cost, schedule, and performance. We explore these alignments more fully in the next section. However, the participants noted that in any given case, different conditions could result in different interactions between the tools and motivations. Participants also speculated on how well the acquisition-training curriculum reflects an understanding of industry motivations as well as context-dependent factors.

Additionally, although COG participants agreed that all of the above factors were industry motivators in some sense, they noted that the relative importance of one factor versus another was variable. As noted above, contractors' key motivators depend on their industry as well as where they are in a contract or program life cycle. With a large, complex program, for example, winning a design contract is beneficial in terms of developing technical skills and intellectual property. Such an award also opens the door for future production and support contracts. Therefore, a contractor may be willing to accept a reduced profit during this early phase in exchange for the ability to influence the follow-on work. Similarly, at the outset of the bidding process, the primary motivation is simply winning (and by doing so, achieving greater industry preeminence). Other factors become relevant later in the contract; however, the significance of these motivators may still differ substantially between different companies and contracts.

When Are Certain Contract Types and Lengths Effective, and How?

COG participants expressed doubt as to the existence of a universally effective contract type. They felt that DoD places too much emphasis on contract type as a way to achieve program success. The COG viewed the development and executions of contracts as being dictated largely by rules, decrees, and mandates. Programs use these rules as the lowest-risk bureaucratic path that will elicit the least amount of criticism as opposed to tailoring the contract to the situation. The programs can blame the policies or rules when actions fail, not their own decisionmaking or management. Guidance and documents provide mechanics as opposed to the critical thinking about what is appropriate for the situation. For example, the COG expressed concern that current emphasis on FPIF contracts would turn into rote use on all contracts and that PMs and their staffs would not want to challenge the guidance because of the desire to avoid risk. Contract type selection should be a dialogue between OSD and the Services as opposed to a checkbox (as we observed above, very few programs discussed contract type in acquisition documents until recently). To get better choices, the government needs to foster a greater degree of personal initiative by considering the following questions:

- What qualities would cause an individual to think outside the guidelines and tailor a program to the circumstances?
- How often is one willing to fight the bureaucracy? Is it too difficult and time-consuming to do so?
- How does the system treat those who take risks and fail?

The group debated whether the GAO's criticism of DoD's administration of award-fee contracts was justified given that the root causes behind the program shortcomings did not seemed to have been explored fully. The COG felt that award-fee contracts can still be a powerful corporate motivator and that the basing of executive bonuses on award fee earned served as a powerful motivator for those executives. However, award fees should be determined through a critical assessment process as the conditions for award evolve over the procurement life span. DoD culture has ingrained a perception that giving zero or low award fees is a signal that their program is having trouble. Thus, programs may be reluctant to give low awards. The COG participants also speculated on whether PMs have the proper training to manage award contracts effectively.

Contract length was also discussed, in particular with regards to multiyear contracts. Multiyear contracts allow the contractor to see returns on investments for cost-reduction initiatives, engage subcontractors/vendors (e.g., through EOQs), or invest in facilities. However, multiyear contracts take away flexibility, which becomes an issue for the services, OSD, and Congress. Also, there is little understanding of how to construct a multiyear contract. When is this strategy viable? For how long should it be (e.g., would you get the same savings with a three-year or a five-year contract)? How do you create conditions necessary for Congress to approve a multiyear contract?

DoD Behaviors and Processes as Enablers or Barriers to Contractor Incentives

In addition to purely contractual tools, the COG participants also explored the unique DoD environment that may lead to enabling or barring effective contractor incentives. People and relationships are extremely important; however, a bad policy, process, or misled intervention by a policymaker can derail benefits from effective relationships or contract mechanisms. One theme continually discussed was the adversarial environment presented by the contract office to the contractor. The contract type establishes the set of rules through which the sponsor and the contractor interact; however, an adversarial or poor relationship between the two can turn even a perfect contract into a failure.

Several in the group observed that there is an increasing tendency on the part of the government toward auditing. (One person termed this trend, "The ascendency of the Defense Contract Audit Agency.") For example, participants observed that DCAA views itself as an independent force. Its function, they thought, should be that of a facilitator and a negotiator, and it has lost sight of this. In their view, DoD has moved

from a partner relationship with contractors to an adversarial one ("we are here to police you"). Cooperation itself is a powerful incentive, especially because this is how buyers and sellers normally work in the commercial business world.

In addition to the adversarial environment, COG members believed that both program offices and contractors lose incentives as a result of excessive reporting requirements. The government requires far more accountability than the private sector, which translates into significant reporting labor, taking available time away from critical thinking. "Trying to feed the system" takes away time for working on other important issues. An important improvement opportunity is to change reporting requirements so that such oversight is achieved, but the reporting burden is lessened.

This audit and reporting activity, the COG felt, provided very little real value to the government. Often, the contractor has to employ overhead staff (typically, compliance personnel) to manage these audits and produce the required reporting documents. Although a prime contractor can absorb such activity, smaller vendors struggle with the additional burden, making working with the government more expensive and difficult. The COG also observed that the true cost to the government is never fully examined. Many reports have documented excess charges recovered by government, but the additional burden on both the government and the contractor for the audit and reporting activity is never examined. Moreover, industry can be forced to carry reserves on their books for several years, as there are significant backlogs in adjudicating discrepancies. All these costs are passed onto the government, eventually.

Moreover, some of the COG participants noted that the audit process was "arcane" compared with commercial practice. Typically, in a commercial environment, the auditors work with the company to resolve issues as they occur. These auditors still report independently to the board of directors, but they work in a way that keeps the business process moving. Defense auditing is done after the fact in most cases and can cause late or delayed payments (which results in additional costs for contractors). It was felt that the Services have lost their ability to conduct independent audits, and this function has been turned over to the Defense Contract Management Agency (DCMA). But the DCMA organization has been "leaned-out" to such an extent that it is difficult for it to be responsive, which has resulted in some backlogs of over a year. Adjudications that are not timely have limited value to PMs and other senior executives. The example given was expeditionary contracting, where there is no ability to surge the staff to the level and pace of the audit demand nor is there an ability to forward-deploy auditors during the initial stages. If the strategy to fight future conflicts remains expeditionary, the contracting and audit groups will have to find a flexible way to meet surge demands. In addition, our feedback is that, unlike the commercial environment, the DCAA and program manager interactions are reported to be becoming more adversarial.

DoD employees often labor under countervailing incentives. The program office and other acquisition staff view their jobs as pleasing their bosses, not making a pro-

gram successful.[57] This may be because of the "interaction of confusion," where lines of communication between acquisition elements are not fully stated or used. Also, DoD has put an increasingly larger emphasis on business practices than on the technical performance of its products. This emphasis is reflected in its incentive strategies. The directive authority on many issues has been delegated to positions so high that it is not a surprise that this is the case. The business side is what these higher-level officials are familiar with; this is also what the DAU is currently capable of teaching. Yet such emphasis may make it difficult for lower-level acquisition staff to focus on the program's technical performance. How do we incorporate technical expertise in the process more efficiently?

One COG participant pointed out that the government is generally limited to motivating the prime contractor. In discussing incentives, it is important to consider the audience: small businesses, hardware producers, etc. For some contractors, the administrative burden may be a huge factor, particularly for small companies; for others, it may not have much effect. The challenge is that this burden is not adjustable on a contract-by-contract basis. How far into the mechanics of oversight do we need to go in examining this issue?

Improving the Acquisitions Process

COG participants were skeptical of some past efforts to improve acquisitions, noting that there is "a strong desire in acquisitions to show that you're 'doing something,'" so entities may strive for something that is superficially plausible rather than proven to be effective. There may be benefit in decreasing the level of government oversight by central authorities to some extent, perhaps giving the contracting officer more authority in the process. Participants expressed concern that arbitrary acquisitions decisions may place a huge burden on contractors, resulting in money wasted litigating disputes. In addition, concern was expressed that during OSD reviews more time should be spent focusing on acquisition and contract strategy and less on activities that add no value, which the group felt is becoming increasingly burdensome. Is there a form of analysis that can demonstrate how much the administrative engine has grown?

With respect to the upcoming budget contraction, participants noted that industry should have been taking action to deal with this for some time—"getting ahead of the game." Contracting officers should tailor the contracts to their objectives. If they do not understand what the contractors are doing or their incentives, then they need more training, possibly to exceed what is currently provided by the DAU.

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[57] Commercial firms face a similar problem. See Robert Jackall, *Moral Mazes: The World of Corporate Managers*, London: Oxford University Press, 2009.

Aligning Government Incentives to Industry Motivations

This section focuses on contract actions that the COG posited will motivate defense industries in the three segments of the military acquisition market that we identified above: large and complex systems, IT and communications, and support services. We highlight those actions that, in the judgment of the COG, will have the strongest stimulant effect on industry. We do so by marrying the government levers with the industry motivators that we discussed above, using matrix tables to display the results of the COG's consensus evaluations. As we describe further below, because defense companies' motivations differ among segments, we display the results separately for each segment. We identify the strongest combinations of government levers and industry motivators with check marks for each of the three acquisition segments and discuss how those marks fall into patterns.

We note up front that the COG felt that executive compensation is an overarching factor that motivates industry executives across all business segments. Executive compensation structures are important for acquisition officers to understand, because they may give them leverage in negotiations. Compensation may vary significantly from company to company, but understanding this variance may also benefit negotiators. Generally speaking, compensation structures are based on corporate performance, division performance, and personal performance. But, although it motivates companies' most senior executives, executive compensation does not always influence individual programs. Several COG members pointed out that boards of directors and corporate finance departments review companies' major programs in detail before proposals to the government are submitted. As a result, we do not feature executive compensation in our matrix tables. Nevertheless, we discuss this factor at some length in Appendix C.

Characterizing Incentive Structures for Large, Complex Systems

The COG first looked at contract mechanisms in large, complex systems. The commitments connected with acquisition contracts for these systems are usually worth billions of dollars and span decades. In recent years, they have accounted for 40 percent of DoD's annual acquisition budgets and underpin all critical military assets.

On the basis of its deliberations in February and April 2013, the COG used nine of the government levers and eight of the industry motivators discussed above to identify 34 combinations, which we also call mechanisms, that could motivate defense contractors involved in providing these complex systems. These are displayed in Figure 2.6. Note that these combinations reflect measures that can be implemented in contracts rather than specific management steps. Of these 34 mechanisms, nearly half were connected with two government levers: contract length and foreign military sales. The COG judged that the longer the contract offered to a contractor, the greater the contractor's motivation to produce complex systems that are on time and within cost and achieve performance goals.

Figure 2.6
Industry Motivators Most Influenced by Government Contract Mechanisms on Large, Complex System Acquisition Programs

		Industry motivators							
		Maintain Preeminence	Cash/ Credit Rating	Owner Value	Manage Financial Risk	Returns	Profitable Growth	Program Stability	Reputation/ Customer Satisfaction
Government contract mechanisms and policies	Competition	✓			✓		✓	✓	✓
	Contract length		✓	✓	✓	✓	✓	✓	✓
	Foreign military sales	✓		✓	✓	✓	✓	✓	✓
	Risk sharing		✓	✓	✓	✓		✓	
	Profit		✓	✓		✓			
	Timely cash flow		✓			✓			
	Production rate						✓	✓	
	Provisions to protect IP	✓			✓		✓		
	Oversight								

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On the other end of the spectrum, the two industry motivators over which the government has the least influence—helping a company to maintain preeminence in an industry or to bolster its reputation—are among the most important to the contractors, in the COG's judgment.[58] This raises a key point: The government's influence over some industry motivators is quite limited. Apart from awarding a company a major contract, the only way for the government to gain a company's preeminence is to promote foreign military sales. COG participants noted that this may be an underused incentive.

Characterizing Incentive Structures for Information Technology and Communications Programs

The COG next looked at contract mechanisms in IT and communications systems. The commitments connected with acquisition contracts for these systems are differentiated by the speed of development and innovation. In contrast to large complex systems, the generation cycle of most IT products is two to three years and is driven by commercial competition. In most new generations of IT systems, about 80 percent of

[58] However, the government can negatively influence preeminence through disparaging public pronouncements.

the IT and communications features are retained from previous generations, whereas only 20 percent of features typically represent new generational breakthroughs. DoD's contracting mechanisms in this arena are slow and ponderous; by the time a contract is placed, the item might be already one to two cycles out of date. Support and maintenance also become a challenge.

Five years in the future, the interdependence of systems inside a platform and the interconnections among platforms will represent the high end of intellectual property. For these contracts, profits come from managing these interconnections and from customizing software and hardware. Although the contract motivators exist as stated above, government levers of influence differ from those in large, complex platforms: Foreign military sales, for instance, may be important in some cases but are not generally useful as a contract award criterion. Similarly, share lines, production rate, and variable cash flow are not as important in these contracts.

After completing its deliberations, the COG again used government levers and industry motivators discussed above to identify 35 combinations that could motivate defense contractors involved in providing IT and communications systems. These are displayed in Figure 2.7. Note that the rosters of levers and motivators differ slightly from

Figure 2.7
Industry Motivators Most Influenced by Government Contract Mechanisms on Information Technology and Communications Acquisition Programs

Government contract mechanisms and policies	Industry Motivators: Maintain Preeminence	Credit Rating	Owner Value	Manage Financial Risk	Returns	Profitable Growth	Cash Flow	Admin Burden	Reputation/ Customer Satisfaction
Competition	✓				✓				✓
Contract length		✓	✓	✓	✓	✓			✓
Foreign military sales	✓		✓	✓	✓	✓	✓		✓
Risk sharing		✓	✓	✓	✓	✓			
Profit		✓	✓		✓				
Timely cash flow		✓			✓				
Provisions to protect IP	✓			✓		✓			
Oversight							✓	✓	✓
Assessment criteria	✓			✓					✓

RAND *MG1171/6-2.7*

the ones that the COG used for the large, complex systems displayed in Figure 2.6.[59] Of these 35 mechanisms, 18 were connected with three government levers: contract length, foreign military sales, and risk sharing. As with complex systems, the longer the contract offered to a contractor, the greater the contractor's motivation. Foreign military sales, if allowed by U.S. law, are particularly attractive to IT firms because they increase contractors' business and customer bases. Risk sharing, in which government and contractors jointly shoulder exposure associated with cost and schedule overruns, is particularly important to this fast-paced industry, in the COG's experience.

Characterizing Incentive Structures for Service Contracts

The third business segment in the COG's examination involved contract mechanisms in service contracts. The COG suggested that service contracts need to be addressed in a different way from contracts for large, complex systems or for IT. These contracts represent more than 50 percent of the value of all DoD contracts. Many of them are low margin and involve significant personnel costs. They involve very little IP, and they require low start-up investments. The main motivator to most service contractors appears to be cash flow, because of significant payroll obligations on the part of many contractors.

In characterizing service contracts, COG participants noted that a distinction can be made between labor-based and knowledge-based services, one that is not clearly defined in current acquisitions procedures. How can the government use levers to incentivize contractors in these different categories?

The COG suggested that contract length is an important motivator for contractors, although, if used improperly, it may also be a disincentive in some cases. For example, if a contract is to be re-competed every three years, contractors may hold back their lowest price until the next competition.

To counter this, the COG suggested that contract lengths should not be fixed. Ideally incentives and length may differ with each contract, but every time poor judgment is exercised, the central authority may further limit flexibility.

The COG used eight government levers and nine industry motivators shown in Figures 2.6 and 2.7 to identify 28 combinations that could motivate defense contractors involved in providing services (Figure 2.8). Note again that the levers and motivators differ slightly from the ones that the COG used to examine large, complex systems or IT systems. Of these 28 mechanisms, 12 were connected with two government levers: contract length and foreign military sales. As in the other business segments, longer contract lengths tend to increase contractors motivations, in the estimation of the COG. Foreign military sales, if allowed by U.S. law and relevant security restric-

[59] An assessment criterion is a government lever that is not one the COG used in large, complex systems. Cash flow and administrative burden are industry motivators that were not used by the COG for those large systems. Foreign military sales are removed from the roster of government levers for IT and communications; they simply do not apply to this industry.

Figure 2.8
Industry Motivators Most Influenced by Government Contract Mechanisms on Service Support Programs

Government contract mechanisms and policies	Industry Motivators: Maintain Preeminence	Cash/ Credit Rating	Owner Value	Manage Financial Risk	Returns	Profitable Growth	Cash Flow	Admin Burden	Reputation/ Customer Satisfaction
Competition	✓			✓		✓			
Contract length	✓	✓	✓		✓		✓		
Foreign military sales	✓		✓	✓	✓	✓	✓		✓
Risk sharing		✓		✓					
Profit			✓			✓			✓
Timely cash flow				✓	✓			✓	
Oversight				✓		✓		✓	
Assessment criteria	✓								✓

RAND *MG1171/6-2.8*

tions, are attractive to service firms for the same reasons they are attractive to IT firms: They tend to increase contractors' business and customer bases.

The COG noted that there was a lack of OSD oversight for service-level contracts, some of which could be quite large.

Summary and Observations

A range of incentive structures exists, and they differ by segment: large, complex systems, information technology and communications and service contracts. However, in each, several combinations of government levers and industry motivators exist that can align the interests of the two groups more closely.

Conclusions and Recommendations

The first part of our research (historical review) has demonstrated that the issues surrounding contract incentives are varied and nuanced. There is a long history of examining contract type effectiveness and also many alternative treatments of contract mechanisms. For major systems acquisition, the phase of the program factors into appropriate contract type. Moreover, the nature of the goods or services being acquired

influences the incentives for both parties and therefore has implications for contracts. Overall, the singular, obvious conclusion is that contracts' form, type, and incentives must be tailored to the situation. A "one-size-fits-all" approach to defense contracting will not work.

