



S T R A T E G Y F O R T H E L O N G H A U L

CSBA

The US Defense Industrial Base

Past, Present and Future

BY BARRY D. WATTS

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE SEP 2008		2. REPORT TYPE		3. DATES COVERED 00-00-2008 to 00-00-2008	
4. TITLE AND SUBTITLE Strategy for the Long Haul: The U.S. Defense Industrial Base, Past, Present and Future				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Center for Strategic and Budgetary Assessments, Washington, DC				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 108	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

About the Center for Strategic and Budgetary Assessments

The Center for Strategic and Budgetary Assessments (CSBA) is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's goal is to enable policymakers to make informed decisions on matters of strategy, security policy and resource allocation.

CSBA provides timely, impartial and insightful analyses to senior decision makers in the executive and legislative branches, as well as to the media and the broader national security community. CSBA encourages thoughtful participation in the development of national security strategy and policy, and in the allocation of scarce human and capital resources. CSBA's analysis and outreach focus on key questions related to existing and emerging threats to US national security. Meeting these challenges will require transforming the national security establishment, and we are devoted to helping achieve this end.

About the Author

Barry D. Watts, Senior Fellow, is an expert on a range of topics, including air power, Air Force transformation, net assessment, and the military use of space. He headed the Office of Program Analysis and Evaluation in the Defense of Department during 2001–2002. Following retirement from the Air Force in 1986, Watts worked for, and later directed, the Northrop Grumman Analysis Center. His recent publications include *US Fighter Modernization Plans* (with Steve Kosiak), *Six Decades of Guided Munitions and Battle Networks*, and *Long-Range Strike: Imperatives, Urgency and Options*. He holds a Bachelor of Science in mathematics from the US Air Force Academy and a Master of Arts in philosophy from the University of Pittsburgh.

THE US DEFENSE INDUSTRIAL BASE: PAST, PRESENT AND FUTURE

STRATEGY FOR THE LONG HAUL

By Barry D. Watts

2008

ABOUT THE **STRATEGY FOR THE LONG HAUL** SERIES

This report is one in a series comprising CSBA's Strategy for the Long Haul intended to inform and shape the next administration's defense strategy review.

THE CHALLENGES TO US NATIONAL SECURITY. Translates the principal challenges to US security into a representative set of contingencies in order to determine what resources will be required, and how they should be apportioned among forces and capabilities.

US MILITARY POWER AND CONCEPTS OF OPERATION. Provides the connective tissue between the threats to US security and the capabilities and force elements needed to address the new challenges confronting the nation.

THE DEFENSE BUDGET. Overviews the budget environment and explores a range of options to make the Services' plans more affordable.

THE DEFENSE INDUSTRIAL BASE. Addresses the US defense industry's role as a strategic asset, and how it can best serve in that role.

MANPOWER. Examines recruitment and retention of quality people in sufficient numbers at an acceptable cost.

TRAINING, OPERATIONAL ART, AND STRATEGIC COMPETENCE. Assesses the need for an overhaul of training and education of America's service personnel and the importance of strategic thinking in senior leaders.

RESTRUCTURING THE US ALLIANCE PORTFOLIO. Considers the nature and type of alliances the United States needs in order to meet existing and emerging security challenges.

GROUND FORCES. Explores how the US Army and Marine Corps might best be organized, structured, modernized, and postured to meet existing and emerging challenges to US security.

SPECIAL OPERATIONS FORCES. Addresses the expansion and growing role of US Special Operations Forces.

MARITIME FORCES. Addresses how US maritime forces might best be organized, structured, modernized, and postured to meet existing and emerging challenges to US Security.

AIR AND SPACE FORCES. Explores how Air and Space Forces might best be organized, structured, modernized, and postured to meet existing and emerging challenges to US Security.

STRATEGIC FORCES. Examines the circumstances under which nuclear strategy and force posture decisions must be made today.

MODERNIZATION STRATEGIES. Explores potential modernization strategies that can best support the US defense posture in an era of great geopolitical uncertainty and rapid technological change.

ORGANIZING FOR NATIONAL SECURITY. Assesses how the United States Government can best organize itself to ensure effective strategic planning and execution of strategy.

A GRAND STRATEGY FOR THE UNITED STATES. Synthesizes the findings and insights of the study series.

CONTENTS

vii	Executive Summary
1	Introduction
9	Chapter 1. Future Funding Levels for Defense
45	Chapter 2. Defense Industry Performance
63	Chapter 3. Influencing the Future US Defense Industrial Base
81	Conclusion. Strengthening the Industrial Base

FIGURES

10	Figure 1. DoD (051) TOA by Major Appropriations Categories, 1948–2007
12	Figure 2. DoD (051) RDT&E, Procurement, and Remaining TOA, 1948–1960
21	Figure 3. DoD (051) RDT&E, Procurement, and Remaining TOA, 1961–1990
28	Figure 4. DoD (051) RDT&E, Procurement, and Remaining TOA, 1991–2007
31	Figure 5. The Consolidation of US Defense Manufacturing, 1993–2007
33	Figure 6. 2007 Sales of DoD’s Top Suppliers
88	Figure 7. The Formal DoD Acquisition Management System

TABLES

46	Table 1. Industry Performance Summary
----	---------------------------------------



EXECUTIVE SUMMARY

The emergence, during the presidency of Dwight Eisenhower, of a peacetime defense industry of significant proportions was an unprecedented event in the history of the American republic. Two geopolitical developments made its emergence more or less unavoidable for a nation committed to leadership of the Free World after World War II. One was the onset of the US-Soviet Cold War in the late 1940s and the formulation, in response, of the strategy of trying to contain Soviet power. The other was North Korea's invasion of South Korea in June 1950, which precipitated the large increases in defense spending called for in Paul Nitze's formulation of containment in April 1950. The standing military-industrial complex that these developments brought into being endures to this day.

Since the 1950s, the US defense industrial base has been a source of long-term strategic advantage for the United States, just as it was during World War II. American defense companies provided the bombers and missiles on which nuclear deterrence rested and armed the US military with world-class weapons, including low-observable aircraft, wide-area surveillance and targeting sensors, and reliable guided munitions cheap enough to be employed in large numbers. They also contributed to the development of modern digital computers, successfully orbited the first reconnaissance satellites, put a man on the moon in less than a decade, and played a pivotal role in developing the worldwide web.

Critics have long emphasized President Eisenhower's warning in his farewell television address that the nation needed to "guard against the acquisition of undue influence, whether sought or unsought, by the military-industrial complex." Usually forgotten or ignored has been an earlier, equally important, passage in Eisenhower's January 1961 speech:

A vital element in keeping the peace is our military establishment. Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction.

Eisenhower's warning about undue influence, rather than the need to maintain American military strength, tends to dominate contemporary discussions of the US defense industrial base. While the percentage of US gross domestic product going to national defense remains low compared to the 1950s and 1960s, there is a growing list of defense programs that have experienced problems with cost, schedule, and, in a few cases, weapon performance. In fairness, the federal government, including the Department of Defense and Congress, is at least as much to blame for many of these programmatic difficulties as US defense firms. Nevertheless, those critical of the defense industry tend to concentrate on these acquisition shortcomings.