With respect to the COG discussions, we note that the group's observations are drawn from long experience, but these have not be verified by independent research. However, they are made by people with long experience in acquisition and thus are worth noting. Some of the group's observations also echoed the perspectives found in our historical research—tailoring is critically important to effective incentives. Beyond that, the COG members made several, general observations on improving contract incentives for DoD:

- **Do Your Homework:** An important aspect to contract incentives is understanding the motivations of the people and firms with which the government negotiates. Understanding these motivations can help both the government and industry come to more beneficial terms. For example, if cash flow and prompt payment are more critical to a firm (or an individual's compensation), then the contract should tailor performance incentives in those areas. In other words, cost performance incentives may not be just a strict share line, but rather progress payments or retention percentages could be adjusted as well. To arrive at more effective incentives, the government must determine the incentive levers before negotiations begin. As we discussed in above, these levers are varied and depend on circumstances. Such an explicit assessment might be part of the documentation for contract award reviews.
- **Expand the Incentive Mechanisms:** The government has limited levers with which to motivate certain contractor incentives. Two of these levers seem to be infrequently used and need more consideration: foreign sales and payment terms. As we discussed earlier, foreign sales can be profitable and are generally sought by industry. Making an early determination of whether a system or service would be open to foreign sales could be used as leverage in negotiating other contract terms. As mentioned in the prior observation, cash flow is critical to certain firms. So, using cash flow as an incentive could be an effective motivation technique. The government has considered beginning pilot efforts under the Superior Supplier Incentive program. This program, in part, aims to allow contracting officers to set more favorable progress payments and withhold payment to firms that qualify. Regrettably, the government has not implemented this program.
- **People Matter:** One feature of contracts and negotiations that COG members felt was important is the fact that deals are made between people. Much contract guidance is about form and structure, but little deals with negotiation and strategy. The group recommended that this personal dimension to contracting be addressed in acquisition training.

- **Review the Cost Benefit of Oversight and Auditing:** Several COG members noted that the level of oversight and auditing on defense contracts seemed excessive in some cases and drawn out in others. They question whether such oversight resulted in any savings to the government. Although these audits did find some problems, they were few and did not balance the level of effort spent by both the government and contractor.[60] The group noted that in the commercial environment, there is far less of this activity, and that auditors work in a collaborative manner. The recommendation of the group is twofold: First, take a critical look at the current oversight process and assess whether it is generating value to the government; second, with regard to expeditionary contracts, examine whether personnel levels and processes support surge operations.
- **Systematically Review the Effectiveness of Incentives on Programs:** One area noted by the COG is that there does not appear to be any systematic review of the effectiveness of various contract incentives on program outcomes. Although GAO and others have reviewed the cost (and sometimes schedule) performance for various contract types, DoD could do more to retrospectively review how various incentives influence other areas such as responsiveness and quality.

[60] COG members observed that every time auditors show up, the company assigns multiple staff to work with them, gather data, and answer questions. This is an allowable expense.

CHAPTER THREE

A Methodology for Anticipating Nunn-McCurdy Breaches

This chapter documents an exploratory analysis to develop an analytical framework that will allow anticipation of MDAP Nunn-McCurdy breaches.[1] Our intent was to develop an approach that supports PARCA's primary missions of conducting root cause analyses and monitoring the performance of MDAPs. The framework draws on lessons learned from the root cause analyses RAND has performed, together with other readily available information, to narrow down the list of MDAPs from typically around 100 programs to a shorter, more manageable list of programs that should be monitored more closely for the possibility that they might breach Nunn-McCurdy thresholds.

This research demonstrated that such an approach, based on existing and readily available information, is feasible and that applying it allows the full MDAP program list to be winnowed down to a shorter list of programs that should be more closely monitored. For these programs, the methodology also provides information on potential risks and possible cost drivers, which can be used both as part of a root cause analysis and as guidance for performance assessment monitoring. This was an initial demonstration of a framework and an approach that could help acquisition oversight officials and analysts focus their attention on specific programs, as opposed to applying the same level of attention to all programs. We did not attempt a formal test for the effectiveness or validity of the approach, and considerable work remains to be done to mature and refine it. The intent was not to predict a future Nunn-McCurdy breach but rather to develop screening criteria that help identify programs that may require relatively more attention and monitoring.

The next section discusses the context for developing this research task and a more complete discussion of our objectives. We next present the analytical framework we developed to inform the methodology and describe our multistep approach. We then present the results of a demonstration run using information available as of

[1] For a brief history of the intent of the Nunn-McCurdy legislation and how it has evolved, see Appendix E.

September 2011.[2] The last two sections of the chapter present observations and key lessons from this exploratory effort and briefly describe possible next steps in terms of both methodology refinement and analysis.

Background and Objectives

PARCA bears responsibility for both root cause analysis and more general monitoring and performance assessment of acquisition programs. An inherent relationship exists between the factors that cause programs to breach their cost thresholds (root causes) and the kinds of things that an analyst would look for when assessing the current performance of a program.

RCAs conducted by RAND enabled us to compile a list of factors that are known to have contributed to a program's critical unit cost breach. The presence of those factors in an ongoing program that has not yet breached might signal a future breach. If we can identify the presence of those factors in a program early enough, we may be able to take action to prevent or mitigate the breach. That is the primary motivation for this research task.

One specific objective of this research task was to develop an analytical framework and methodology that enable oversight officials to anticipate critical unit cost breaches. Using information readily available to a PARCA analyst or other oversight official, the framework facilitates the screening of MDAPs to identify the presence of factors known to be associated with, though not necessarily cause, problems in program planning and execution, thus identifying programs that warrant more thorough monitoring and analysis. When applied to the full list of MDAPs, the framework enables the winnowing of the list to a smaller subset of programs that warrant more careful monitoring and assessment. This potentially allows DoD to prepare for, and perhaps even avert or at least mitigate, a critical unit cost breach.

Analytical Framework and Methodology

Since the overall purpose is to help senior oversight officials and the analysts supporting them to anticipate which programs are likely to breach their unit cost thresholds in the near term and therefore identify which programs require a greater degree of oversight, the framework needs to rest on the foundation of information available before an actual breach. The specific factors (variables, or metrics to the model) should be both conceptually and practically related to unit cost growth, and information about

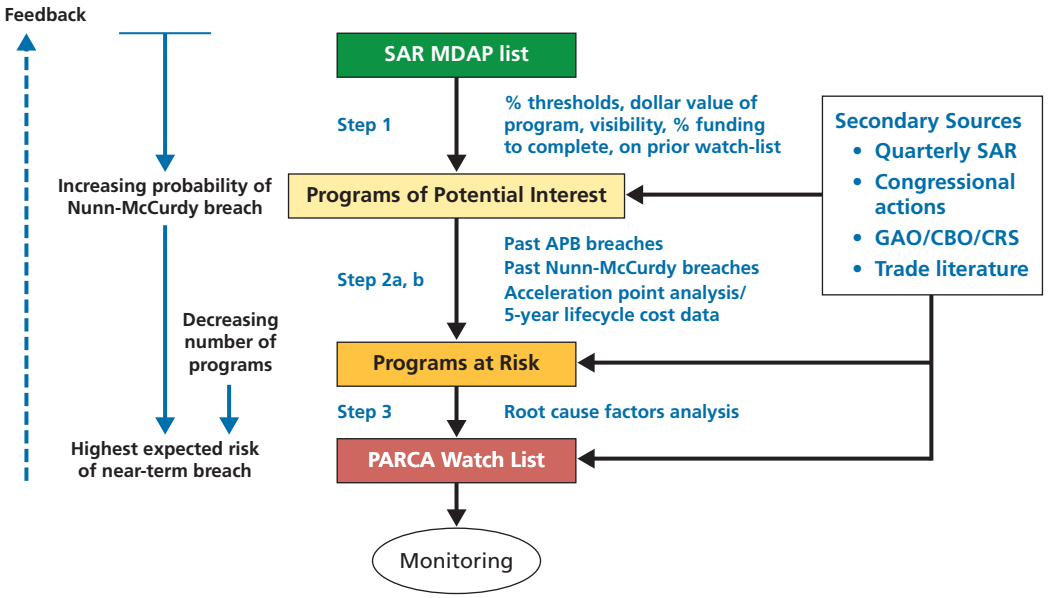
[2] This research task began in early 2011. The initial methodology was demonstrated using 2009 information and then checked against 2010 actual breaches. We then refined the framework and applied it to information available through the September 2011 Selected Acquisition Report (SAR) submission.

those factors must be readily available. The primary information sources include SARs, Defense Acquisition Executive Summary (DAES) reports, and ad hoc reports from DAMIR. Secondary sources include the trade literature, reports on programs from research or government agencies (e.g., RAND, GAO, Congressional Budget Office (CBO), or CRS).

The framework also needs to be relatively low-cost.[3] The framework applies criteria in a screening function to focus resource-constrained management and analysis attention on the programs and issues most likely to need it. Detailed assessment of these programs comes later and is outside this framework.

Our three-step approach begins with the current official MDAP list, which typically contains more than 100 programs. This list must be updated at the beginning of the analysis because it changes frequently because of program cancellations, the start-up of new programs, and the end of reporting requirements either because 90 percent of funds have been expended or thresholds on quantities delivered have been reached. As Figure 3.1 shows, our approach is implemented in three sequential steps, each of which draws on unique information, analysis, and criteria. Each step is designed to winnow down the MDAP list so that by the end of Step 3, a shorter and more man-

Figure 3.1
Overview of Anticipating Breaches Framework



RAND *MG1171/6-3.1*

[3] The initial development of the framework and the subsequent update required two researchers working less than half time over an approximately six-month equivalent period.

ageable list of MDAPs that warrant further assessment has been identified. Each step builds on the results of the previous one, and all information generated in each step is recorded in an Excel data file in a way that makes the specific information on a program and how that information was used completely transparent and fully documented. As we move sequentially through the steps, the criteria for adding or keeping a program on the list change from largely objective empirical criteria to measures that require informed judgment.

Throughout the analysis process, secondary information sources, such as trade literature articles or GAO reports, may offer new information about a program. After verifying this information as much as possible, it is incorporated into the analysis. If the program is being carried through from Step 1, then the new information is added to our database. If the new information identifies a program not on the list, and that information satisfies the criteria for one or more steps, we add that program to our evolving list. This latter action is important because although some programs are establishing a new acquisition program baseline, there may not be sufficient unit cost information to move a program past Step 1. We therefore need to rely on other sources beyond unit cost growth to decide whether the program should be added and carried on the list.

The overall approach is intended to be dynamic in the sense that new information from any credible source can be added, and the analysis is continuous and iterative. After a Watch List is developed (at the end of Step 3), the analyst draws on new or updated information about those programs and looks for information that would cause a new program to be added to or removed from the list.

Step 1

Step 1 begins with the official MDAP list as obtained from DAMIR. Each program is then independently assessed against the following six criteria:

- The program was on the Watch List generated in a prior iteration of the methodology.
- The program had a recent Nunn-McCurdy breach (either significant or critical) in the past few years.
- At least one unit cost growth metric is greater than 5 percent (this metric also takes into account prior year unit cost growth to determine if there are any major increases from year to year).
- The total program size (in dollars) is greater than $8 billion.
- More than 50 percent of the funds remain to be expended.
- The program is considered high visibility.

The program is included and moved to the second step if one or more of these criteria apply.

The first criterion is simply whether the program was on the RAND Watch List generated in a previous iteration, for whatever reason. If it was, the program is automatically carried on the Programs of Interest list into Step 2 for further assessment.

The next three criteria are empirically based thresholds. The 5 percent or greater unit cost growth is measured in the Nunn-McCurdy relevant metrics of program acquisition unit cost (PAUC) and average procurement unit cost (APUC) against both the original and current baseline. Program size is measured by total estimated program costs; in this case, greater than $8 billion is considered relevant. The amount of funds remaining to complete the program is also considered as an indicator; in this case, greater than 50 percent remains to be spent. All three cost-related metrics can be taken either directly from the SAR or calculated using information in the SAR.[4] The program size and percentage to complete metrics were suggested by PARCA and enable us to capture programs that may pass the unit cost growth metric but are either large enough that even below threshold cost growth could involve significant dollars or have a significant amount of time left in which a problem could develop. Although these two metrics are not necessarily associated with cost growth, they are indicators that should cause oversight officials to monitor program performance more closely.

The high-visibility metric is intended to capture programs of special interest that should be examined more carefully (in Step 2). These programs would include those receiving congressional attention or otherwise politically sensitive, programs with important implications for the industrial base, and very large dollar programs. Although these are relatively subjective measures, we wanted to construct a criterion that would allow us to capture programs that we know from secondary sources are highly visible or politically sensitive to examine more closely and determine, through subsequent steps, whether the program should be placed on the Watch List and monitored more closely.

Programs meeting one or more of the Step 1 criteria are placed on an intermediate list—Programs of Potential Interest—to be further assessed in Step 2.[5]

Step 2

Step 2 involves two distinct analytic tasks, either one of which can result in the program being carried forward into Step 3. One task analyzes the historical record of breaches for the Step 1 Programs of Potential Interest, paying particular attention to recent breaches. The second task—acceleration curve analysis—uses historical cost and quantity data to identify patterns and significant discrepancies that may indicate current or future cost growth. Both tasks bring new information into the analysis and

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[4] The data are from the unit cost, total program cost, and annual appropriate profile tables in the latest SAR.

[5] In practice, the programs on the Watch List from the previous iteration of the methodology would also automatically be placed on the Step 1 Programs of Potential Interest list. We would expect some overlap between the prior Watch List programs and those meeting Step 1 criteria in the current iteration.

require relatively more analytical judgment and data processing. All necessary information is attainable through DAMIR.

The first task collects data on past breaches for each program of interest. These data are readily available in DAMIR through generation of a preprogramed ad hoc report that counts the number of breaches in each program's history; the resulting data are downloaded to an Excel file and merged with the data from Step 1. There are two kinds of breaches: APB and Nunn-McCurdy. APB breaches track the number of times the program has exceeded certain thresholds, including RDT&E cost, procurement cost, unit cost (PAUC and APUC), schedule, and performance metrics. In this case, a breach occurs anytime the value of the metric exceeds its baseline estimate threshold value, regardless of magnitude of the breach. Schedule and performance breaches are referenced to the specific schedule milestones and key performance parameters (KPPs) listed in a program's SAR. Nunn-McCurdy breaches have statutory definitions—PAUC and APUC percentage increases measured against both the original and current program baselines—and may be either "significant" or "critical." As in the case of APB breaches, we are simply counting the number of historical Nunn-McCurdy breaches, without reference to their magnitude.[6] For both types of breaches, we count the different kinds of breaches separately, in aggregate (total sum), and the number of recent (in the last two years) breaches.[7]

Acceleration curve analysis involves plotting annual cost and quantity metrics over time for each program to identify one or more points that suggest discontinuous or episodic change. Such changes in patterns of cost or quantity over time can indicate that something happened in the program that warrants more attention. In developing this aspect of the approach, we plotted and examined many different kinds of cost- and quantity-related curves for many programs and settled on the following as the best indicators (see Figures 3.2–3.5):

- a line chart of unit cost (PAUC and APUC) values, with quantity plotted on the alternate axis
- a stacked bar chart composed of RDT&E and procurement cost
- a stacked bar chart showing annual (year-to-year) percent change in RDT&E and procurement costs
- a line chart showing development and procurement (adjusted and unadjusted for changes in quantity) cost growth factors.

The objective of both Step 2 tasks is to identify programs that appear to have experienced an event or other incident that may have increased cost. These events do

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[6] The actual magnitude of the current Nunn-McCurdy unit cost metrics (all four) are recorded in the database as part of Step 1. This is how the 5 percent cost growth threshold is implemented.

[7] DAMIR has an ad hoc report that produces an Excel file with the number of Nunn-McCurdy and APB breaches, which facilitates this part of the Step 2 analysis.

not need to be explained as part of Step 2, though any possible explanatory information may be captured for use in Step 3.

Step 2 results in a shorter Programs at Risk list that combines the results of Step 1 and both Step 2 subtasks. Programs are eliminated from the Step 1 programs of interest list if they do not show a significant history of APB or Nunn-McCurdy breaches, recent APB or Nunn-McCurdy breaches, or evidence from the cost curves that costs are beginning to increase at an accelerated rate.

Step 3

Step 3 is the root cause analysis. It is the most analytically intensive of the steps and requires some knowledge of the history of each program on the Programs at Risk list from Step 2. This step is very much like a "mini RCA" in the sense that program-related materials are searched for indications that one or more factors known to be associated with cost increases are present. The primary program documentation reviewed includes both SARs and DAES. Within the SARs, the relevant sections are the executive summary and change explanations associated with the schedule, cost, and contracting sections. In the DAES, the executive summary and the assessment sections are the most informative. In both reports, we have found that any explanations of problems associated with reported breaches are also useful. In addition, DAES reports provide PM and OSD assessments on a variety of functional subject categories (e.g., cost, schedule, performance) that are also useful. If the information in the DAES or SARs is inadequate or we need more detail on a particular problem, we can refer to the monthly/quarterly DAES Program Status Charts that provide more details on risks and mitigations. Multiple reports of each type are reviewed, particularly from years in which data from Step 2 indicated that breaches occurred or the acceleration curves indicated a major change in cost or quantity. This step is best accomplished while logged in to DAMIR so that all necessary reports can be easily accessed.

Step 3 criteria include evidence that one or more of the factors known to affect program cost (or program outcomes more generally) may be present.[8] That evidence, found in the text of the report sections identified above, does not need to be fully validated at this stage. Rather, the analyst uses judgment and experience to determine whether an individual factor may be affecting the program. We also do not need an assessment of the extent to which a given factor may be present; a simple yes or no determination is sufficient for our purposes here. The supporting evidence (text from the SAR or DAES) is literally copied and pasted into the relevant cell of a preformatted Excel file in which columns are labeled with specific factors.

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[8] See, for example, Mark V. Arena, Robert S. Leonard, Sheila E. Murray, and Obaid Younossi, *Historical Cost Growth of Completed Weapon System Programs,* Santa Monica, Calif.: RAND Corporation, TR-343-AF, 2006; 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; and Blickstein et al., 2012.

Table 3.1 lists the factors and their definitions as currently formulated. This factor list was generated based on a review of the RCAs that RAND has performed to date, as well as factors that other research has shown to be associated with cost increases.

As mentioned above, a review of secondary-source material (trade literature, GAO reports, etc.) is continuous. If that review identifies programs that meet the criteria of any step, the program is included on the appropriate list. Secondary-source material may also inform the root cause factors analysis in Step 3.

Programs are removed from the Step 2 Programs at Risk list if no evidence is found that one or more factors may be affecting program execution and outcomes. The result is the RAND Watch List. Programs on the Watch List are those that have been determined to have a relatively higher risk of a near-term Nunn-McCurdy breach. This is not intended to be a definitive prediction; rather, programs on the Watch List are those for which a preliminary analysis, using a wide variety of information available at the time, shows a qualitative (and therefore undefined) probability of incurring a Nunn-McCurdy breach in the near term. We anticipate that these programs may breach unit cost thresholds over the next few years and therefore warrant somewhat closer monitoring than programs not on the Watch List.

The analysis in Step 3 also points to specific factors that should be assessed more thoroughly. Should one of these programs incur a critical Nunn-McCurdy breach, an RCA can begin with the information documented in the anticipating-breaches database and the analysis already begun. The anticipating-breaches framework has given the RCA team a place to start by posing hypotheses about program cost drivers and assembling a limited amount of supporting evidence.

The information generated during application of the framework is documented and stored in its entirety in an easily used Excel file. This information can support additional analysis to refine the Watch List, identify programs with particular kinds of risks, or support other related analyses. More important, it provides a foundation of information to inform decisions on which programs to monitor more closely in the near term, and a set of data to begin that assessment.

An Initial Demonstration of the Framework

The framework described above was initially developed and refined using information available in 2009. The resulting Watch List was then compared with the programs that actually incurred a Nunn-McCurdy breach in 2010. Although the initial demonstration predicted only five of the nine programs in breach in 2010, it did allow proof of concept and provide lessons for refining the framework. Those lessons included how to represent and document the information used in each of the three steps, the importance of making the analysis process dynamic and able to incorporate new information from primary and secondary sources as it becomes available, how to handle programs

Table 3.1
Factors Affecting Program Breaches

Factor	Description
1. Areas within DoD control	**Decisions, choices**
1A. Program Planning	Activities, events, or issues associated with planning prior program initiation
1A.1. Resource estimating	Labor, time, money, materials required
1A.1.a. Cost	Underestimation
1A.1.b. Schedule	Unrealistic (cannot accomplish in time allowed)
1A.1.c. Labor/workforce	Unavailability (number and required skills)
1A.1.d. Budget	Notfully funded in Program Objectives Memorandum
1A.2. Requirements setting	
1A.2.a. Capability description	KPPs incomplete (performance not fully defined)
1A.2.b. Performance expectations	Infeasible (not achievable with current or expected technology)
1A.3. Technological maturity	
1A.3.a. TRL	TRL ≤ 6
1A.4. Production planning	
1A.4.a. Production design	Layout, tooling issues not thought through
1A.4.b. Production readiness	"MRL" ≤ 6 (system or production design issues remain)
1A.5. Test planning	
1A.5.a. Test description	Incomplete (tests, resources needed)
1A.5.b. Resource availability	Resource availability not assured
1A.6. Other acquisition strategy related	
1A.6.a. Contracting strategy	Not defined completely Not appropriate
1A.6.b. Transition plan	No plan exists, or is incomplete, or unexecutable
1B. Program execution	Activities, events, or issues associated conduct of program
1B.1. Requirements change	
1B.1.a. Quantity	Change in number of units procured
1B.1.b Capabilities	Change in system performance
1B.1.c. Threat	Change in mission need
1B.2. Technical difficulty	
1B.2.a. Design	Infeasible, overly complicated, or too complex

Table 3.1—Continued

Factor	Description
1B.2.b. Engineering	Part or component failure; integration issue; development issue
1B.2.c. Manufacturing	Part or component failure; integration issue; producibility issue
1B.3. Resources	
1B.3.a. Cost	Cost growth (total, R&D, procurement, unit)
1B.3.b. Budget stability	Large or frequent reduction to budget
1B.3.c. Accounting artifact	Color of money (i.e., which appropriation category) rules, computational, accounting categories
1B.4. Human capital	
1B.4.c. Number (gap)	Too few people (simple count)
1B.4.d Skill match	Inadequate knowledge and experience
1B.5. Oversight performance	
1B.5.a. Contractor	
1B.5.a. 1. Experience	Inadequate prior experience, incompetent, lack of functional knowledge
1B.5.a.2. Process integrity	Poor internal management
1B.5.b. OSD and Service oversight organizations	
1B.5.a. 1. Experience	Inadequate prior experience, incompetent, lack of functional knowledge
1B.5.a.2. Process integrity	Poor internal management
1B.5.c. Government program management office	
1B.5.a. 1. Experience	Inadequate prior experience, incompetent, lack of functional knowledge
1B.5.a.2. Process integrity	Poor internal management
1B.5.d. Quality of interactions	Mutual support/collaboration
1B.6. Other	
2. Areas not within DoD control	**External**
2A. Market-based environment	Events or issues associated with industry or product related market
2A.1. Increase in material, labor, or component costs	Price increase

Table 3.1—Continued

Factor	Description
2A.2. Material or component availability	Not available, long lead times
2A.3. Industry base collapse	Structural or financial collapse
2A.4. Change in commercial market	Changes in commercial demand, manufacturing base
2B. Disasters	
2B.1. Man-made	Intentional/terrorism; accidental
2B.2. Natural	Earthquake, fire, flood, etc.
2C. Actions of other government organizations	Non-DoD organizations
2C.1. Executive	Non-DoD actions not captured elsewhere
2C.2. Judicial	Actions not captured elsewhere
2C.3. Legislative	Actions not captured elsewhere
2C.4. Foreign government decisions	Allies, adversaries
2C.5. International organizations	North Atlantic Treaty Organization, United Nations

that are either new or are no longer reporting SARs and DAES, and the need for consistency in how each criterion is applied across programs. Those lessons were incorporated during the second demonstration, the results of which are presented below.[9] It is also important to recognize that we are not trying to predict which programs will breach but rather identify a set of programs at relatively higher risk of a near-term breach. This identification will allow PARCA to focus its limited resources on a smaller set of programs.

Of the 102 programs on the official FY 2010 MDAP list, 52 had unit cost growth in at least one metric that exceeded the 5 percent threshold, which is one screening criterion in Step 1 of our process. Twenty-four additional programs were identified as programs of potential interest based on the other Step 1 criteria—program size >$8 billion, >50 percent to complete, on a prior (2009) watch list, or high visibility. However, 14 programs on the MDAP list had a final SAR in December 2010/Quarterly 2011, which eliminated eight programs with 5 percent or greater unit cost growth: B-2 Radar Modernization Program (RMP), C-5 Avionics Modernization Plan (AMP), Expeditionary Fighting Vehicle (EFV), Increment 1, Early Infantry Brigade Combat Team, Joint Tactical Radio System Ground Mobile Radio (JTRS GMR), Longbow Apache,

[9] The results documented below are based on information available through September 2011, including the December 2010 SAR, quarterly SARs and DAES reports, and other relevant material.

Space-Based Space Surveillance (SBSS) B10, and T-AKE.[10] Because these programs were no longer reporting, they were excluded from further analysis here. The rationale for dropping these programs is that they were either complete or had been canceled, meaning that there was no future program that warranted monitoring. Other programs that ended reporting include Advanced SINCGARS Improvement Program, Advanced Threat Infrared Countermeasures, Force XXI Battle Command, Brigade-and-Below (FBCB2), Joint Mine Resistant Ambush Protected (MRAP) vehicle, and large aircraft infrared countermeasure. The total program count at the end of Step 1 was 68, listed in Table 3.2.

Table 3.3 shows the results of the first element of Step 2—counting the number of breaches—by ranking the 68 programs of interest by the total number of near-term APB and Nunn-McCurdy breaches. There appears to be some association between the cumulative number of breaches and whether a program has a Nunn-McCurdy breach.

The second part of Step 2 is the acceleration curve analysis. Figures 3.2–3.5 represent the several chart types we used in this analysis for a single program (Global Hawk). We generated these four chart types for all 68 programs on the Step 2 Programs of Interest list. Figure 3.2 plots the unit cost metrics (PAUC and APUC) and quantity over time. As mentioned above, these data are extracted directly from the program's SAR. The two oval overlays indicate the relative acceleration points in these metrics for this program. The oval indicating a more recent acceleration is of immediate interest here, particularly the sharp changes in PAUC and quantity in 2009 and 2010. Although the focus in this part of the analysis is on recent changes, it is important to acknowledge and explore (in Step 3) the changes in past years. It is often the case that the drivers of a Nunn-McCurdy breach have their origins in earlier time periods. The cumulative or aggregate effects of cost drivers over time may contribute to a breach in any given year.

Figure 3.3 plots total RDT&E and procurement current estimates over time in a stacked bar format. For this particular program, both cost metrics steadily increase over time. Of special interest is the change from December 2008 to December 2009 in procurement and the change in RDT&E costs from December 2009 to December 2010.

Figure 3.4 shows the third type of acceleration curve we use: the annual percentage change in RDT&E and procurement accounts. In the Global Hawk example, the same time periods as other charts had indicated show large year-to-year changes in RDT&E and procurement. This is not unexpected given the metrics we are using, but the relative magnitude of the change is more apparent. This chart also suggests, given what we know about the program's schedule, that year-to-year changes in RDT&E are more likely to occur during development, and year-to-year procurement cost changes

[10] EFV and JTRS GMR had at least one critical Nunn-McCurdy breach; Increment 1 E-IBCT (a Future Combat System spinoff) had a significant breach.

Table 3.2
Step 1 Results: Programs of Potential Interest List

Program Name		
AB3A remanufacture	EA-18G	MH-60R
AB3B new build	Excalibur (rebaselining)	MH-60S
Advanced EHF	F/A-18E/F	MP-RTIP
AGM-88E AARGM	FAB-T Increment 1	NAS
AIM-9X	FMTV	Navstar GPS – Space and Control
AMF JTRS	Global Hawk (RQ-4A/B UAS)	NED (JTRS)
AMRAAM (AIM-120)	GMLRS	NPOESS
Army IAMD	GPS IIIA	Patriot PAC-3
B-2 EHF Increment 1	H-1 upgrades (4BW/4BN)	Patriot/MEADS CAP – fire unit
BAMS UAS	HC/MC-130 recapitalization	Patriot/MEADS CAP – missile
Black Hawk UH-60M	HIMARS	Reaper
BMDS	HMS (JTRS)	RMS
C-130 AMP	IDECM – IDECM Blocks 2/3	SBIRS High
C-130J Hercules	JASSM (baseline)	SM-6
CEC	JCA (C-27J)	Stryker
CH-47F (ICH)	JDAM	Tomahawk (R/UGM-109E)
CH-53K program	JLENS	Trident II missile
Chem Demil – ACWA	JSF (F-35)	*Virginia*-class sub (SSN 774)
Chem Demil – CMA	JSOW – Unitary	VTUAV
Cobra Judy replacement	KC-46 (first SAR September 2011)	WGS
DDG-1000 destroyer	LCS	WIN-T Increment 2
DDG-51 destroyer	LHA 6	WIN-T Increment 3
E-2D AHE	LPD 17 class	

NOTES: Eight programs do not have unit cost data. Three programs have PAUC but not APUC. Unit cost data are from the December 2010 SARs. Data do not include quarterly SAR data, except for the KC-46. Programs in blue had a critical Nunn-McCurdy breach in either 2010 or 2011 and those in green had a significant Nunn-McCurdy breach in either 2010 or 2011. Data are as of September 2011.

are more likely to occur during production. Although this may seem obvious in hindsight, the relationship provides a strong clue about what analysts should be looking for by program phase.

Table 3.3
Step 2 Analysis: Rank Ordering of Programs, by Number of Breaches

Program	Total No. of Breaches	Program	Total No. of Breaches	Program	Total No. of Breaches
Chem Demil – ACWA	14	AIM-9X	4	F/A-18E/F	1
JLENS	12	NPOESS	4	GPS IIIA	1
Global Hawk (RQ-4A/B UAS)	10	Patriot/MEADS CAP – missile	4	MH-60R	1
Virginia-class sub (SSN 774)	9	Tomahawk (R/UGM-109E)	4	SM-6	1
RMS	9	Patriot/MEADS CAP –fire unit	4	Trident II missile	1
SBIRS High	9	Black Hawk UH-60M	3	WIN-T Increment 2	1
FAB-T Increment 1	8	CH-47F (ICH)	3	AMF JTRS	1
JASSM (baseline)	8	GMLRS	3	WIN-T Increment 3	1
Excalibur	7	Navstar GPS – Space and Control	3	B-2 EHF Increment 1	0
Stryker	7	NED (JTRS)	3	C-130J Hercules	0
CH-53K program	6	AGM-88E AARGM	2	CEC	0
LHA 6	6	AMRAAM (AIM-120)	2	H-1 upgrades (4BW/4BN)	0
MH-60S	6	IDECM – IDECM Blocks 2/3	2	HIMARS	0
VTUAV	6	JSOW – Unitary	2	JDAM	0
AB3A remanufacture	6	LPD 17 class	2	NAS	0
Advanced EHF	6	Patriot PAC-3	2	AB3B new build	0
DDG-1000 destroyer	6	Chem Demil – CMA	2	BAMS UAS	0
JSF (F-35)	6	E-2D AHE	2	BMDS	0
WGS	6	FMTV	2	HC/MC-130 recapitalization	0
C-130 AMP	5	MP-RTIP	2	KC-46	0
Cobra Judy replacement	5	Army IAMD	1	LCS	0
JCA (C-27J)	5	DDG-51 destroyer	1	Reaper	0
HMS (JTRS)	5	EA-18G	1		

NOTES: Programs in blue had a critical Nunn-McCurdy breach and those in green had a significant breach in either 2010 or 2011. Data are as of September 2011.