The main focus of this report is on a larger question. How prepared is the US defense industrial base to meet the needs of the US military Services in coming decades? The Cold War challenge of Soviet power has largely ebbed, but new challenges have emerged. There is the immediate threat of the violence stemming from Salafi-Takfiri and Khomeinist terrorist groups and their state sponsors, that have consumed so much American blood and treasure in Iraq; the longer-term challenge of authoritarian capitalist regimes epitomized by the rise of China and a resurgent Russia; and, not least, the worsening problem of proliferation, particularly of nuclear weapons. In the face of these more complex and varied challenges, it would surely be premature to begin dismantling the US defense industry. From a competitive perspective, therefore, the vital question about the defense industrial base is whether it will be as much a source of long-term advantage in the decades ahead as it has been since the 1950s.

The bulk of this report is contained in three chapters. Chapter 1 traces the evolution of the US defense industrial base since World War II. Chapter 2 offers an assessment of the industry's performance to date. Chapter 3 addresses two questions: first, what kind of defense industry is in the best interests of the United States, especially in the foreseeable future? Second, if the defense industry best suited to cope with the challenges of the early twenty-first century is substantially different from the one which exists today, what steps might be undertaken to begin bringing about the required changes?

There do not appear to be easy answers to either question. It is probably not possible, nor would it be wise, for the federal government to set about imposing a purportedly more efficient or effective structure on the US defense industrial base. During the 1990s, US political leaders and defense industry analysts called for replacing a defense industry largely isolated from the commercial sectors of the US economy with a single, integrated industrial base that would serve multiple customers. While some defense companies tried to follow this advice, most had little success. In hindsight, such advice seems to have overlooked the unique requirements and government-imposed constraints that pervade major weapons programs, and defense-industry leaders were probably right not to go very far down the road in trying to heed it.

That said, how active a role should the US federal government play in structuring the defense industrial base? In 1993, former Defense Secretary Les Aspin told the

leaders of about fifteen leading defense firms that around half of them needed either to exit the defense business or disappear. How these firms should respond was pretty much left to industry leaders to determine for themselves. The government's policy was to take a hands-off approach to the future structure of the industrial base, and the result was the emergence of supplier monopolies or duopolies in many defense product lines. For example, the nation's six shipbuilding yards are now owned by two large defense firms, Northrop Grumman and General Dynamics, and Lockheed Martin is getting close to being the only prime contractor with a full capacity to design, develop, and produce advanced combat aircraft. Moreover, Boeing is now the only US supplier of the large transport aircraft that could be modified to replace the US Air Force's aging KC-135 fleet of aerial tankers. These developments, which erode healthy competition and limit the military's choice of suppliers, argue that the federal government should not continue with its laissez-faire approach to the structure of the defense industry.

Chapter 3 therefore argues in favor of a compromise between having the federal government embrace hands-off policies toward the defense industry and imposing a specific structure. The discussion also suggests some broad principles the government could pursue regarding the industrial base in order to cope more effectively with the uncertainty and risks inherent in the future security environment. In addition, three areas are discussed (accessing commercial technologies and products, low-volume production versus surge, and government buying practices) in which more sensible policies, if consistently pursued over successive administrations, might positively influence the defense industry's structure without actually dictating it or returning to some sort of arsenal system. The US defense industry is certainly not without its flaws and limitations. Yet, in comparison with other countries', it is certainly the most impressive and enviable. The US industrial base has been a source of American strategic advantage in the past, and there is every reason to think that, with enlightened policies and behavior on the part of the federal government, it can continue to be a source of enduring advantage in the future.

While there may be no simple answer to the question of how the US defense industry should be structured to best meet the challenges of the early twenty-first century, the federal government's approach since World War II has mostly been a mixture of benign neglect and occasional intervention to prevent excessive consolidation. No sustained, consistent efforts to dictate a structure for the industry, much less movement towards an arsenal system, have been pursued, and there is little likelihood that either course will be adopted. Nevertheless, the overriding conclusion that emerges from the evidence and history reviewed in this report is that in order to ensure the United States has the strong, innovative defense industry the nation will certainly require in the decades ahead, the federal government will need to develop more consistent, thoughtful, long-term, and effective policies toward the defense-industrial base.

Doing so will not be easy. If there is one clear message that emerges from the evolution of the US industrial base since World War II it is the sheer difficulty of shaping the industry for the better. The reasons improvement is so difficult include the many uncertainties about future defense needs, the greater complexity of twenty-first century threats to American security compared to the monolithic Soviet threat of the Cold War, the lack of anything approaching a bipartisan consensus on national security strategy, the ability of defense companies to lobby their congressional representatives and senators, and the prospect that Congress may do more to hinder than help the emergence of a more enlightened approach to improving the defense industry.

The first step toward a more active and effective approach to the US defense industry will be for the National Security Council and the Department of Defense (DoD) to begin seriously addressing the core issue of the industry's health and structure. This challenge is far broader than merely trying to reduce cost overruns or schedule slippage in individual defense-acquisition programs. A recent assessment of the Defense Department's acquisition performance reviewed no less than 128 studies that addressed perceived problems with the system. But even within DoD there are two other processes that affect acquisition narrowly construed: the requirements process, which was recast in 2003 as a joint enterprise overseen by the Joint Staff, and the Pentagon's planning, programming, budgeting, and execution process. Both of these are constantly subject to interventions from members of Congress, congressional committees, and their staffs. Consequently the questions about the ability of the defense industrial base to deal with future national security challenges involve many more power centers and stakeholders than just those in the Defense Department.

Nor is the future structure and effectiveness of the defense industrial base a problem that can be solved with a one-time fix. A sustained effort over successive administrations will be required, involving incremental adjustments as circumstances and the security environment change. The foremost problem, though, is that the US government has yet to begin the necessary thinking about the industrial base broadly construed. In July 2006, a Defense Science Board report argued that there was a critical need for the Defense Department to develop a National Security Industrial Vision. Not only have past DoD vision documents tended to be thin on substance, but the last time any high-level government policy or strategy document even mentioned the need to pay attention to the defense industrial base was in 1997, when the National Defense Panel published its report *Transforming Defense*.

What considerations are relevant to the development of a more consistent, thoughtful, longer-term strategy for ensuring that the US defense industrial base continues to be a source of American advantage in the future? Based on the history and evidence in this report, a number of suggestions come to mind. The most important, though, concerns the longstanding emphasis in US acquisition practices and regulations on the costs of individual programs as the primary metric for managing and evaluating

the development and procurement of military goods and services. The Government Accountability Office's latest comparison of past and current portfolios of major defense programs has shown that the single-minded emphasis on the costs has not succeeded in stemming cost growth or schedule slippage. Are there viable alternatives? The most promising alternative, which has been largely captured in the Defense Acquisition Performance Assessment's 2007 report, is to shift the government's primary emphasis in acquisition programs from cost to time-based metrics.