Figure 3.2
Acceleration Curve Analysis Example 1

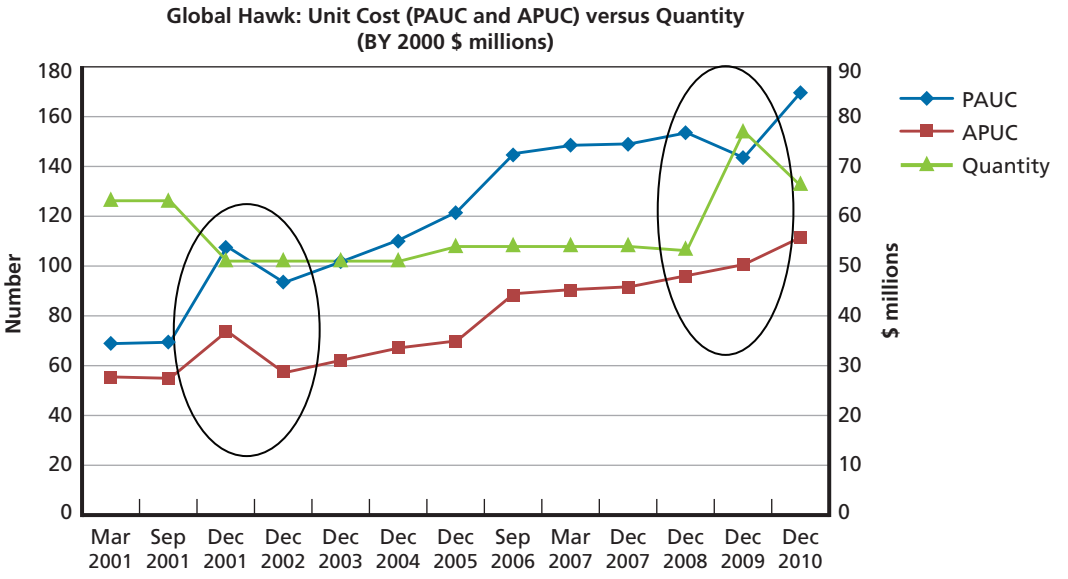

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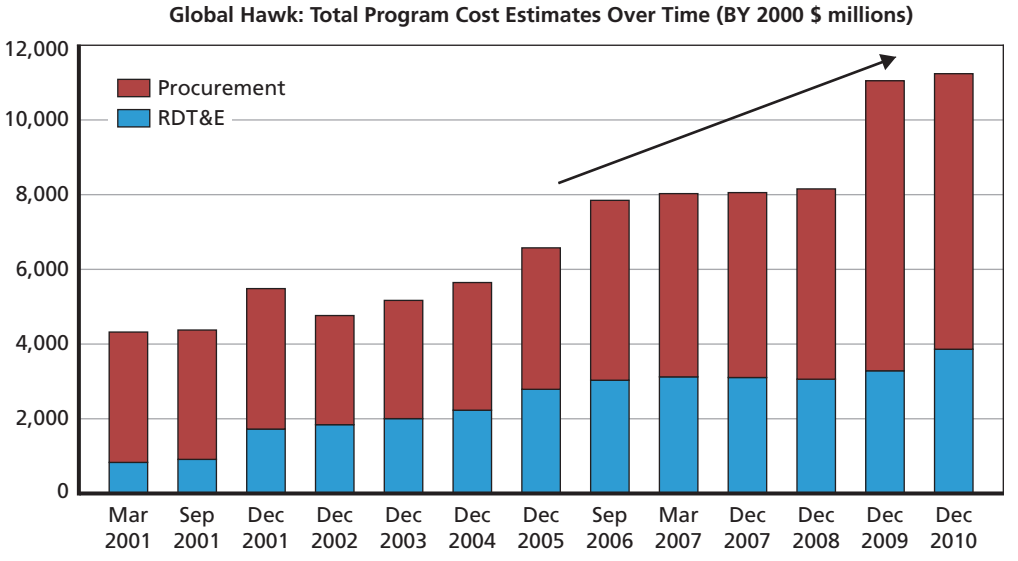
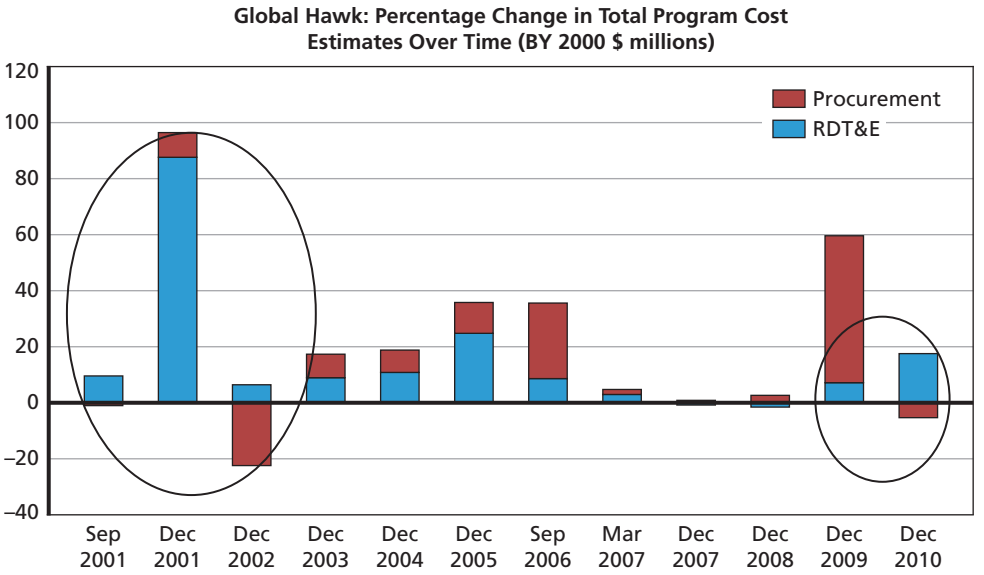
Figure 3.3
Acceleration Curve Analysis Example 2



RAND *MG1171/6-3.3*

Figure 3.4
Acceleration Curve Analysis Example 3



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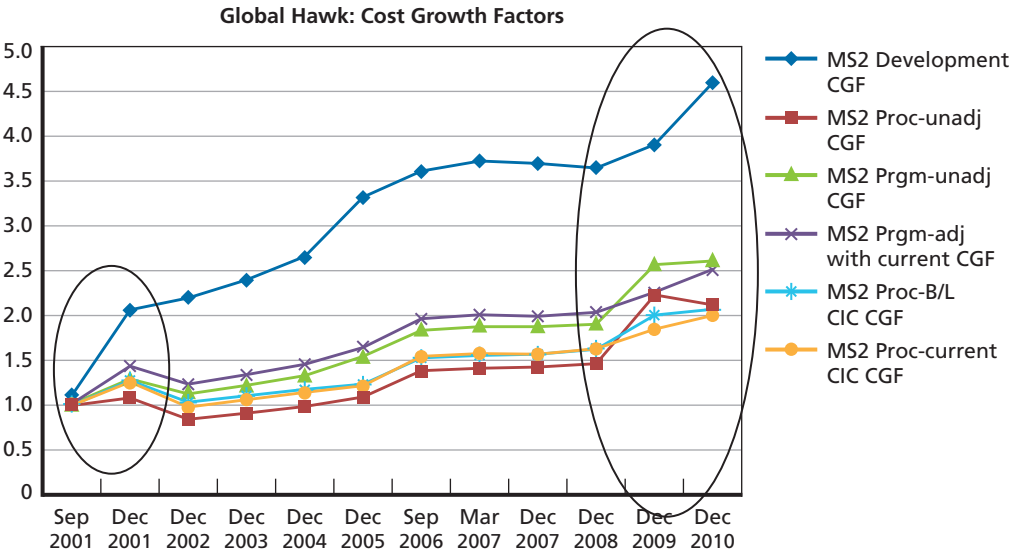
The final acceleration curve chart we use plots RDT&E, procurement, and total program cost growth factors (CGFs) over time (Figure 3.5).[11] These factors are drawn from a long-standing RAND database that tracks cost growth for all MDAPs using data in the SARs.[12] The total program CGF includes both RDT&E and procurement. In RAND's cost growth methodology, procurement cost growth is adjusted for changes in quantity, normalizing costs back to the original baseline quantity estimate, resulting in adjusted and unadjusted factors. For our use here, we are more interested in the unadjusted factors, since changes in quantity is one potential cause of a unit cost breach. As Figure 3.5 shows, the same time periods indicate sharp increases in most of cost growth metrics plotted. In all four figures, we are looking for sharp (i.e.,

[11] Total program cost growth is calculated by adding RDT&E and procurement dollars (either adjusted for quantity or unadjusted) and then dividing by the baseline total program cost estimate (RDT&E + procurement). In Figure 3.5, the MS2 label means that the Milestone II (now MS B) point is used as the baseline against which cost growth is measured. The development CGF is just RDT&E dollars. The Proc-unadj and Prgm-unadj CGFs are the unadjusted procurement and total program cost growth factors, respectively. The Prgm-Adj w/Current and Proc-Current CIC CGFs use the current (most recent SAR) annual funding table to estimate a cost improvement curve (CIC) to adjust the procurement dollars for changes in quantity. The Proc-B/L CIC CGF uses the baseline (B/L) annual funding table from to calculate the CIC and adjust for changes in quantity.

[12] For more information, see J. 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; and Arena et al., 2006.

Figure 3.5
Acceleration Curve Analysis Example 4



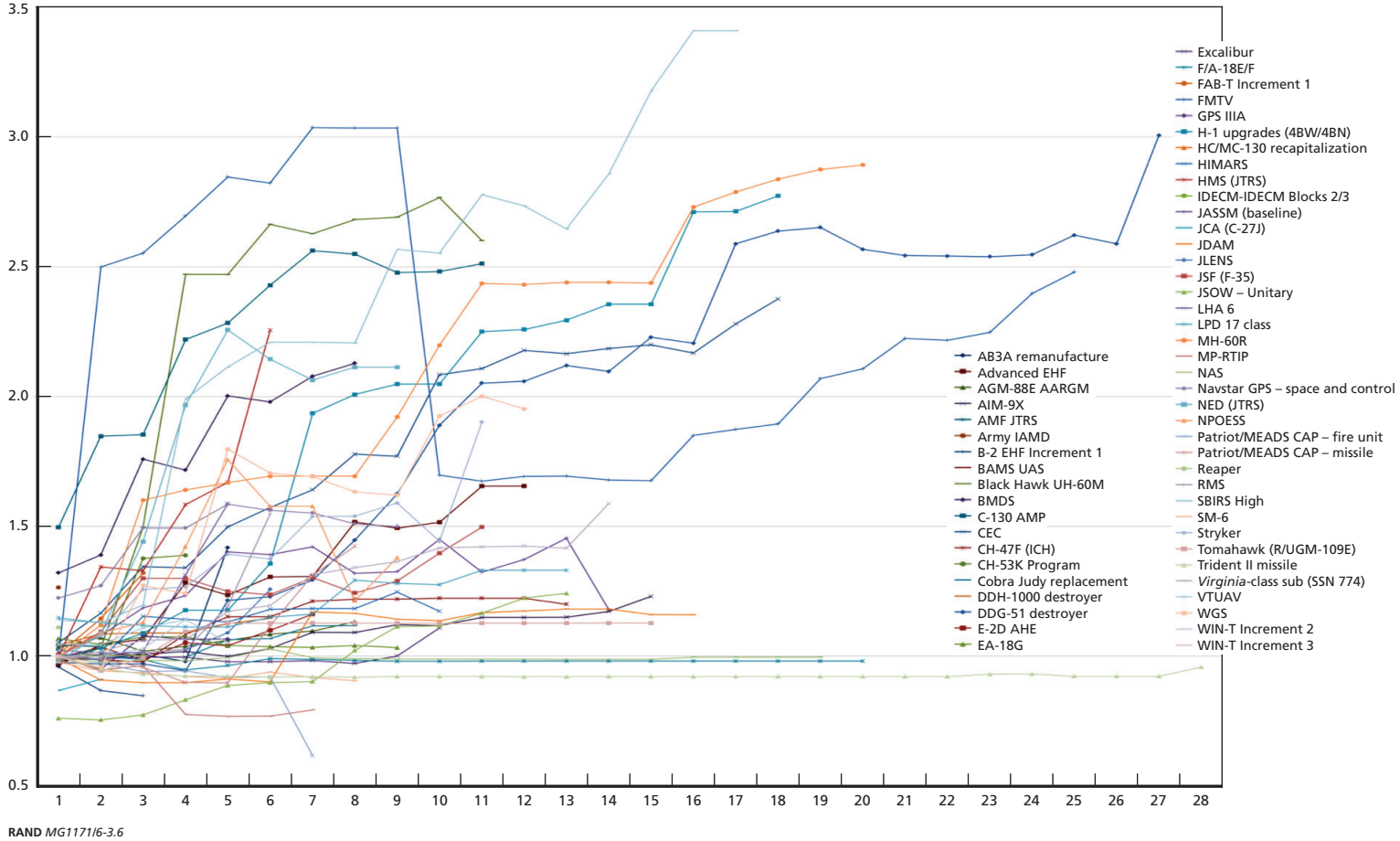
RAND *MG1171/6-3.5*

accelerated) changes in the metrics as indicative of an underlying factor that should be explored more thoroughly.

The development cost growth factor is particularly useful in the context of anticipating and mitigating potential problems that could cause a program to breach Nunn-McCurdy thresholds in the future. Development cost growth can be considered as something of a leading indicator: Sharp increases not long after MS B indicate that the technical and integration issues may not have been fully understood, whereas development cost growth later in the development cycle might indicate technical and manufacturing problems as the design is transitioned from development to production (the final development units are usually close to representing production units).

One way to use this information is to plot the development cost growth factor for programs of interest in a years-past-MS B format (as opposed to calendar-based). In fact, using years past MS B in the x-axis normalizes programs for maturity and allows comparisons across programs. Comparing programs in this fashion provides an opportunity to identify those programs that have had relatively sharp increases in development costs, which usually indicates either technical or requirements-related challenges. One interesting observation from Figure 3.6 is that these increases tend to happen three to five years after MS B. In the context of anticipating future Nunn-McCurdy breaches, this suggests that programs that have sharp development cost growth soon after MS B appear to have much higher total development cost growth than programs that experience a lower and more continuous rate of cost growth; such programs may

Figure 3.6
Development Cost Growth Factors Normalized for Maturity



RAND *MG1171/6-3.6*

be at relatively greater risk of a future breach. It also suggests that if the causes of that breach are not sufficiently addressed, a subsequent breach is relatively more likely.

Table 3.4 shows the results of the Step 2 analysis; 15 programs were removed from the Programs of Interest list, leaving 53 on the Programs at Risk list. These remaining programs have a history of APB or Nunn-McCurdy breaches, or the quantity, development and procurement cost, and CGFs show relatively sharp increases.

Step 3 introduces information that begins to explain the patterns observed in programs from the past APB and Nunn-McCurdy breaches and acceleration curve

Table 3.4
Step 2 Results: Programs at Risk

Programs		
AB3A remanufacture	E-2D AHE	LPD 17 class
AB3B new build	Excalibur	MH-60S
Advanced EHF	F/A-18E/F	MP-RTIP
AIM-9X	FAB-T Increment 1	NAS
AMF JTRS	FMTV	Navstar GPS – space and control
AMRAAM (AIM-120)	Global Hawk (RQ-4A/B UAS)	NED (JTRS)
Army IAMD	GPS IIIA	NPOESS
B-2 EHF Increment 1	H-1 upgrades (4BW/4BN)	Patriot PAC-3
Black Hawk UH-60M	HC/MC-130 recapitalization	Patriot/MEADS CAP – fire unit
BMDS	HMS (JTRS)	REAPER
C-130 AMP	JASSM (baseline)	RMS
CEC	JCA (C-27J)	SBIRS High
CH-47F (ICH)	JLENS	Stryker
CH-53K program	JSF (F-35)	Tomahawk (R/UGM-109E)
Chem Demil – ACWA	JSOW – Unitary	*Virginia*-class sub (SSN 774)
Cobra Judy replacement	KC-46	VTUAV
DDG-1000 destroyer	LCS	WGS
DDG-51 destroyer	LHA 6	

NOTE: Programs in blue had a critical Nunn-McCurdy breach in either 2010 or 2011, and those in green had a significant breach in either 2010 or 2011.

analysis. For each program on the Programs at Risk (Step 2) list, we used information in the SAR and DAES, DAES assessments, SAR cost, schedule, and contract change explanations, and available trade literature to determine whether one or more of the factors listed in Table 2.1 are present and potentially affecting program outcomes.

The result is the Watch List shown in Table 3.5. There are 39 active programs (i.e., still reporting SARs or DAES as of September 2011) on the Watch List. The analysis in Step 3 determined that each of these programs was being adversely affected by one or more of the root cause factors listed in Table 3.1. The Step 3 analysis is not intended as a definitive statement but rather reflects and determination that there was enough evidence in the primary- and secondary-source materials to warrant further monitoring and a more detailed, focused assessment.

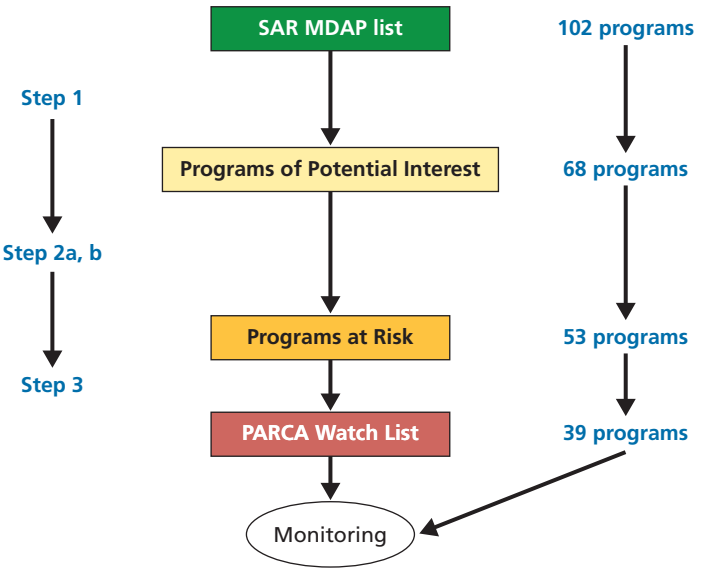
A summary of how the anticipating-breaches methodology winnowed down the list of MDAPs is shown in Figure 3.7. Beginning with the 102 programs on the 2010 MDAP list, the methodology identified programs to be either retained or removed from the list in a series of steps resulting in a final list of 39 programs. Each step adds a different set of information and different criteria to the previous step.

Table 3.5
Step 3 Results: 2010–2011 Watch List

Programs		
Advanced EHF	Global Hawk (RQ-4A/B UAS)	MP-RTIP
AIM-9X	GPS IIIA	Navstar GPS – space and control
AMF JTRS	H-1 upgrades (4BW/4BN)	NED (JTRS)
AMRAAM (AIM-120)	HMS (JTRS)	NPOESS
Army IAMD	JASSM (baseline)	Patriot PAC-3
C-130 AMP	JCA (C-27J)	Reaper
CH-53K program	JLENS	RMS
Chem Demil – ACWA	JSF (F-35)	SBIRS High
DDG-1000 destroyer	KC-46	Stryker
E-2D AHE	LCS	Tomahawk (R/UGM-109E)
Excalibur	LHA 6	*Virginia*-class sub (SSN 774)
F/A-18E/F	LPD 17 class	VTUAV
FAB-T Increment 1	MH-60S	WGS

NOTES: Programs in blue had a critical Nunn-McCurdy breach in either 2010 or 2011, and those in green had a significant breach in either 2010 or 2011. Data are as of September 2011.

Figure 3.7
Summary of Program Elimination



RAND *MG1171/6-3.7*

Observations and Extensions

This exploratory analysis demonstrates that readily available information can be used to identify a set of programs that appear to be at relatively higher risk of a future breach. Although we cannot yet accurately predict which programs will incur a Nunn-McCurdy breach in the near term, we can sort through the complete MDAP list and identify programs that are at higher risk than other programs using criteria derived from readily available information. Application of the framework results in a shorter and more manageable list of programs to monitor and also provides hypotheses about what exactly to look for in each program.