Shifting from cost-based to time-based metrics offers a number of advantages. Time is easier to understand than cost and less subject to abuse through artful ways of portraying costs. Government program managers and contractor executives alike might well be more resistant to endless requirements changes because acquiescing would endanger meeting schedule. Further, because the uncertainties about who or where the US military may fight next are greater than in the past, committing to lengthy acquisition programs risks fielding systems whose utility has been significantly eroded by the time they enter operational service. Lengthy acquisitions also jeopardize the numbers ultimately procured due to growth in costs and, because the new systems arrive later than expected, require the retention of aging systems longer than planned. A time-based approach could, if properly implemented, ameliorate these problems. In addition, by enabling the US military to field new systems more often, the force structure should, at any point in time, contain a richer mix of advanced systems, thereby making it more difficult for adversaries to counter American capabilities. Finally, while development times and the lengths of production runs would tend to decrease, more frequent new starts would benefit industry design teams and make losing a given competition less of a threat to a company's survival, whether in specific product lines or the defense business in general. Thus, the government's adoption of time-based acquisitions would incentivize more companies to remain in the defense industry, and possibly attract others to enter the defense market, by offering more new business opportunities more frequently than in the past.

The US defense industrial base is not on the brink of imminent crisis or near collapse. The industry remains fairly innovative, relatively strong, and is capable of supplying American soldiers, sailors, marines, and airmen with world-class weapons and systems, even if they tend to reach the fielded forces later than expected and at increasingly higher costs than initially anticipated. Perhaps the most fundamental issue raised in this report, then, is the degree to which the American defense industry will, in the decades ahead, continue to be an enduring source of strategic advantage. For that to happen, the federal government will need to embrace a more consistent, thoughtful, longer-term, and active strategy for influencing the structure and capabilities of the American defense-industrial base. It remains to be seen whether future administrations will do so.



INTRODUCTION

Since the end of World War II, the United States has been one of the leading military powers in the world, if not *the* leading military power. Some may question the merits of the United States occupying such a position, or whether the country should endeavor to retain a dominant military position in coming decades. One can also point to occasions during the past six decades when the application of American military power failed to achieve American political ends, or even secure military victory, as happened in the case of Vietnam. Nevertheless, there is little doubt that no other nation today can project military power as rapidly, comprehensively, and decisively around the globe as can the United States. Nor does any other country enjoy such broadly based superiority in combined-arms land warfare, air power, sea control, power projection, networked operations, and the military use of orbital space for reconnaissance and command and control.

Credit for this enviable position can justifiably be claimed by many individuals, groups, organizations, and constituencies. One of these, of course, is the American military: its all-volunteer enlisted and officer ranks, sophisticated operational doctrines, training practices, growing combat experience in early twenty-first century conflicts, proven ability to adapt and learn from that experience, logistic capabilities to sustain its forces in distant overseas theaters, and proficiency in operating complex weapon systems have made it the most dominant armed force since Roman times. A second group that has played a major role includes the defense companies and government entities that have invented, developed, produced, supported, and upgraded the weapons and other systems that the American military Services employ. As President Dwight Eisenhower pointed out in January 1961, not only had the American military establishment become a “vital element in keeping the peace,” but the Korean War and the thermonuclear revolution of the 1950s had compelled the United States “to create

No other nation today can project military power as rapidly, comprehensively, and decisively around the globe as can the United States.

The principal aim of this report is to examine the history, current status, and future prospects of the firms whose businesses have emphasized supplying weapons and systems to the US military.

a permanent armaments industry of vast proportions.”¹ Eisenhower cautioned the country to “guard against the acquisition of unwarranted influence . . . by the military industrial complex.” Yet, notwithstanding his oft-cited warning, nearly seventeen years after the Soviet Union itself collapsed, a large American defense industry remains a pillar of US military power and influence.

Both the US military Services and the American defense industry have undergone major changes during the past half-century. As this report will suggest, not all of these changes have been for the better. Nevertheless, if one had to choose a “military-industrial complex” that has stood above all others since the early 1940s, and continues to do so today, the American military-industrial complex would surely be the one most people and nations would choose.

This report concentrates on the companies that have comprised the American defense industrial base since World War II. This focus is not intended to deny that American universities, government and industry laboratories, private think-tanks large and small, government-sponsored and private laboratories, and government-funded research organizations such as the RAND, MITRE, and the Aerospace corporations have also contributed to US national defense. However, the principal aim of this report is to examine the history, current status, and future prospects of the firms whose businesses have emphasized supplying weapons and systems to the US military.

These companies have experienced substantial changes in their markets, product lines, the structure of their industry, and their relations with government customers during the last six decades, especially since the end of the US-Soviet Cold War. Beginning in the late-1980s, when President Ronald Reagan’s defense buildup began to ebb, the US defense industry began to contract and, in the early 1990s, entered a period of considerable consolidation. Today the major surviving firms are larger than defense companies have ever been in the history of the US defense industry. Further, whereas several decades ago the US government could choose among many companies for the next tank, warship, or combat aircraft, today the number of firms that can viably offer “prime contractor” capabilities has shrunk to three, two, or, in some areas, a single supplier. Competition for major programs has become intense, with companies increasingly viewing new-start programs as “must-wins.” This shrinkage in the number of firms able to supply major weapon systems to the US military Services has, in turn, altered the relationship between the companies and government as the monopsony customer and supplier oligopolies or monopolies have become more widespread.

In addition, the attitudes of the companies toward their defense businesses have changed. Since the 1970s, American defense firms have increasingly adopted management practices from the commercial sector. These practices have resulted in the strategic goals of many defense firms more closely resembling those of commercial

¹ Eisenhower’s farewell address as president was televised on January 17, 1961. It is available on the Internet and can be viewed on YouTube.

firms. Top managers of many defense firms have found themselves concentrating more and more on bottom-line financial returns for their shareholders, increasing their share of the market, and eliminating competition.

Because American industry in general, and the defense sector within it in particular, constitute essential elements of US military power, the fundamental questions regarding the future of America's defense industry appear to be:

- 1) What kind of defense industry is in the best interest of the United States, today and in the future?
- 2) If the defense industry best suited to cope with the challenges of the decades ahead is substantially different from what it is today, what steps might be taken to begin bringing about the required transformation?

To address these questions, this report examines the history of the industry, assesses its performance, and explores the major factors that have shaped its current structure, activities, and output. The report then suggests the type of defense industry most likely to be needed in future decades and evaluates the prospects of achieving such an industrial base. Ultimately, the goal is to address the question of whether today's American defense industry is "up to the tasks" of the early twenty-first century.

The basic approach to addressing these questions will be to examine the US defense industry from the same business perspective one would apply to any other industrial sector, from computers to packaged goods or automobiles. This approach entails analyzing the major forces that drive the industry, exploring how its past experiences have shaped its present structure and future prospects, and examining the regulatory and political constraints that confront US companies participating in the defense business, the prospective levels of financial returns, and the barriers to entry into, or exit from, the defense business.

By and large, this report draws from the past work of various experts, study groups, industry executives, and scholars who have analyzed aspects of the US acquisition system and its industrial base over the past half-century. The reason for taking this approach stems from the fact that the US defense industry and various weapon programs have been the focus of extensive research and study since World War II. For example, the 2006 report of the Defense Acquisition Performance Assessment (DAPA) panel reviewed more than 1,500 documents on acquisition reform, heard from 107 defense experts, received more than 170 hours of briefings, and conducted a detailed survey of over 130 government and industry acquisition professionals.² By one count, over many years there have been 128 studies conducted to address perceived problems

This report examines the history of the industry, assesses its performance, and explores the major factors that have shaped its current structure, activities, and output.

² Lieutenant General Ronald Kadish (USAF, Ret.), Dr. Gerald Abbott, Frank Cappuccio, General Richard Hawley (USAF, Ret.), General Paul Kern (USA, Ret.), and Donald Kozlowski, *Defense Acquisition Performance Assessment Report*, January 2006, p. 3.

with the US defense acquisition system and to prevent waste, fraud and abuse.³ Suffice it so say that a single author cannot hope to duplicate such depth of research. Instead, it seems best to draw on existing research, studies, assessments, analyses, and scholarly works focused on the US defense industry and its performance. The presumption is that this literature, which interviews and surveys of individuals inside and outside both government and industry, highlights the more important factors and trends affecting US defense companies, their products, and their services. Past research and analysis on the US defense industrial base and the government's acquisition practices provide extensive information on what have been perceived as the key trends affecting the firms at various times, the ways in which the industry and government have interacted, and how views of the future held by industry leaders, managers, and program personnel have affected the strategic choices their firms made over time.

Granted, there are limitations to this approach. The measurements and the data-collection techniques not only vary among the many sources on which this report is based, but exhibit substantial limitations. For example, a major 1962 study of the weapons acquisition process stated that a "major problem . . . exists in the paucity of reliable, systematic data on company participation in various areas of weapons acquisition over time."⁴ Nor does this problem appear to have been solved. As recently as 2006, the DAPA panel made much the same observation, concluding that the clarity of their "detailed review [of the acquisition process] was complicated by the absence of a standard, consistent and coherent cost tracking system."⁵ There is also disagreement as to what data are important, to say nothing of what they may imply about the defense industry and the government's increasingly complex relationships with these firms since the late 1940s.

Recurring themes in many past studies of the US defense acquisition system and its industrial base have been the influence of changes and fluctuations in government defense spending and Service budgets on what the military buys, how military systems and weapons are developed, and the quantities in which they are procured. Given the large number of past studies and analyses, this report will not recount all the recommendations for changes in the government's acquisition practices, bureaucratic and political decision-making, or planning, programming and budgeting. Individuals interested in recommended changes to these activities and processes should review past evaluations. A good starting point is the 1986 report of the Blue Ribbon Commission on Defense Management chaired by David Packard. The DAPA panel noted in 2006 that it saw "some of the same issues as problems today that the Packard Commission saw 20 years ago."⁶

³ Kadish et al., *Defense Acquisition Performance Assessment Report*, p. 2.

⁴ Frederic Scherer and Merton Peck, *The Weapons Acquisition Process: An Economic Analysis* (Graduate School of Business Administration, Harvard University, 1962), p. 190.

⁵ Kadish et al., *Defense Acquisition Performance Assessment Report*, p. 3.

⁶ *Ibid.*, p. 2.

The reader should be aware that this report uses a broader notion of “acquisition” than that found in the “how to buy” policies and practices detailed in Department of Defense (DoD) Directive 5000.1, *The Defense Acquisition System*, and DoD Instruction 5000.2, *Operation of the Defense Acquisition System*, as revised in 2003. Expanding on the narrow view of defense acquisition in these documents, the report construes the notion of US government’s “buying practices” to include additionally the Joint Capabilities Integration and Development System (JCIDS) instituted to improve DoD’s requirements process⁷; the DoD planning, programming and budgeting system (PPBS) used to execute defense programs; the decisions made by the White House and Congress regarding defense programs; and the informal activities that have evolved among these various participants in defense acquisition, including bargaining, gamesmanship, and tacit alliances among various stakeholders and participants.⁸

This report also touches upon various aspects of what is probably best termed “business strategy.” Strategic thinking in American business began to emerge as a distinct discipline in the 1950s. Since then, business strategists have developed a range of concepts, a number of which have come to be used by companies worldwide. Some of these concepts — core competencies, portfolios, capabilities-based planning, and competitive advantage — have been adopted in certain places within the government and DoD. For example, the 2001 Quadrennial Defense Review announced, as “strategic tenets” of the new administration, that the Defense Department was shifting to a capabilities-based approach and intended to develop a broad portfolio of military capabilities.⁹ A distinctive aspect of good business strategy has been its emphasis on implementation — the idea that strategy in competitive situations is fundamentally about finding ways to achieve strategic goals *within* existing resource constraints and *despite* actions of competitors or changes in the business environment. By contrast, especially in recent years, the public versions of US national security strategy documents have consisted of lists of eminently desirable goals with little indication of how those goals might actually be achieved.

Two other notions of strategy occasionally surface in this report: defense strategy and military strategy. “Defense strategy” addresses the broader uses of military power in peacetime as well as in wartime to gain comparative advantage over opponents, including deterring conflict and shaping enemy as well as allied perceptions. “Military strategy,” on the other hand, focuses on the application of military force in wartime to achieve one’s military objectives while denying the opponents theirs. The Defense Department’s competitive strategies initiative in the late 1980s, which sought

⁷ For an overview of JCIDS, see Lieutenant General Walter L. Sharp, Joint Staff Director, “Joint Capabilities Integration and Development System,” Chairman of the Joint Chiefs of Staff Instruction 3170.01F, May 1, 2007.

⁸ This broader definition is similar but not identical to that used by DAPA (see Kadish, et al., *Defense Acquisition Performance Assessment Report*, pp. 4–5).