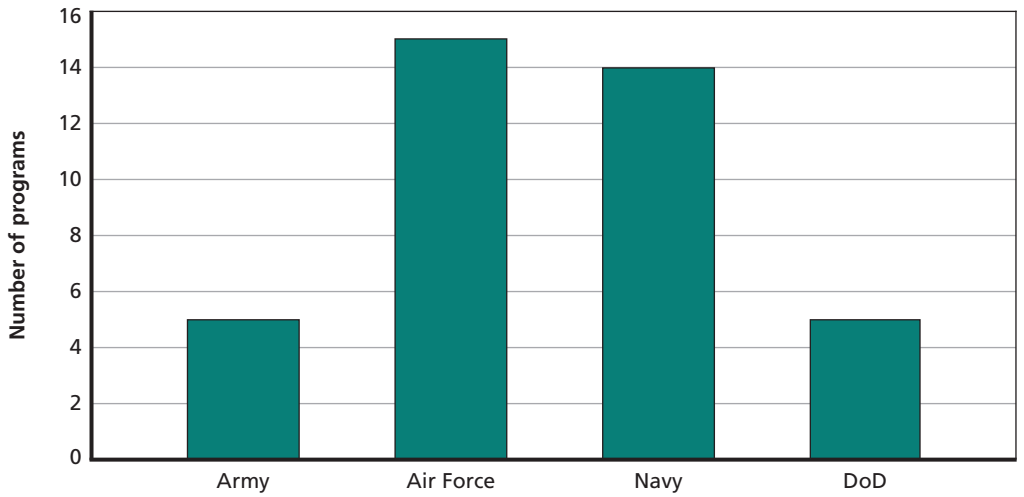
The framework is designed to be dynamic, and the Watch List can be continuously updated as specific new criteria or information on programs becomes available. The methodology is also designed to be refined easily as specific new models or methods become available. Capabilities can be added to the approach with relative ease (e.g., automating specific data sorts to provide different perspectives in Step 1 or specific graphical representations of the data).

As discussed above, the purpose of the framework is to help identify a set of programs that may require relatively more attentive monitoring than the average MDAP. Although the Watch List is the final product of the framework, it is only the beginning of the analysis. Using the information generated in this approach, or additional information external to the methodology, provides a foundation for analysts and oversight officials to focus their attention and conduct more detailed assessments of each pro-

gram. The most direct application would be to organize the information about each program on the Watch List into the beginnings of a formal RCA, thus providing a head start in the event of a critical Nunn-McCurdy breach. But there are other ways to use the Watch List and associated program information to generate insight into the factors affecting program outcomes; a few examples are discussed below. These examples illustrate analyses made easier because the information required has already been collected, processed, and formatted in the Excel workbook supporting the main anticipating-breaches framework.

For instance, Figure 3.8 shows the number of programs on the Watch List by DoD component. The Army has the fewest programs on the list, which is in contrast to other studies suggesting that the Army has a serious program management problem, as shown by the relative number of canceled MDAPs over the last decade.[13] However, this result is a function of how our approach works. Once canceled, a program stops reporting SARs and DAES and therefore gets dropped moving from one step to the next. Although this is valid given the purpose of our framework—identifying programs that require relatively more monitoring and detailed assessment—it does not mean that the Army has better program outcomes than its sister Services. That said, the apparent difference between the number of Army and DoD programs on the one hand and Air

Figure 3.8
Watch List Programs, by Component



RAND *MG1171/6-3.8*

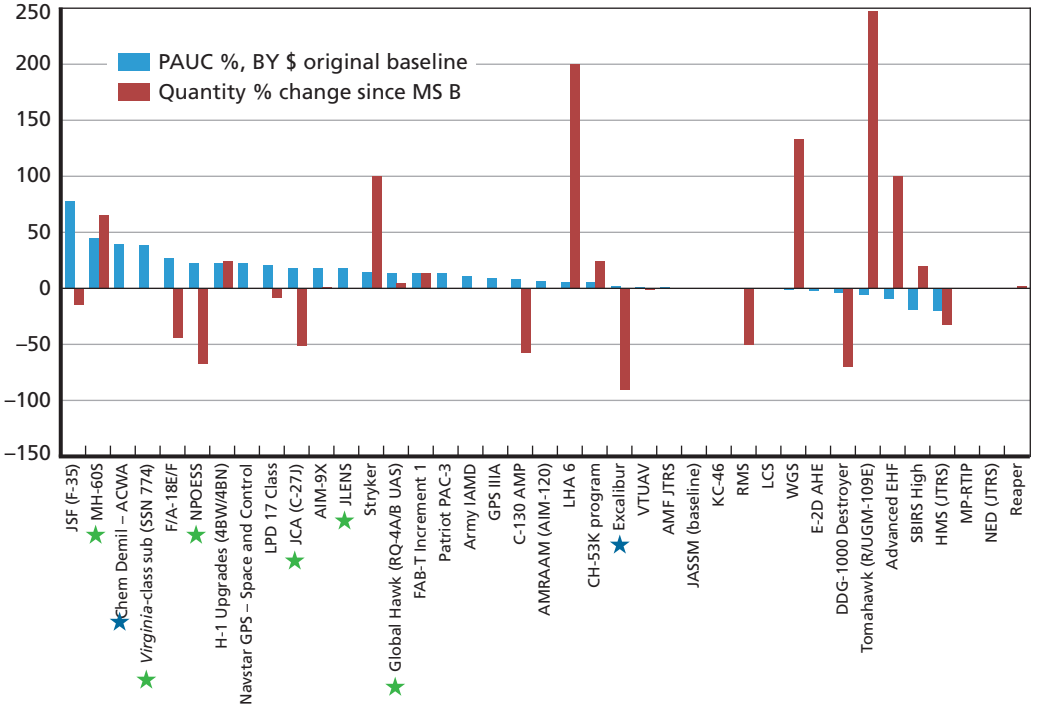
[13] See Gilbert F. Decker, Louis C. Wagner, Jr., William H. Forster, David M. Maddox, George T. Singley III, and George G. Williams, *Army Strong: Equipped, Trained, and Ready: Final Report of the 2010 Army Acquisition Review*, Washington, D.C.: Department of the Army, 2010.

Force and Navy programs on the other suggest that explaining those differences might yield important insight into program management practices.

Figures 3.9 and 3.10 illustrate a different way to assemble and view the results. In this case, Watch List programs are rank-ordered by PAUC growth from the original baseline with quantity change (Figure 3.9) or the number of quantity changes (Figure 3.10) plotted at the same time. This offers a simple way to determine visually whether PAUC growth is related to changes in quantity-related metrics. In this case, no apparent correlation exists.

This same technique can be used to make a quick determination whether changes in a Nunn-McCurdy cost metric (there are four: PAUC and APUC measured against either the original or current baseline) are associated with other variables. For instance, we could plot the total number of breaches, or the number of recent breaches (i.e., the past three years), or any other variable of interest to determine whether a more thorough analysis of the relationship is warranted.

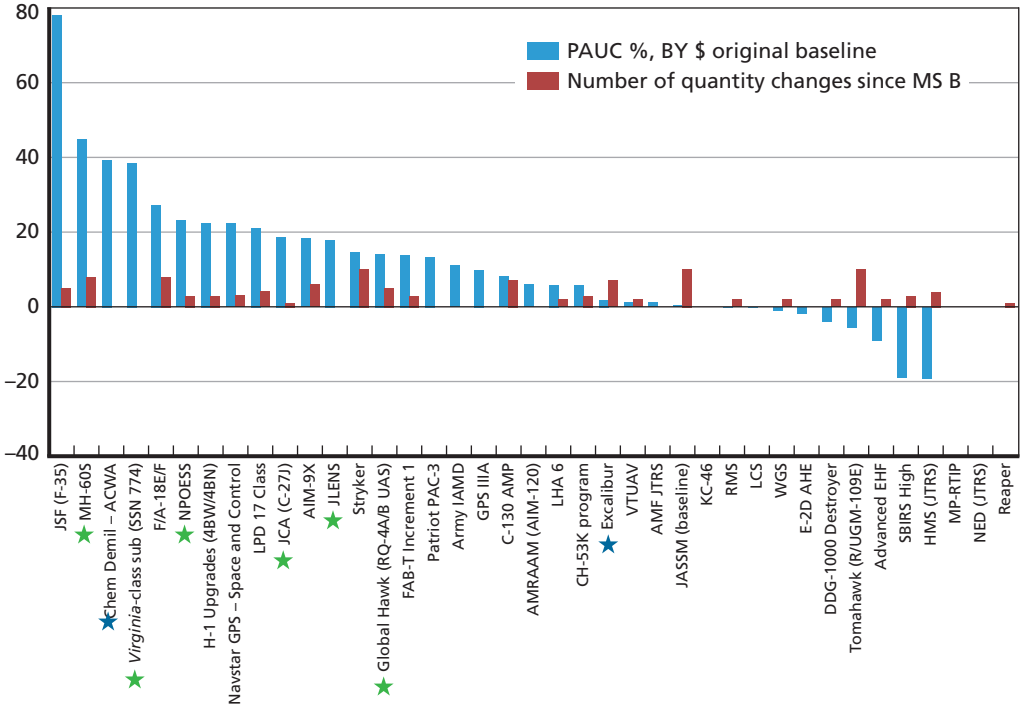
Figure 3.9
Watch List Programs by Percentage Change in PAUC and Quantity



NOTES: Blue stars indicate a critical breach, and green stars indicate a significant breach. Programs are sorted by PAUC. Current DAES unit cost growth data were used for AEHF, JASSM, and JSF in the absence of data in the December 2010 SAR. AMRAAM and Patriot PAC-3 have quantity data, but these data are not shown here because they are not entirely in DAMIR after MS B. KC-46 and LCS are new programs after MS B and do not have any quantity change.

RAND *MG1171/6-3.9*

Figure 3.10
Watch List Programs, by Percentage Change in PAUC and Number of Quantity Changes



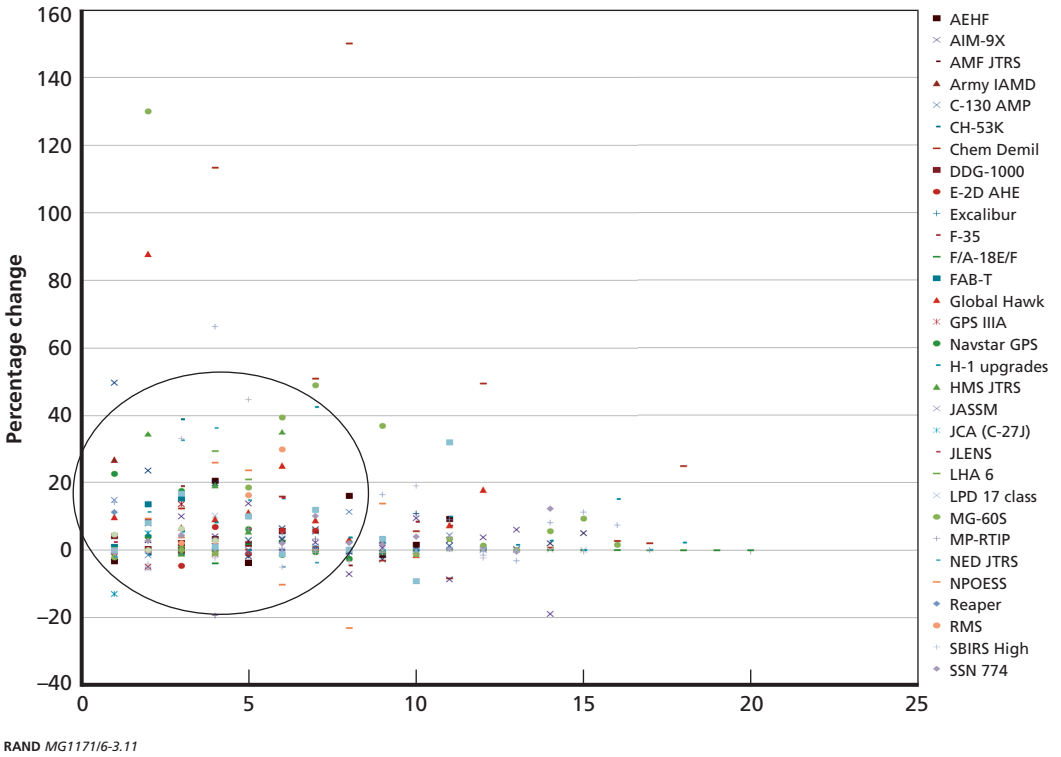
NOTES: Blue stars indicate a critical breach, and green stars indicate a significant breach. Programs are sorted by PAUC. Current DAES unit cost growth data were used for AEHF, JASSM, and JSF in the absence of data in the December 2010 SAR. AMRAAM and Patriot PAC-3 have quantity data, but these data are not shown here because they are not entirely in DAMIR after MS B. KC-46 and LCS are new programs after MS B and do not have any quantity change.

RAND *MG1171/6-3.10*

Figure 3.11 is a variation of Figure 3.6. In this case, we are plotting the annual percentage change in RDT&E costs for the Watch List programs by years past MS B (a measure of program maturity). This graphic allows an analyst to visualize the timing of when the largest development cost increases occur; such increases are a proxy for technical difficulties.

The Joint Requirements Oversight Council (JROC) also develops an annual Watch List; the version corresponding to the time period in which this analysis took place lists 24 programs. Table 3.6 compares the JROC list with the results of the anticipating-breaches framework. Fourteen programs appear on both lists, 10 only on the JROC list, and 25 only on the RAND list. Several of the programs only on the JROC list—EFV, JTRS GMR, Increment 1 E-IBCT—had critical or significant Nunn-McCurdy breaches and would have been included on the RAND list for that reason; these programs were canceled as part of the FY 2012 budget process. Four additional programs only on the JROC list ended SAR/DAES reporting, usually because

Figure 3.11
Scatter Diagram of Watch List Programs Showing Percentage Change in RDT&E Dollars Versus Years Past Milestone B



RAND *MG1171/6-3.11*

they reached their 90 percent complete reporting threshold and were therefore not included in the RAND list: Longbow Apache, C-5 AMP, ATRICM, and SBSS Block 10.

The criteria used to generate the "political threat" list in Table 3.7 were included in Step 1 of the framework. This means that the framework already includes an assessment of political threat (e.g., large, high-visibility programs with substantial funds still to spend) in the results. It is useful to use the political threat criterion to rank-order our watch list to define a subset of programs that PARCA (and DoD) should monitor more carefully (see Table 3.7). The programs higher up on that list are characterized by large size, significant time/money to complete, and current problems that will likely affect costs in the near future. This list could be provided to PARCA for near-term monitoring or information gathering. Table 3.7 is an example of how the Watch List can be used to identify programs with certain combinations of characteristics that might need different kinds of attention from senior officials.

While this exploratory analysis demonstrated a relatively low-cost approach to identifying a set of programs warranting further assessment, the steps and criteria are

Table 3.6
Comparison of JROC and RAND Watch Lists

Program Name	List	Program Name	List
Advanced EHF	RAND	JSF (F-35)	RAND
AIM-9X	RAND	JSOW (baseline/unitary)	JROC
AMF JTRS	RAND	JTRS GMR*	JROC
AMRAAM (AIM-120)	RAND	KC-46	RAND
ATIRCM/CMWS*	JROC	LCS	RAND
C-130 AMP	RAND	LHA 6	RAND
C-27J (JCA)	Both	Longbow Apache*	JROC
C-5 AMP*	JROC	LPD 17 class	RAND
CH-53K program	RAND	MH-60S	Both
Chem Demil – ACWA	Both	MP-RTIP	RAND
Cobra Judy replacement	JROC	Navstar GPS – space and control	RAND
DDG-1000 destroyer	RAND	NED (JTRS)	RAND
E-2D AHE	RAND	NPOESS	Both
EFV*	JROC	Patriot PAC-3	RAND
Excalibur	RAND	Reaper	RAND
F/A-18E/F	Both	RMS	RAND
FAB-T	Both	RQ-4A/B UAS Global Hawk	Both
GPS IIIA	RAND	SBIRS High	RAND
H-1 upgrades (4BW/4BN)	Both	SBSS Block 10*	JROC
HMS (JTRS)	RAND	SSN 774 (*Virginia*-class)	Both
IAMD	Both	Stryker	RAND
IDECM	JROC	Tactical Tomahawk	Both
Increment 1 E-IBCT*	JROC	VTUAV	Both
JASSM (JASSM/JASSM-ER)	Both	WGS	RAND
JLENS	Both		

NOTE: Programs in blue had a critical Nunn-McCurdy breach in either 2010 or 2011, and those in green indicate a significant Nunn-McCurdy breach in 2010 or 2011.

* Signifies that a program ended reporting.