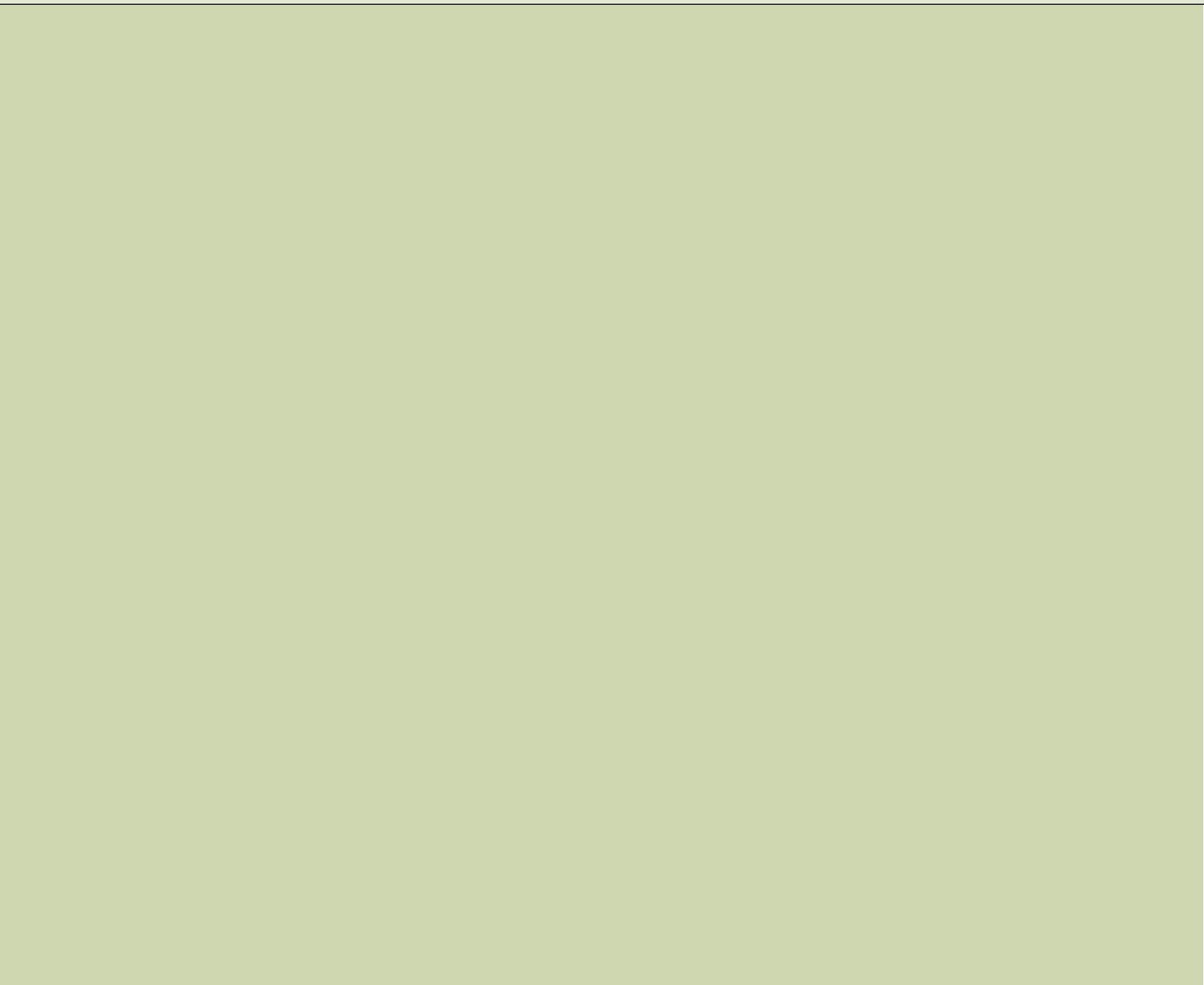
⁹ DoD, *Quadrennial Defense Review Report*, September 30, 2001, pp. 13, 15.

to impose greater costs on the Soviet defense establishment by taking advantage of such proclivities as the Soviet military's obsession with territorial air defense and fear that the United States might field effective defenses against ballistic missiles, is one example of a defense strategy. The design of the major-operations phase of Operation Iraqi Freedom in 2003 exemplifies military strategy.

Lastly, the American defense industry is not viewed as negatively in this report as it is in many other assessments, particularly those of staunch critics of US defense spending and military operations. In his foreword to the 2006 Defense Acquisition Performance Assessment, Norman Augustine, formerly the chief executive officer of Martin Marietta, observed that the “problems in defense acquisition—and there are many—tend to be widely misunderstood.”¹⁰ The viewpoint of many observers of the American defense industry, including organizations such as the Government Accountability Office (GAO), has been to ignore the industry's positive contributions to national defense and portray it largely in terms of ever-increasing costs and schedule overruns.¹¹ This report endeavors to offer a broader, more positive and nuanced view of the industry, especially of its potential to meet America's defense needs in the early twenty-first century.

¹⁰ Kadish et al., *Defense Acquisition Performance Assessment Report*, p. vii.

¹¹ See GAO, “Defense Acquisitions: Assessments of Selected Weapon Programs,” GAO-08-467SP, March 2008.



CHAPTER 1 > FUTURE FUNDING LEVELS FOR DEFENSE

The US defense industry's development since 1945 can be divided into three periods: (1) formation and early growth after World War II (1945–1960); (2) stabilization as a distinct industry during the Cold War (1960–1990); and (3), post-Cold War fundamental restructuring (1990–2007). These periods roughly parallel the emergence of the Cold War, its prosecution, and the industry's efforts to deal with the security environment that emerged after the Cold War ended. The boundaries between these periods are not precise, and within each period there were developments that affected the US industrial base, including military conflicts, fluctuations in defense spending, the introduction of new technologies, and emergence of new types of systems. Nevertheless, each period has distinct characteristics in terms of customer interest and actions, overall government buying practices, and the size and structure of the industrial base.

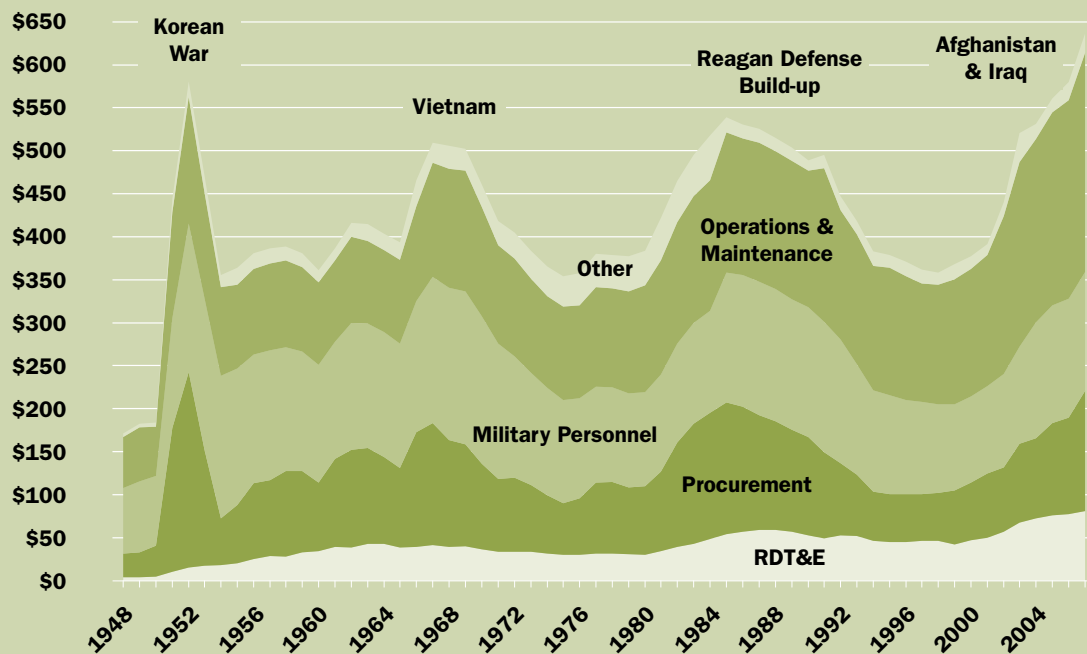
Many analyses of the defense industry focus on the role that defense spending has played over time in the revenues, profitability and incentives of the companies.¹² DoD spending on research, development, test and evaluation (RDT&E) and procurement are the portions of the annual defense budget that affect defense firms most directly. While these expenditures will be discussed in each of the three periods, this chapter also highlights some of the other factors that have shaped the industry. As a point of

¹² In contrast to many industries, the customer (the US government) publishes its overall spending plans for at least five years into the future on an annual basis. These government budget documents also go into great detail to describe individual programs and their expenditures and even the companies who receive the funding. This makes broad analyses of market trends somewhat more straightforward than in many other industries, although major analytical effort is still expended to ascertain the realism of these forecasts and to identify potential opportunities. However, government defense budget projections also discourage major investment in innovations by companies. If, after all, all major spending is already identified, and only small amounts are set aside for future programs, how much persuasive power do innovators in large firms have in arguing that their initiative will open up a major new business? In other words, how can firms create a new demand when virtually all the buying power of the customer seems to have been committed for several years in the future?

departure, Figure 1 displays DoD total obligational authority (TOA) for both RDT&E and procurement from fiscal year (FY) 1948 through FY 2007.¹³ The expenditures are in constant FY 2009 dollars, which means that the effects of inflation over time have been eliminated. From 1948 to 2007, DoD's annual RDT&E investments show a gradual long-term increase, but do not exhibit the volatility of procurement from one year or period to the next. Note, too, the increases in procurement associated with the Korean and Vietnam Wars, as well as with the later increases associated with the build-up in defense spending during the first term of President Ronald Reagan's administration. Starting in 2001, DoD TOA also begins including supplemental

¹³ TOA is a DoD financial term expressing the value of the *direct* defense program for a given fiscal year. Budget Authority (BA) is the authority to incur legally binding obligations of government funds that will result in immediate or future outlays. Outlays or expenditures are the liquidation of the government's obligations and generally represent cash payments. TOA may differ from BA for a number of reasons, including BA lapsing before obligations have been incurred, reappropriations by Congress, rescissions, etc.

FIGURE 1. **DoD (051) TOA BY MAJOR APPROPRIATIONS CATEGORIES, 1948–2007***
(BILLIONS OF CONSTANT FY 2009 DOLLARS)



* Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2009*, March 2008, pp. 62–67. The government categorizes expenditures for all its activities by numerical codes. In that accounting system 050 is “National Defense,” and its subcategories include 051 “DoD.” Figure 1 is for account 051 and the figures are in constant Fiscal Year 2009 dollars. Additionally, as Figure 1 reveals, within account 051, the appropriations categories that consume the lion’s share of DoD’s TOA are: Military Personnel, Operations and Maintenance, Procurement, and RDT&E.

funding for the Global War on Terror (GWOT). Some of this money has gone into RDT&E and procurement, but it is difficult to depict how much is in relation to the traditional appropriations categories (RDT&E, procurement, military personnel, etc.). The best guess from the Congressional Budget Office (CBO) is that perhaps 19 percent of the supplemental spending through FY 2007, totaling over \$100 billion, has gone into RDT&E and procurement.¹⁴

Detailed analyses and histories of defense spending have been conducted by many organizations within and outside of the US government. This report, however, focuses on the budget only to the extent that it has affected the broad development and structure of the defense industry over time. In this regard the following points can be made about the patterns in Figure 1 and the defense industry:

- > From an industrial base perspective, the defense business is a cyclical market. Peaks in DoD spending are tied to major events such as wars or the Reagan administration's efforts to use defense spending to put pressure on the Soviet Union during the final decade of the Cold War,. In the wake of these events, defense spending declines. The cycles are measured in decades. Debates are now ongoing about whether there will be a post-Iraq decline. The answer to that question will influence how firms in the industry view the future business opportunities in national defense, affecting their decisions about whether to remain in this market.
- > The surges appear to be mainly in procurement, although over time there has been steady, long-term growth in military personnel and operating costs. Today's all-volunteer force is more expensive to pay and operate than the military establishment was when personnel could be drafted. These costs have consumed an increasing percentage of the DoD budget and put more downward pressure on procurement. Consequently, manufacturing—historically the key source of revenue and profitability for companies—has been subject to significant swings in demand and has been under increasing pressure even in the periods between peaks in DoD TOA. This affects the attractiveness of the industry to companies.
- > On an annual basis, R&D funding has shown long-term growth since the late 1940s. It has also not been cut significantly even in the troughs between periods of peak defense spending. Over the period 1948–2007, total RDT&E funding has been about 42 percent of DoD's cumulative procurement spending. At the broadest level these observations suggest that the government has become increasingly inclined over time to invest in technology but not always willing to move new military technology into significant production of new equipment.
- > Finally, the pattern of the defense industry over the past half century—and particularly during the past two decades—has been one of fewer and fewer competitors

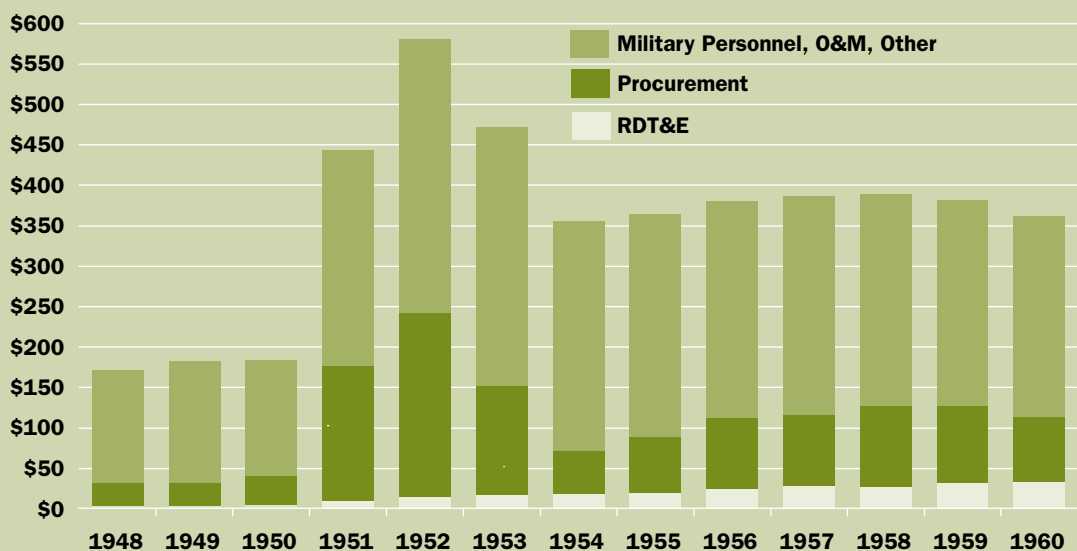
¹⁴ CBO, "Analysis of the Growth in Funding for Operations in Iraq, Afghanistan, and Elsewhere in the War on Terrorism," February 11, 2008, p. 3.

in major systems (aircraft, ships, and armored fighting vehicles). Even as defense spending has grown in real dollars since the 1950s, companies have ultimately exited the business or reduced their capabilities. This inverse correlation between long-term defense spending and the number of companies willing to participate suggest that factors other than defense spending are influencing the composition of the industry. Relying on defense spending in the future as the major incentive to improving the participation of companies, therefore, would probably be ineffective.