Table 3.7
Using a Political Threat Criterion to Narrow the Focus

Program	Size (TY$M)	To Complete (%)
JSF (F-35)	$379,393	85.31
Virginia-class sub (SSN 774)	$93,069	57.15
KC-46	$51,700	99.73
F/A-18E/F	$50,980	15.21
LCS	$37,439	87.35
Chem Demil – ACWA	$29,459	76.48
CH-53K program	$25,745	91.72
DDG-1000 destroyer	$20,891	16.53
AMRAAM (AIM-120)	$20,481	45.17
LPD 17 class	$18,835	13.15
E-2D AHE	$18,458	72.51
SBIRS High	$17,575	43.71
Stryker	$17,083	12.73
Global Hawk (RQ-4A/B UAS)	$13,935	52.42
Advanced EHF	$13,514	34.06

NOTES: Programs in green had a significant Nunn-McCurdy breach in 2010 or 2011, and those in blue had a critical breach in 2010 or 2011. Data are as of September 2011.

preliminary and offer only a starting point from which analysts might continue to seek a more carefully justified and validated methodology.[14]

Concluding Remarks and Recommendation

The criteria used in the approach emerged from a review of readily available data from common sources, project team discussions, and discussions with the client. This was a demonstration activity intended to gain insight into whether data are available that may help anticipate which programs are subjectively more likely to breach in a near-term (two- to four-year) horizon. We did not formally apply a stepwise discriminant analysis to evaluate the marginal cost and effectiveness of each criterion. Should this methodology be developed further, we recommend a more formal approach in which the cost and marginal effectiveness of each potential criterion is assessed.

[14] As mentioned above, this work formed the foundation for a new, ongoing research effort for PARCA focused on developing a methodology for characterizing the risk of a portfolio of programs.

CHAPTER FOUR

Concluding Observations

The chapter on contractor incentives distills observations from several individuals with extensive experience in defense acquisition. A major thrust of their deliberations is that DoD needs to develop a wider understanding of the issues—especially financial ones—that drive contractor behavior. Implicit in this recommendation is the notion that a more cooperative rather than adversarial relationship is likely to be more productive in getting the best product for the best price. This is not to say that contractors should not be subject to oversight. However, the relationship would ultimately be more productive if each party to the contract had a better understanding of what drives the other.

The discussion of Nunn-McCurdy breaches presents an initial effort to determine whether it would be feasible to anticipate which programs would be most likely to incur a breach. This analysis represents an exploratory effort. However, it does suggest that, using readily available information, it is possible to identify a set of programs that appear to be at relatively higher risk of a future breach. This is not to say that such programs will incur a Nunn-McCurdy breach in the near term. However, it is possible to sort through the complete MDAP list and identify programs that are at higher risk than other programs using criteria derived from readily available information. Application of the framework enables managers to monitor a much smaller subset of programs and also provides hypotheses about what exactly to look for in each.

APPENDIX A

Membership of the COG

The COG was made up of experts with government and industry experience, current government executives, and RAND analysts.

Government and Industry Experts

Millard Firebaugh
Michael Hammes
Paul Kern
George Muellner
Eleanor Spector

Office of the Secretary of Defense (PARCA) Executives

Gary Bliss
Jim Woolsey

APPENDIX B

Truth-Revealing Incentive Mechanisms Manages Asymmetric Information Example

As discussed in the body of the report, we need some notion of the expected cost, the range of costs, the target fee, and the desired range of share ratios. If the contractor can deliver the product for less than the cost target, the contractor has a larger profit pool, enabling lower bids, and the total costs are lower for the government. Furthermore, if the contractor delivers below the bid, the contractor and the government share in the savings. Thus, both the government and the contractor would like the contractor to deliver at the lowest-cost target possible.

To display how Truth-Revealing Incentive Mechanisms (TRIM) functions, we make the following assumptions for this TRIM example:

- cost of $12 million with ±10 percent range
- target fee of 10 percent
- share ratio between 20 percent and 40 percent.

These assumptions are sufficient to construct the TRIM menu in Table B.1.[1] The government will present this menu to the vendors, and a vendor will select one of the contracts from A to E. This contract will specify the cost target, share ratio, and profit pool. The cost target is the vendor's estimate for the cost to perform the contract. The share ratio is the share of the difference between the cost target and the actual cost that is added to or comes from the vendor's profit pool for the final payout. The profit pool is the profit for the vendor if the product is delivered at the cost target. The final profit for the vendor will be higher if the vendor delivers below the cost target and will be lower if the product is above the cost target. As can be seen in this menu, the profit pool is larger for lower bids and will encourage vendors to select lower targets if feasible. The total cost column in Table B.1 is the baseline cost for the government (it is the sum of the cost target and the profit pool). The total cost will be lower if the vendor

[1] The details for the calculations used to construct this example can be found in William P. Rogerson, "Simple Menus of Contracts in Cost-Based Procurement and Regulation," *The American Economic Review*, Vol. 93, No. 3, June 2003.

Table B.1
TRIM Example

Contract	Cost Target	Share Ratio	Profit Pool	Total Cost
A	$10,800,000	.40	$1,620,000	$12,420,000
B	$11,400,000	.35	$1,395,306	$12,795,306
C	$12,000,000	.30	$1,200,000	$13,200,000
D	$12,600,000	.25	$1,035,307	$13,635,307
E	$13,200,000	.20	$900,000	$14,100,000

can deliver below the cost target and will be higher if the costs come in over the target. For the rest of the example, we will assume that the vendor selected contract C.

Table B.2 has the vendor's profit for each cost target assuming an actual cost of $12 million. The vendor profit will be the difference between the profit pool and the vendor's share of the difference between the cost target and the actual cost (vendor profit = profit pool – share ratio × [actual cost – target cost]). For any given actual cost, the vendor will maximize its profit by selecting this actual cost as the target cost. Thus, the vendor is incentivized to bid the actual cost (this is the "truth-revealing" property).

Table B.3 shows how vendor profit and government costs vary with the actual cost for a given cost target selected from the menu. The vendor's profit is higher if it can perform better than its bid, which will encourage a vendor to perform regardless of the initial bid. The government also benefits through lower costs if the vendor can perform better than its bid. Government and vendor prefer lower cost for a target cost in the example below with the following assumptions:

Table B.2
TRIM Example (Continued) Assuming an Actual Cost of $12 Million

Cost Target	Share Ratio	Profit Pool	Vendor Profit
$10,800,000	.40	$1,620,000	$1,140,000
$11,400,000	.35	$1,395,306	$1,185,306
$12,000,000	.30	$1,200,000	$1,200,000
$12,600,000	.25	$1,035,307	$1,185,307
$13,200,000	.20	$900,000	$1,140,000

Table B.3
TRIM Example (Continued) Assuming a Cost Target of $12 Million

Actual Cost	Share Ratio	Vendor Profit	Government Costs
$10,800,000	.40	$1,560,000	$12,360,000
$11,400,000	.35	$1,380,000	$12,780,000
$12,000,000	.30	$1,200,000	$13,200,000
$12,600,000	.25	$1,020,000	$13,620,000
$13,200,000	.20	$840,000	$14,040,000

- The target cost is $12 million.
- Government benefits if the actual cost is lower than the target.
- Vendor also benefits if the actual cost is lower than the target but would have a higher profit if it also bid lower.

The primary disadvantages with TRIM involve constructing the menu. The government must have sufficient information about the costs to construct the menu initially. If the initial target is substantially too low, contractors may not want to bid. Alternatively, if the initial target is too high, the government will spend too much.

TRIM will result in a more accurate cost estimate because the contractor gets the highest payout if its bid is equal to its actual cost. The government and contractor incentives are aligned because the contractor receives a higher profit if it delivers the product at a lower cost and the government will capture some of the savings too. Because the contractor is incentivized to bid its expected cost, the government gains information in the bidding process. Thus, TRIM could be a useful tool to align incentives and gain information.

APPENDIX C

Executive Compensation

DoD could gain insight into a contractor's driving behaviors by examining how it measures success and then awards its executives. To gain insight into this, RAND examined the terms of executive compensation from several contractors' definitive proxy statements filed under the U.S. Securities and Exchange Commission. The examined contractors were chosen to provide a variety of company sizes and defense sectors. See Table C.1 for the list of contractors and their contractual relationship with DoD.

Table C.1
Contract Size at a Representative Sample of U.S. Defense Contractors, FY 2012

Global Vendor Name	Number of Contract Actions	DoD Dollars Obligated	Percentage of Total Contract Actions	Percentage of Total Dollars
Lockheed Martin Corporation	18,673	$29,882,775,955.67	0.1319	8.3781
Raytheon Company	10,728	$14,183,020,301.10	0.0758	3.9764
The Boeing Company	13,994	$27,792,927,422.25	0.0988	7.7922
Alliant Techsystems Inc.	1,296	$1,411,987,084.14	0.0092	0.3959
Caci International Inc.	3,185	$1,938,596,999.89	0.0225	0.5435
Ch2m Hill Companies Ltd.	1,286	$370,903,805.01	0.0091	0.1040
Computer Sciences Corporation	3,296	$2,071,935,354.38	0.0233	0.5809
Huntington Ingalls Industries Inc.	5,961	$7,303,499,779.25	0.0421	2.0476
Mantech International Corporation	1,417	$1,743,676,681.04	0.0100	0.4889
SAIC Inc.	27,727	$5,074,425,484.56	0.1958	1.4227

SOURCE: Federal Procurement Data System, "Top 100 Contractors Report for Fiscal Year 2012," undated.

Breakdown of Compensation Categories

To incentivize the short- and long-term performance of their executives, contractors vary compensation by its type and its timing of reward. Contractors offer a mix of cash and equity compensation tied to predetermined fixed and variable percentages over short-term (typically annual) and long-term (typically three-year) time periods. The contractors varied in their explicitness regarding the divisions of executive compensation types, as evidenced by Table C.2. However, it appears that, in general, contractors tie compensation heavily to predetermined performance metrics, resulting in a greater percentage of variable compensation and also to a long-term focus.[1] The division between equity and cash compensation across the companies was less pronounced. Many contractors also varied percentage breakdowns across their own executives.

Table C.2
Executive Compensation

	Fixed Versus Variable Compensation		Short-Term Versus Long-Term Compensation		Cash Compensation Versus Equity Incentives	
Company	**Fixed**	**Variable**	**Long-Term**	**Short-Term**	**Equity**	**Cash**
Lockheed Martin	11%	89%	73%	27%	56%	44%
Raytheon	20%	80%	60%	40%	60%	40%
Boeing	10–20%	80–90%	66%	34%	[a]	[a]
Alliant	[a]	[a]	65-55%	35-45%	[a]	[a]
CACI	~25%	~75%	[a]	[a]	[a]	[a]
CH2M	28.6%	71.4%	61.1%	38.9%	49.7%	50.3%
Computer Science Corporation	10.3–21.7%	89.7–78.3%	54.4–69.2%	45.6–30.8%	[a]	[a]
Huntington Ingalls	~23%	~77%	[a]	[a]	[a]	[a]
Mantech	[a]	[a]	[a]	[a]	[a]	[a]
SAIC	17–27%	73–83%	[a]	[a]	47–63%	37–53%

[a] Not explicitly stated within most recent definitive proxy statements.

[1] In the case of these selected contractors, long-term compensation was based on an assessment of a company's past three-year performance.

Compensation Performance Metrics

Strategic goals and business plans for individual contractors determine the emphasis they place on measures of performance. For example, some may value revenue growth and others may value earning growth. To determine the amounts of compensation between annual and long-term incentives, contractors use a variety of financial and performance metrics. Though weighting distribution varies among contractors, most focus primarily on financial metrics. As one can see in Tables C.3 and C.4, contractors use a wide variety of financial metrics for both short- and long-term incentive compensation. The two most common metrics in our sample dealt with earnings/profit and cash flow for annual compensation as well as earnings/profit and return on invested capital for long-term compensation (definitions of terms are provided in Table C.5).

Table C.3
Annual Financial Metrics for Variable Compensation, by Contractor

	Lockheed Martin	Raytheon	Boeing	Alliant	CACI	CH2M	Computer Sciences Corp.	Huntington Ingalls	Mantech	SAIC
Bookings		X							X	
Days working capital										X
Earnings/profit (before interest and taxes, operating margin per share, per share segment, net after tax)	X		X	X	X	X	X		X	
Cash flow, cash from operations	X	X		X		X	X	X		
Operating income from continuous operations		X					X			X
(Segment) operating margin	X				X			X		
Overhead cost						X		X		
Return on sales								X		
Return on capital invested	X	X					X			
Revenue							X		X	X
Sales	X	X		X						
Year-end gross margin backlog						X				

Table C.4
Three-Year Financial Metrics for Variable Compensation, by Contractor

	Lockheed Martin	Raytheon	Boeing	Alliant	CACI	CH2M	Computer Sciences Corp.	Huntington Ingalls	Mantech	SAIC
Cash flow, cash from operations	X	X						X		
International gross margin						X				
Earnings/profit (net after tax profitability, operating margin, earnings before interest and taxes (EBIT), growth per share)			X	X	X	X		X		X
Relative total shareholder returns, compounded annual growth rate of common stock	X	X				X				
Return on invested capital	X	X		X			X	X		
Revenue (internal growth, relative performance)							X			X
Sales				X						

Though two contractors may have similar financial metrics, they may vary in their weighting schemes. For example, though Lockheed Martin and Raytheon share similar metrics for long-term compensation, Lockheed weights return on investment capital (ROIC) at 25 percent of its total financial measures, whereas Raytheon weights ROIC at 50 percent.

Most performance metrics are set by individual executives and represent a smaller percentage of the variable compensation equation. Some examples of performance metrics include:

- supply chain management
- human capital management
- workplace safety
- identification of growth markets outside of core business
- customer and trade relationships.

Observations

By gaining a greater understanding of how contractors measure success and incentivize their executives, DoD can identify which of its contracting tools may be more

Table C.5
Definitions of Terms

Term	Definition
Bookings	Funds expected to be received from customers in near future, based on accepted orders or contracts
Cash flow	Operating cash flow minus capital expenditures
Cash from operations	Funds a company brings in from regular business activities, not including long-term capital or investment costs (EBIT + depreciation – taxes)
Compounded annual growth rate of common stock	The year-over-year growth rate of an investment over a specified period of time
Cumulative operating margin	A ratio used to measure a company's pricing strategy and operating efficiency (operating income divided by net sales)
Days working capital	How many days it will take for a company to convert its working capital into revenue
EBIT	An indicator of a company's profitability, calculated as revenue minus expenses, excluding tax and interest
Earnings per share	The portion of a company's profit allocated to each outstanding share of common stock
Economic profit	Profit after tax, less capital charge
Internal revenue growth	The highest level of growth achievable for a business without obtaining outside financing
International gross margin	Gross margin due to international sales
Net after tax profitability	Net income/net sales—measures the overall profitability of the company, or how much is being brought to the bottom line
Operating income from continuous operations	Income from operations is generated from running the primary business and excludes income from other sources
Operating margin earnings per share	Profit earned after subtracting from revenues those expenses that are directly associated with operating the business, such as cost of goods sold, administration and marketing, depreciation and other general operating costs
Overhead cost	All ongoing business expenses not including or related to direct labor, direct materials or third-party expenses that are billed directly to customers
Relative total shareholder returns	Returns to shareholder (stock price and dividends) relative to other companies in the business segment.
Return on invested capital	The net income less the dividends, together divided by the total cost of capital
Revenue	Calculated by multiplying the price at which goods or services are sold by the number of units or amount sold
Segment operating profit	Segment revenue less segment cost of revenue (excluding depreciation, accretion and amortization)
Stock price	The cost of purchasing a security on an exchange

potent in incentivizing desired behavior. For example, cash flow is a common metric in short-term executive compensation; therefore, tying incentives to cash flow amounts and scheduling within a contract may prove to be a greater incentive than profit alone. Also, contractors and their executives also have a focus on the long term, typically three years. Devising contracts or portfolios on contracts that help a contractor see increased ROIC may also prove to be a successful contracting tool. However, as the variance on the above tables shows, one cannot simply apply a magic bullet when trying to take advantage of executive incentives. Rather, understanding the individual metrics of each contractor's executive compensation and the weights placed on them will help DoD tailor its contracting strategies.

APPENDIX D

Exploration of Multiyear Use

Particularly in recent years, MYP contracts have been used primarily with large, complex systems, such as the *Virginia*-class submarine or the CV-22 Osprey. The traditional rationale for using MYP contracts with such programs emphasizes the savings derived from a contractor's up-front investment, incentivized by the more stable multiyear contracting environment. A second and significant advantage comes from the application of cost savings from the multiyear period to any subsequent single-year contracts.[1] Contract length can be coordinated with competition structures and a program's technological cycle to offer contractor incentives that ultimately reward the government in subsequent buys.

In this appendix, we examine the possible benefits of MYP contracts as applied to systems in which contract length is less commonly used as an incentive. In contrast to the large, complex systems listed in the FY 2013 Appropriations Act, we consider here smaller, less-complex systems with large buy quantities, cheaper unit costs, and shorter technology cycles, such as missile systems or small munitions and electronic or communications equipment. Although MYP contracts approved in the most recent appropriations acts have included few examples of these program types, earlier years provide some precedent for this expanded use (see Table D.1). Additionally, smaller-cost multiyear contracts that do not meet the threshold requiring congressional approval occasionally appear in the budget justification books; for example, a component of the Combat Identification Program (communications equipment purchased by the Army) used a three-year multiyear agreement starting in FY 2000.

A conventional viewpoint on the use of multiyear contracts is that they are best employed with systems where other common sources of savings would not apply.[2] For example, the DDG-51-class ship has a single-year EOQ of only one to two ships, likely too low to elicit the savings associated with a larger production quantity. Unless the government commits to multiple years of procurement up-front, disruptions to the EOQ could result in cost increases; this is cited in the FY 2013 President's Budget sub-

[1] William P. Rogerson, "Economic Incentives and the Defense Procurement Process," *The Journal of Economic Perspectives*, Vol. 8, No. 4, 1994, pp. 65–90.