THE “GROWTH” PERIOD: 1945–1960

The years following World War II saw dramatic changes in the US approach to its peacetime defense posture. Immediately after the war, the United States demobilized and defense budgets plunged. But as it became clear that a new period of rivalry with the Soviet Union was unavoidable, the administration of President Harry Truman embarked on a strategy of containment. National Security Council 68 (NSC-68), produced under Paul H. Nitze in the spring of 1950, recommended a rapid buildup of US political, economic, and military strength to halt, if not reverse, the spread of Soviet power. Truman, wedded to balanced budgets, and his defense secretary at the time,

FIGURE 2. **DOD (051) RDT&E, PROCUREMENT, AND REMAINING TOA, 1948–1960**
(BILLIONS OF CONSTANT FY 2009 DOLLARS)



Louis Johnson, were unenthusiastic about the hefty increases in military spending implicit in NSC-68.¹⁵ Once war broke out on the Korean Peninsula, however, an ad hoc NSC committee drafted NSC-68/1, which envisioned US defense spending growing from \$35.3 billion in 1951 to \$63.4 billion by 1953.¹⁶ As a result, DoD's budget authority quickly swelled to a peak of \$60.2 billion in FY 1952 (\$604.2 billion in FY 2009 constant dollars).¹⁷

The years 1948 to 1960 saw the establishment of America's first large-scale peacetime military force. Investments in research and development (R&D) and procurement to outfit that force occurred along with corresponding increases in annual funding for national defense. These developments led to the emergence of a large set of private-sector companies supporting the US military. Much of the military's inventory was not only replaced, but fundamentally redesigned. Entirely new technology approaches to weapons and systems appeared in nuclear submarines, large deck aircraft carriers, high performance jet aircraft, ballistic missiles, satellites, tanks, and armored personnel carriers.¹⁸ New technology systems were tested as much by prototyping, procuring, and operating as by laboratory level work.¹⁹ Individual systems were bought in large annual quantities.

As Figure 2 indicates, even ignoring the spike in defense spending associated with the Korean War, from 1948 to 1960 the US defense budget grew substantially. The growth rate over this period averaged between 6.4 and 6.5% per year, depending on whether one uses TOA (the direct value of the defense program in a given fiscal year) or budget authority (the ability to obligate funds either immediately or in the future).²⁰ Using budget authority (BA), the O51 appropriations account went from \$171.4 billion (in FY 2009 constant dollars) to \$361.3 billion. Looking at subsequent time spans of about a decade, the next period in which DoD's average annual TOA growth rate matched that of the 1948–1960 period is 1998–2007.

¹⁵ Nitze's "back of the envelope figure" for the increases in defense spending required by NSC-68 was \$50 billion — Walter Isaacson and Evan Thomas, *The Wise Men: Six Friends and the World They Made* (New York: Simon & Schuster, 1986), p. 499. \$50 billion in 1950 dollars would be over \$600 billion in FY 2009 dollars.

¹⁶ S. Nelson Drew (ed.), *NSC-68: Forging the Strategy of Containment* (Washington, DC: National Defense University Press, 1994), p. 98.

¹⁷ OUSD/Comptroller, *National Defense Budget Estimates for FY 2009*, March 2008, pp. 110, 128.

¹⁸ See Scherer and Peck, *The Weapons Acquisition Process*, pp. 107–110, 161–163.

¹⁹ For example, in the case of military aircraft, more new designs reached flight status in the 1950s than in all the four subsequent decades combined — Jeffrey A. Drezner, Giles K. Smith, Lucille E. Hogan, Curt Rogers, and Rachel Schmidt, *Maintaining Future Military Aircraft Design Capability* (Santa Monica, CA: RAND, 1992), p. 28. Some went no further than a flying prototype (e.g., the B-45); others had small production runs until better versions were developed (e.g., the F-102 interceptor that led to the F-106); others had successful runs until obsolesced by technology (e.g., the F-86 until the F-100); and some aircraft not only had large manufacturing runs but became enduring parts of the force structure (e.g., the KC-135 tanker and the B-52 bomber).

²⁰ Comparison of O51 BA and TOA over the 1948–2007 period shows only minor, occasional differences between these two measures of defense spending. The larger differences are between TOA or BA and outlays.

The government continued a practice begun before World War II of migrating more and more production of weapons and systems from government-owned and operated facilities to commercial suppliers.

The surge in early 1950s due to the Korean War produced, in FY 1952, a peak defense budget from 1948 to 1960 that was 67 percent higher than that of 1960, using BA. Indeed, from FY 1950 to FY 1952, the US defense budget grew by an average of almost 83 percent a year, an average annual rate of increase not seen since. Using BA, the percentage of the defense budget devoted to procurement plus research and development (R&D) rose from around 22% in 1948 to over 32% in 1960, reflecting the growing level of American investment in technology and advanced combat systems.²¹ The increased emphasis on R&D is reflected in the fact that during 1948–1960 RDT&E grew at an average annual rate of over 18 percent while procurement only increased at an average rate of 8.3 percent.

The need for large standing military forces in peacetime and commensurate growth in defense spending generated by the Cold War and the Korean War led to the development, after World War II, of the first large defense industry in the history of the American republic.²² As with any emerging industrial sector, the early years were dynamic ones of change and expansion, including the entry and exit of many companies. Barriers to entry were “relatively low compared to much of manufacturing,” because of the “high rate of technological change.”²³ Exits by companies deciding to get out of the defense business were often voluntary. The major military suppliers during World War II “were actually commercial companies that had been drawn into military production, some willingly, some not, and at the war’s end they rapidly returned to making consumer products.”²⁴ In addition, the government continued a practice begun before World War II of migrating more and more production of weapons and systems from government-owned and operated facilities to commercial suppliers. Before the war almost all Army ordnance, at least 10 percent of Navy aircraft, and most Navy ships were produced in arsenals. But by 1958 arsenals accounted for

²¹ The terms “research and development” (R&D) and “research, development, test and evaluation” (RDT&E) are used interchangeably in this paper. The formal distinction is that RDT&E is an appropriation account, while R&D is a subset of the expenditures within that appropriation account. R&D is a category in PPBS into which certain classes of research are placed.

²² “The permanent state of confrontation . . . that characterized the Cold War, necessitated the creation and maintenance of an equally permanent defense industrial base” (Center for Strategic & International Studies (CSIS), “The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base: Draft Findings and Recommendations,” November 17, 1997, p. 14).

²³ Scherer and Peck, *The Weapons Acquisition Process*, pp. 190–203.