[2] COG discussion, April 3, 2013.

Table D.1
Selected Programs Approved for MYP in Congressional Appropriations Acts

Fiscal Year	Program Approved
2006	Modern Target Acquisition Designation Sight/Pilot Night Vision Sensor
2004	Tactical Tomahawk missile
2000	Javelin missile
1999	Longbow Hellfire missile
1998	Javelin missile
	Mk19-3 grenade machine guns
	M16A2 rifles
	M249 squad automatic weapons
	M4 carbine rifles
	M240B machine guns
1995	Mk19-3 grenade machine guns
	M16A2 rifles
	M249 squad automatic weapons
	M4 carbine rifles
1992	Army tactical missile
1991	MK-45 gun mount/MK-6 ammunition hoist

mission as a rationale for the program's FY 2013–2017 MYP.[3] This particular source of savings is less relevant with a program that already has a large single year EOQ, as with communications equipment or small munitions. However, several other characteristics of these programs may justify or even encourage the use of MYP contracts.

The criteria for multiyear contracts suggest the possibility that missile/munitions and communications and electronics programs may actually be better suited to multiyear agreements than some of the larger programs with which multiyear contracts are used regularly. The two key requisite elements of stable design and requirements are more likely to be achieved with a program that is based on preexisting technologies than with a technologically ambitious system just emerging from the RDT&E phase. Indeed, past criticisms of the use of multiyear contracts have emphasized the fact that such programs are often approved without truly demonstrating stability of design. A 2008 GAO report examining DoD practices in using MYP found that three programs—the C-17A Globemaster, F/A-18E/F Super Hornet, and the Apache Long-

[3] Presidential Budget Submission, MYPs and Revised MYPs, February 2012.

bow Helicopter—all experienced unit cost increases. By contrast, multiyear contracts awarded for the F117, the C-17A engine, achieved anticipated savings, a success GAO attributes to the design stability:

> These procurements appear to have been successful with demonstrated stability during the multiyear period and price breaks based on the multiyear contract. The F117 engine is a commercially available engine with a stable design and manufacturing process. There were no engineering or design changes; no advanced procurement or EOQ requirements; and no cancellation ceilings associated with either contract.[4]

As with the F117 engine, much of DoD's communications and electronics procurement is based on adaptations of commercially available, preexisting technology with an established manufacturing process. The same holds true for many types of small munitions. Missile systems, of course, are not based on commercial technology, but with their block/generational development, they have some technological precedent for each subsequent generation. Additionally, they have been purchased with MYP contracts in the past with some regularity.

In addition to fulfillment of MYP criteria, a point of emphasis here is on the savings derived from continued procurement following the multiyear contract. MYP contracts may fit well into the production cycles for these incrementally developed technologies. The lifecycle for communications/electronics runs approximately three years; for missile systems, it may be similar or somewhat longer between blocks. With these systems, the shorter production lead time as compared to that of large, complex systems may offer a window for negotiating the subsequent contract: Perhaps halfway through a multiyear agreement, the government can negotiate a new contract. The contractor is thus incentivized to offer the best price in the next competition, using the savings derived from the initial MYP. This enables the government to capitalize on both the contractor incentives and realized savings associated with multiyear agreements. We explore the significance of this cycle time and prospective savings in the next two sections, in which we use a thought experiment to consider the application of MYP contracts to three different missile programs (Standard Missile 3, Javelin, and Advanced Medium Range Air-to-Air Missile) as well as Night Vision electronic equipment.[5]

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[4] GAO, 2008, p. 18

[5] It is important to note that this is not intended as an in-depth examination or endorsement of the programs' suitability for MYP contracts from a technological or requirements standpoint. This analysis is based on programmatic planning as indicated in the President's Budget Submission and program SARs.

Case Exploration: RIM-161 Standard Missile 3

Some missile programs have been procured with MYP contracts in recent years,[6] but we here examine the RIM-161 Standard Missile 3 (SM-3) program, purchased under single-year procurements since 2008, for a notional idea of how contract length incentives may elicit savings for the government. Selection of the SM-3 as a hypothetical candidate for MYP was based on discussion with a group of experts in the April 2013 COG convening.

The SM-3 surface-to-air missile is being developed as an interceptor for short- to intermediate-range ballistic missiles. Procurement is overseen by the Missile Defense Agency (MDA) as part of the AEGIS Ballistic Missile Defense system. To date, the prime contractor for all SM-3 procurement has been Raytheon, although the development of the program's fourth phase, Block IIB, was initially competed by Lockheed Martin and Boeing in addition to Raytheon via a 2011 concept-development contract.[7] However, Secretary of Defense Chuck Hagel announced a restructuring of these plans in a March 2013 statement, stating that they would reallocate resources from the Block IIB program to other technologies.[8]

The SM-3 evolved from its predecessor, the SM-2 Block IV. The initial version produced during the RDT&E phase was Block I, which was first delivered in 2004, and the MDA first awarded development contracts for the next generation, Block IA, in 2005, also using RDT&E funding. Procurement of Block IA began in FY 2008 and ended in FY 2012. The next variant, Block IB, began procurement in FY 2012 and is expected to continue through the Five-Year Defense Plan (FYDP), with an additional variant, Block IIA, beginning procurement in FY 2017. Figure D.1 shows the planned procurement quantities of the three missile blocks from 2008 through 2018, and the appropriations in each year in BY 2013 dollars.

The average time between the initial request for proposals and the contract award date for Blocks IA and IB is approximately three and a half months. The average production lead time is just over two years. The budget submissions indicate that the unit cost for each block is expected to decline incrementally over time (see Figure D.2), although the data are limited because of the Block IA procurement using RDT&E funds for the initial years of purchasing. Block IB shows a very gradual reduction in unit cost after EOQ is increased following the first year of procurement.

Given this procurement plan, we consider how a multiyear contract might be used to produce savings. In this plan, Block IB missiles are purchased with a series of seven single-year contracts. If the first five single-year procurement (SYP) contracts were replaced with a five-year MYP contract, the government would, given the admin-

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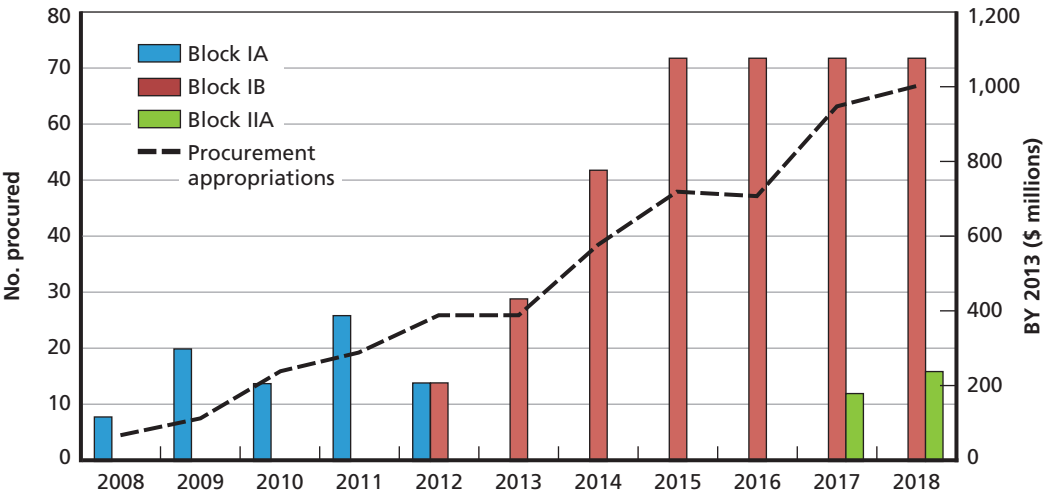
6 The Navy's Evolved SEA SPARROW missile and the Army's TOW missiles were procured with three- and five-year MYP contracts, respectively, as listed in the FY 2013 Presidential Budget Submission.

7 "Raytheon's Missile Killers," *Arizona Daily Star*, June 5, 2011.

8 U.S. Department of Defense, "Missile Defense Announcement," March 15, 2013.

Figure D.1
Actual and Planned Procurement of SM-3 Variants



SOURCES: FY 2013 and FY 2014 President's Budget Submissions.
NOTES: Between 2008 and 2010, the MDA purchased 24 missiles using RDT&E funds that were spread over the three-year period. They were not allocated to a specific fiscal year but are distributed here across the three years for clarity. This explains the discrepancy between the procurement quantity and appropriations in FY 2009. Additional Block IA missiles were procured in 2009 and 2010 using FY-specific appropriations.

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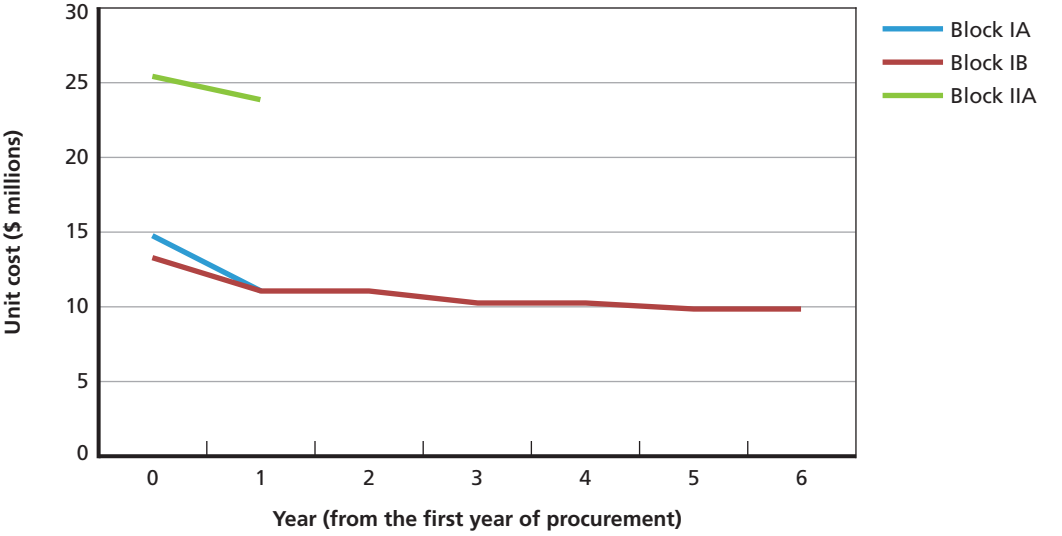
Figure D.2
Unit Cost for SM-3 Variants



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istrative and production lead times, have adequate opportunity to compete the two remaining years of procurement as single-year contracts. A key benefit here may derive from the increased EOQs in the later years of procurement (see Figure D.1). Planned procurement quantity increases dramatically over the first four years of purchasing, indicating that an MYP agreement might produce substantial savings based on the increased EOQ alone. Additionally, the government plans to procure 144 missiles in years 6 and 7, totaling 37.6 percent of the total quantity purchased over the seven-year period. A notional five-year MYP contract beginning in the first year of procurement would end in 2016, allowing the benefits to be captured in the FY 2017 and FY 2018 buys under SYP contracts. The savings elicited by contractor investment under the MYP are likely to be shared between the government and the contractor; given enough visibility into the savings, however, the government may be the sole beneficiary of those savings for the period following.

Table D.2 illustrates the notional benefit of the government increasing savings during the period of highest annual procurement. The table estimates how much the government might save on an initial unit cost of 1.0 if 239 missiles are procured under an MYP with a share ratio applied to expected savings of 10 percent and the remaining 144 missiles are procured under two annual contracts in which the government is the sole beneficiary of the expected savings. The additional savings during the last two years of procurement exert a substantial influence on the total average unit cost.

Additional Missile Programs

To better understand how a multiyear contract may fit into missile procurement planning, we examine two additional programs: the Javelin antitank missile (AAWS-M) and the Advanced Medium Range Air-to-Air Missile (AMRAAM). The Army is responsible for Javelin, and the Air Force and Navy are jointly responsible for AMRAMM. Each program has procurement data in the FY 2014 President's Budget Submission extending through the FYDP.

Table D.2
Notional Unit Cost Savings with Differing Share Ratios

Share Ratio During MYP (Government/ Contractor)	Government Realized Unit Cost During MYP	Government Unit Cost During SYPs	Average Government Unit Cost Savings[a]
80%/20%	0.92	0.9	9%
50%/50%	0.95	0.9	7%
20%/80%	0.98	0.9	5%

[a] Calculated based on expected procurement quantity under a notional five-year MYP followed by two single-year contracts based on the procurement projections in the FY 2014 President's Budget Submission.

The Javelin missile system has a modular design to "allow the system to meet changing threats and requirements" with upgrades to both software and hardware, and planned procurement funding through the FYDP does not specify separate blocks or variations of the missile.[9] The Army has used MYP contracts to procure Javelin in the past; multiyear authorization was granted by Congress in 1997 and 2000[10] despite a 2006 GAO assessment that reported the program was not ready for the MYP because of instability of design and insufficient testing.[11] The most recent MYP contract awarded was in 2000, to Raytheon and Lockheed Martin.[12] Procurement since then has been via SYP. According to the FY2014 President's Budget, Javelin procurement is planned to continue through the FYDP and beyond at a rate of hundreds of missiles per year. The production lead-time for Javelin averages two years.

AMRAAM (AIM-120) has been in service since 1991. The current procurement version is AIM-120D, which differs from previous versions in that it "provides improved performance from GPS-aided navigation, a two-way data link to enhance aircrew survivability and network compatibility, and new guidance software which improves kinematic and weapon effectiveness performance."[13] The program has an acquisition objective of 4,461 missiles, with consistent procurement planned through the FYDP and beyond. Single-year acquisitions quantities within the FYDP range from 54 to 170 missiles per year. The administrative lead time for AMRAAM averages 10.6 months, and production lead time averages two years.

Given the production and procurement cycles for the three missile programs, we consider how a multiyear contract would fit into a program. The production lead time of approximately two years is consistent for all three programs. Figure D.3 shows the planned appropriations for the SM-3 Block IB, AMRAAM, and Javelin from FY 2012 to FY 2018. We have also included a line for each program indicating a notional five-year MYP with 15 percent savings and a share ratio of 50/50 (thus the government will realize savings of approximately 8 percent from the SYP funding).[14] Finally, we indicate the notional increased savings if the government continues to procure missiles in years 6 and 7 with the realized savings from the previous MYP. The point at which the government might complete the follow-on SYPs is indicated based on estimated

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9 President's Budget Submission, Army, April 2013.

10 O'Rourke and Schwartz, 2012.

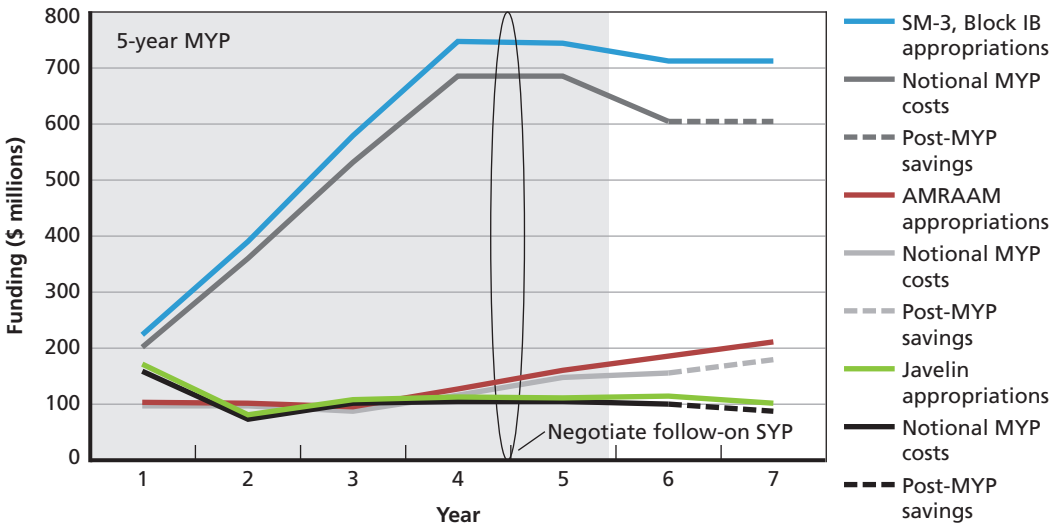
11 GAO, *Javelin Is Not Ready for Multiyear Procurement*, GAO/NSIAD-96-199, Washington, D.C., September 1996.

12 "Raytheon-Lockheed Martin Javelin Joint Venture Receives $1.236 Billion Multi-Year Production Contract," *PRNewswire*, August 8, 2000.

13 President's Budget Submission, Navy, April 2013.

14 The projected MYP savings shown here are based on the savings realized in other MYP programs and represent an entirely notional construct.

Figure D.3
Notional MYP Savings for Three Missile Programs



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contract lead time. This analysis suggests a possible timeline for implementing a MYP contract with a missile program that would lead to successful follow-on savings.

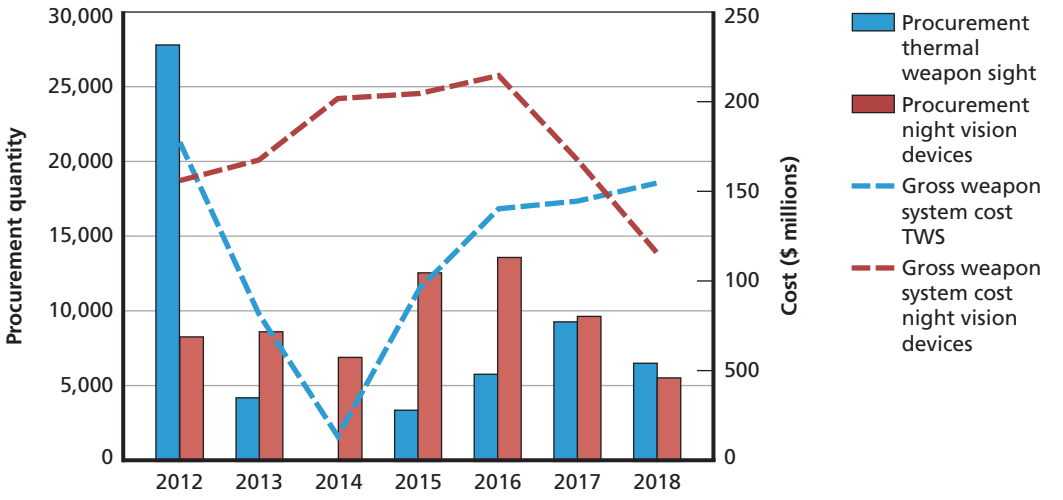
Case Exploration: Night Vision Equipment

A second line of multiyear contracting exploration focused on communications and electronics equipment. In this case, we examine the collective set of night vision devices acquired by DoD. There are three separate night vision line items in the 2014 budget submission: Army night vision devices, Army thermal weapon sights, and Navy (Marine Corps) night vision equipment, which encompass a variety of devices (including thermal weapon sights) but are not disambiguated by quantity or device. The format of the budget reporting for these line items is not detailed enough to perform an analysis of the kind done above with missile systems. The Army night vision line items list quantities procured per year but do not distinguish between devices and thus prevent the possibility of a unit cost examination (see Figure D.4).

A study of past night vision–related procurement, however, reveals that extended contract length has been employed in multiple prior purchases. The Congressional Appropriations Acts list one example, a 2006 authorization of a multiyear buy of modifications to AH-64 Apache attack helicopters, including the Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor.[15] These modifications (known as

[15] Public Law 109-148, Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006, December 30, 2005.

Figure D.4
Army Night Vision Planned Procurement in the FY 2014 President's Budget Submission



NOTE: Procurement quantities here encompass a family of different night vision devices that are not disaggregated in the budget submission.

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the Arrowhead system) were purchased in eight lots, with the first contract awarded in December 2003 and the final lot purchased in 2011.[16] The production lead time for the full suite of modifications is approximately three years.

Additionally, since 1985, the Army has procured night vision equipment using a series of multiyear contracts referred to as "Omnibus" (see Table D.3). The most recent Omnibus contract was awarded in 2011 for the purchase of Generation 3 night vision goggles.[17] These contracts are IDIQ contracts for multiple products and thus are analogous to but are not subject to the same regulations as the multiyear contracts discussed above. Army thermal weapons sights (PAS-13) have also been purchased using IDIQ contracts, with the most recent awarded to Raytheon in February 2011.[18]

Night vision devices have been developed in generations, and the current IDIQ procurement includes generation three devices. Devices have a production lead time of approximately nine months to one year;[19] this relatively short lead time, presents a useful window for renegotiation in multiyear contracting. The government may choose

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16 "Apache Helicopter Pilots Take Aim with Arrowhead," *Defense Industry Daily,* March 12, 2013.

17 ITT Corporation, "ITT Awarded U.S. Army Omnibus VIII Contract for Generation 3 Night Vision Goggles," ITT Corporation press release, April 4, 2011.

18 "PAS-13 Thermal Weapon Sights on Order," *Defense Industry Daily*, February 15, 2011.

19 According to the FY 2014 President's Budget Submission, released in April 2013, production lead times for various night vision devices are as follows: laser target locator systems, one year; helmet mounted enhanced vision devices (AN/PSQ-20), nine months; sniper night sights, ten months; and thermal weapons sights, ten months.

Table D.3
Omnibus Night Vision Procurement Contracts

Contract	Year Awarded	Recipients	Night Vision Devices Procured
Omnibus I	1985	Litton; ITT/Varo	AN/AVS-6; AN/PVS-7A; AN/PVS-7B
Omnibus II	1990	ITT	AN/AVS-6
Omnibus III	1992	Litton/ITT	AN/AVS-6
Omnibus IV	1996	ITT	AN/AVS-6; AN/PVS-7B
Omnibus V	1998	Litton/ITT	AN/PVS-7D; AN/PVS-14
Omnibus VI	2002	ITT	AN/AVS-6; AN/PVS-7D; AN/PVS-14
Omnibus VII	2005	ITT/Northrop Grumman	AN/PVS-7D; AN/PVS-14; MX-10130; MX-11769
Omnibus VIII	2011	ITT	AN/PVS-7D; AN/PVS-14

SOURCE: "Through a Glass Darkly: Night Vision Gives US Troops Edge," *Defense Industry Daily,* October 14, 2012.

to compete a new contract partway through prior contract period—for example, in the third year of a five-year agreement. This will incentivize the contractor to incorporate the savings from the initial MYP into its bid to win the contract. It is worth noting that competition is present in this industry, with night vision Omnibus contracts being awarded to several different corporations. Unlike with other MDAPs, in which the entity that wins the development contract controls much of the follow-on work, the communications and electronics industries may benefit significantly from the use of competition and multiyear agreements in tandem.

APPENDIX E

Evolution of Nunn-McCurdy Legislation

The Nunn-McCurdy Act, whose purpose is to help control cost growth in MDAPs, requires that DoD report unit costs for major weapons systems to Congress. This legislation was originally signed into law in the early 1980s and has undergone a variety of changes over the past 30 years. Nunn-McCurdy legislation established thresholds as a way of monitoring cost growth. When cost growth surpasses the thresholds established in the legislation, a process is set in motion whereby the program office and other parties in DoD must notify Congress of the growth and reasons behind the growth.

Original Nunn-McCurdy Legislation

In 1981, Senator Samuel Nunn and Congressman David McCurdy introduced the Nunn-McCurdy amendment[1] to the Department of Defense Authorization Act of 1982.[2] The purpose of the amendment was to establish congressional oversight of defense weapon system acquisition programs that experience cost growth above limits specified in the amendment. The Nunn-McCurdy amendment defined two types of unit cost: total PAUC, which is the sum of development funding and procurement funding divided by the number of units procured[3]; and APUC, which is the procurement funding divided by the number of units procured.[4] Cost growth of a weapon system was measured by how much the unit costs in 1982 exceeded the same respective unit costs in the weapon system's SAR dated March 31, 1981. Hence, the amendment applied only to those major weapon systems with March 31, 1981, SARs.

The original amendment required that the Secretary of Defense notify Congress when a major weapon system unit cost growth exceeded 15 percent. If unit cost growth

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[1] The Nunn-McCurdy amendment is also known as the Nunn-McCurdy provision. See Nunn-McCurdy Amendment, Department of Defense Authorization Act, 1982, Report No. 97-311, November 3, 1981.

[2] Public Law 97-86, National Defense Authorization Act of 1982, December 29, 1981.

[3] PAUC = [total development $ + procurement $ + construction $] ÷ total program quantity.

[4] APUC = total procurement $ ÷ procurement quantity.

exceeded 25 percent, the program was assumed terminated unless the Secretary of Defense submitted specific written certifications to Congress within 60 days of making the cost growth determination. These certifications survive in current law.

Congress made the provisions of the Nunn-McCurdy amendment permanent in the 1983 Authorization Act[5] by requiring that the secretary of each military department establish a baseline description of each major weapon system acquisition program under the jurisdiction of the secretary. The baseline description was to include a baseline estimate of the program cost. The permanent Nunn-McCurdy provisions measured unit cost growth by comparing the current unit costs against the same respective unit costs in the baseline estimate. The cost thresholds for notifying Congress and for program termination presumptions in the original Nunn-McCurdy amendment remained unchanged in the 1983 Authorization Act but have subsequently changed.

Changes to Nunn-McCurdy Legislation Since 1982

Since the original Nunn-McCurdy legislation was enacted, Nunn-McCurdy legislation has evolved with significant changes in both 2006 and 2009. Other changes were relatively minor in comparison and included changes to previously established thresholds, definitions of unit cost measures, Nunn-McCurdy process time lines and deadlines, and documentation requirements. See Figure E.1 for more details on the changes over time.

The FY 2006 National Defense Authorization Act included a major addition to the Nunn-McCurdy legislation that affected MDAPs and the management of those programs. Congress mandated that cost growth be measured against the current baseline estimate and the original baseline estimate. In FY 2006:

> Congress added the original baseline estimate as a benchmark against which to measure cost growth. The original baseline estimate is defined as the baseline description prepared before the program enters development, or at program initiation, whichever is later, without adjustment or revision. By adding the original baseline estimate as a benchmark against which to measure cost growth, and by restricting the circumstances in which an original baseline estimate may be revised, DOD can no longer avoid Nunn-McCurdy breaches by simply revising a program's baseline estimate. While DOD acquisition policy still allows current baseline estimates to be revised, the policy was modified in 2008 to limit the circumstances under which this may be done.[6]

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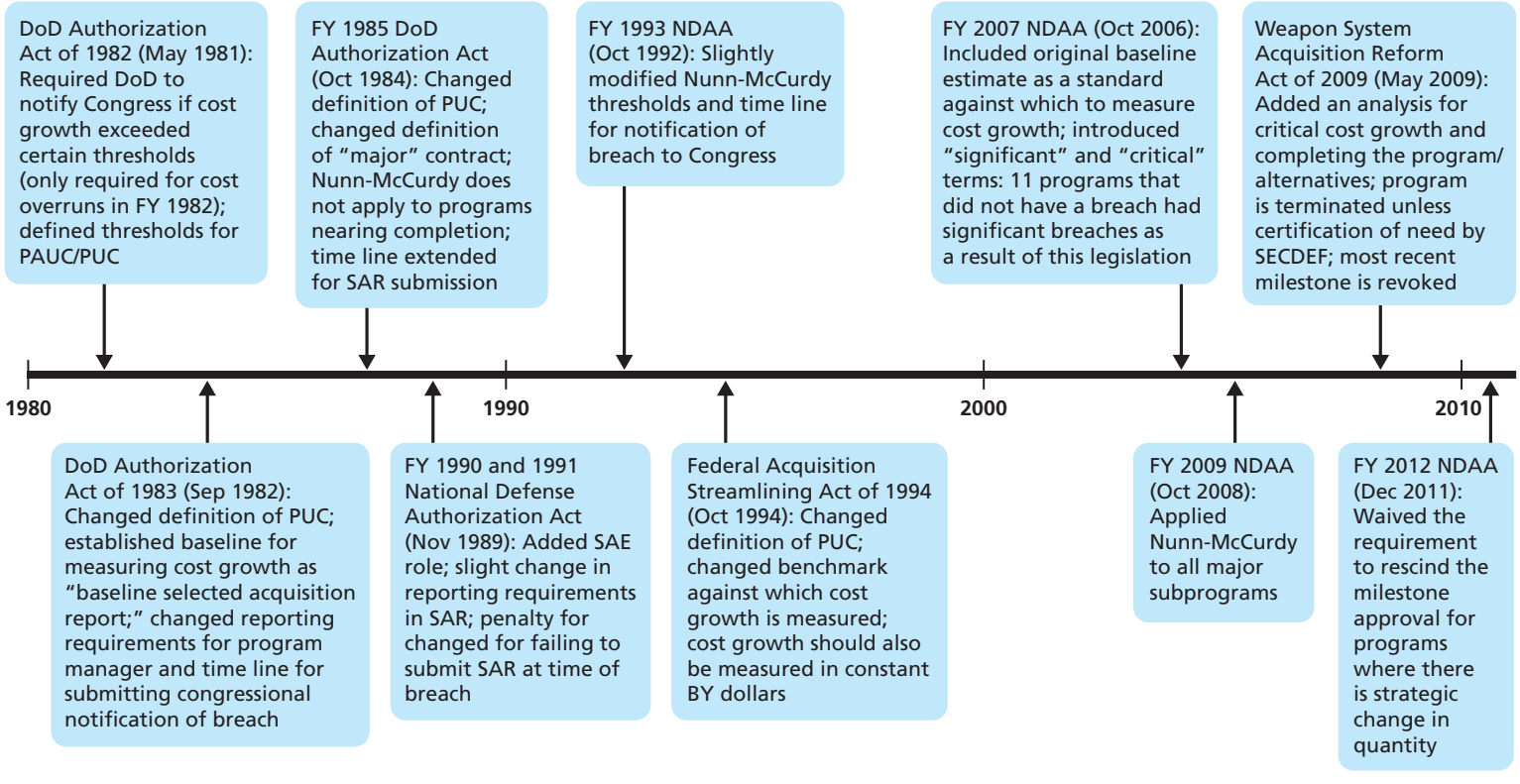
[5] Public Law 97-252, National Defense Authorization Act of 1983, September 8, 1982.

[6] GAO, *Trends in Nunn-McCurdy Breaches,* GAO-11-295R, Washington, D.C., March 9, 2011b, pp. 3–4.

Figure E.1
Nunn-McCurdy Process over Time



SOURCE: Moshe Schwartz, *The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress*, Washington, D.C.: Congressional Research Service, January 31, 2011, pp. 20–29.

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As a result of this legislation, more programs had Nunn-McCurdy breaches than otherwise would have been the case. "According to DOD, 11 programs that did not have a Nunn-McCurdy breach prior to the new FY2006 requirements were recategorized as having significant breaches as a result of the legislation's new original baseline."[7] This change in legislation is particularly relevant to the section of this report on repeat Nunn-McCurdy programs. Some of the repeat Nunn-McCurdy breaches can be attributed in part to changes in legislation. In addition to legislative changes, GAO also attributes some of the repeat breaches to changes in presidential administration.[8]

Approximately three years after the 2006 legislation, the Weapon System Acquisition Reform Act of 2009 (P.L. 111-23) was passed. WSARA revised Nunn-McCurdy laws to include a more complicated process and established a new office to examine the causes of Nunn-McCurdy breaches and related issues. Specifically, WSARA required the following for programs that the OUSD (AT&L) believes should not be terminated:

- Additional certification to Congress is required, stating the program is higher priority than programs whose funding must be cut to cover the cost growth of current program.
- Revocation of most the recent milestone approval is required, and no new contracts can be awarded without new milestone approval or MDA approval.
- Analysis should be conducted to determine the root cause of cost growth.
- Program must be restructured to address root causes of cost growth.
- Failure to certify to Congress the results of the above findings results in program termination.[9]

The WSARA changes may be the most pivotal since the Nunn-McCurdy legislation was enacted in 1982. In fact, they may have been too extensive, as Congress backtracked on some of the requirements from WSARA regarding Nunn-McCurdy reporting in Section 801 of Title VIII of the FY 2012 legislation because of concerns about the burden (or costs) of compliance:

> The committee recommends a provision that would allow the waiver of certain requirements applicable to programs that experience critical Nunn-McCurdy breaches as a result of steep growth in unit costs, in cases where such cost growth is attributable entirely (or almost entirely) to changes in the number of units to be purchased. The provision recommended by the committee includes strict standards to ensure that all Nunn-McCurdy requirements remain applicable in any

7 Schwartz, 2011, p. 10.

8 GAO, 2011, p. 2.

9 Schwartz, 2011, p. 10.

case where poor program management or performance contributes to the increase in unit costs.[10]

Current Nunn-McCurdy Process

The current Nunn-McCurdy process is largely the same as the original except for the major additions in 2006 and 2009. If a program breaches the Nunn-McCurdy thresholds, then the program undergoes considerable scrutiny by Congress and DoD. in which the program office must provide Congress with reasons for cost growth and plans on how to avoid it in the future. Currently, two unit cost criteria are considered for the thresholds. The first is PAUC and the second is APUC. Both are required to be reported in BY dollars to take into account inflation. Both of the current estimates[11] of these unit costs are then compared to both the current baseline estimate[12] and to the original baseline estimate.[13] The law requires specific actions and reporting if a program breaches the unit cost thresholds. A "significant" breach is when the current baseline estimate is breached by 15 percent or the original baseline estimate is breached by 30 percent. A "critical" breach is when the current baseline estimate is breached by 25 percent or the original baseline estimate is breached by 50 percent.

If a program has a "significant" Nunn-McCurdy breach, the appropriate service secretary must notify Congress within 45 days of the unit cost report. This usually takes the form of a "program deviation report." DoD then submits an SAR with required unit cost breach information (this may be a quarterly SAR or can be included in the annual SAR).

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[10] Public Law 112-81, National Defense Authorization Act for Fiscal Year 2012, 112th Congress, 1st Session Report, June 22, 2011, p. 135.

[11] Latest estimate of approved program.

[12] Currently approved APB.

[13] APB approved at MS B or program initiation, whichever occurs later.

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With an eye to making defense acquisition more effective and efficient, the authors explore defense contractor motivations in pursuing defense contracts and identify mechanisms that might more closely align those incentives with Department of Defense goals. They enumerate several motivations that drive contractors, most of which center on the financial aspects of running an enterprise. Then, they turn to the other side of the negotiating table and identify areas of influence or levers that the government can use to align the contracting process more closely with contractor motivations. They also analyze major defense acquisition programs to determine if it is possible to identify programs that might incur a future Nunn-McCurdy breach by reviewing a number of acquisition programs that have incurred breaches in the past and analyzing them for common characteristics. Their analytic framework enables oversight officials to identify programs with a greater risk of incurring a critical cost breach, which enables officials to focus more intently on a smaller set of programs and which provides hypotheses about what to look for in these programs.

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