²⁴ Price Waterhouse, “Aerospace/Defense 93 Mission: Change—Survey of Business and Financial Issues in a Key American Industry,” 1993, p. 60. After World War II, many companies returned to the parent sectors of the economy from which they had come. By contrast, firms seeking to exit the defense industry towards the end of the twentieth century had built their businesses over decades around defense products and services. Converting to non-defense markets in the economy, consequently, has become a much more difficult task for these companies.

less than 10 percent of US weapons production.²⁵ Private firms assumed ever larger positions as the major providers of ordnance and weaponry.²⁶

Defense companies appear to have flourished in this environment. “The period was an era of technological revolution. . . . [T]echnical changes led to the rearrangement of specialties among defense contractors with the emergence of new firms and the relative displacement of some established producers. Within firms, the changing technology . . . resulted in new divisions, new functions, and new scientific specialties.”²⁷ Comparisons in 1959 of the top twenty defense firms versus twenty top commercially oriented companies of similar size showed that the return on invested capital was roughly the same. “With government furnished facilities, profits that were relatively modest percentages of sales were extremely favorable in terms of return on investment.”²⁸ Of the twelve major aircraft companies in 1955, the weighted average profit was 3.4 percent of sales but average return on net worth was 25.6 percent, compared to 10 percent for all manufacturing corporations. The aircraft industry in 1956 and 1957 ranked second in return on stockholder equity behind the drug industry. “From 1956 to 1959 . . . very high growth rates (of electronics firms) . . . made such companies the darlings of the stock market.”²⁹

The growth in defense spending was so substantial that by the late 1950s the defense industry was one of the leading sectors in the nation’s economy. From 1952 to 1960, defense spending was between 9.3 percent and 13.2 percent of the US GDP. In 1960 the government funded 58 percent of all the nation’s industrial R&D.³⁰ The defense industry was the biggest industrial sector of the US economy, exceeding that of automobiles, steel or oil. The 1957 recession was blamed in part on the government’s stretching out of DoD programs and reducing progress payments to defense companies in order to avoid raising the ceiling on the federal debt. As one study noted, “we would be remiss if we did not underline the fact that the sheer size of the weapons industry, its widespread dispersion throughout the country and its crucial importance

The growth in defense spending was so substantial that by the late 1950s the defense industry was one of the leading sectors in the nation’s economy.

²⁵ Scherer and Peck, *The Weapons Acquisition Process*, p. 98.

²⁶ See J. Sterling Livingston “Weapon System Contracting,” *Harvard Business Review*, July–August 1959, for examples of the government’s remaining internal production efforts and a description of the management methods and concerns about relying on contractors instead of the government. The article contains observations about the 1950s that seem pertinent today. For example, “the services have found they did not possess the talent needed to perform all the functions required of weapon system managers. . . . they lack the ‘in-house’ systems engineering capability”; also, “There is opposition to the weapon system concept, stemming primarily from the fear that this . . . will lead to concentration of military work in the hands of relatively few giant companies.”

²⁷ Scherer and Peck, *The Weapons Acquisition Process*, p. 15. This passage describes the period 1945–1960 and emergence of missiles, electronics and supersonic aircraft.

²⁸ *Ibid.*, pp.168, 211

²⁹ *Ibid.*, p. 167. For a description of the growth of high-tech, defense-related industry in California’s Silicon Valley and the Route 128 area outside Boston, see Annalee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1994), pp. 11–27.

³⁰ Scherer and Peck, *The Weapons Acquisition Process*, pp. 99–107, 214–215.

The barriers to entry and exit grew as the industry moved from its formative period to maturity.

to certain regions . . . mean that changes in the weapons acquisition process have widespread economic consequences.”³¹

The period also included marked changes in the government’s organization and management of national security affairs and, consequently, how it managed its relationships with the expanding defense industry. The Department of Defense and the United States Air Force (USAF) were created in 1947. During the following decade, DoD began to exercise increasing levels of control over the R&D and procurement activities of the military Services. The growing size of the Defense Department led to a bureaucratic acquisition system in which many organizations and individuals were involved in buying decisions. DoD began controlling the procurement habits of the military, not just regarding the numbers of systems bought but also decisions regarding which systems were chosen and the degree of commonality and interoperability among them. By 1962, red-tape, slow decision-making and poor quality of government personnel were seen as disincentives to be in the business, but many firms simply accepted these impediments as facts of life.³²

By the end of the 1950s enduring patterns also began to emerge that were increasingly to mark the defense industry as a unique sector with special demands. In the coming decades, these characteristics of the defense business would alter its attractiveness to companies and affect the flow of firms in and out of defense acquisition. In essence, the barriers to entry and exit grew as the industry moved from its formative period to maturity. These emerging characteristics included:

- > THE INCREASING CONCENTRATION OF SALES IN THE LARGER DEFENSE FIRMS: In World War II the 100 largest military contractors held 67 percent of all defense contracts, and the top twenty-five companies 47 percent. By 1958–1960, after the major post-war contraction and the onset of the early Cold War, these percentages had actually increased. The top one hundred defense firms held 74 percent of defense contracts, and the top twenty-five firms 55 percent. For example, in FY 1959

³¹ Ibid., p. 107.

³² Ibid., 68–78, 85–95, 218–219. For example, “Government personnel to oversee and manage projects have been insufficient in numbers and skills.” “Several studies . . . in every instance . . . concluded the government’s capabilities for planning and implementing advance weapons programs have been generally inadequate” (ibid., p. 86). The result is a pool of government engineers lacking a “close feel for the technology in their fields” (ibid., pp. 85–95). Thirty years later a RAND study concluded that a key ingredient in program shortfalls was whether the government had “qualified technical staff, possessing sufficient flexibility (or slack) to respond to both unexpected or unanticipated difficulties in the program, coupled with oversight that is qualified and that forces consideration of program issues that are beyond the purview of program managers” (Thomas K. Glennan, Jr., Susan J. Bodilly, Frank Camm, Kenneth R. Mayer, and Timothy J. Webb, “Barriers to Managing Risk in Large Scale Weapons System Development Programs,” RAND, 1993, p. xi). Fifteen years later, in 2008, one individual with program experience observed that those who are supposed to watch over us are, in many cases, technically incapable of even understanding what we propose, much less identifying technical deficiencies.” The lack of qualified government personnel has consequently been an enduring problem in effective management of programs and the industry itself. It is also one that DoD has taken steps in the past few years to rectify.

the top ten defense contractors had 60 percent of the nearly \$14 billion in prime contracts, and the top twenty firms had 82 percent.³³

- > **EMPHASIS ON ADVANCED TECHNOLOGY:** By the late 1950s, the American defense industry had already demonstrated its heavy emphasis on research and development. Studies showed that it spent or consumed more R&D investment dollars per sales dollar than non-defense industries. For example, in 1956 the R&D expenditures for aircraft and aircraft parts were about 19 percent of sales while the percentage for American industry overall was less than 3 percent. Military R&D also often led, rather than lagged, the commercial sector in the application of technology to products. While defense R&D often focused on new hardware and systems, in commercial firms the majority of R&D was for product improvements.³⁴
- > **REQUIREMENTS FOR INDUSTRY TO MAINTAIN HIGH LEVELS OF ENGINEERING SKILLS AND CAPABILITIES:** In the 1950s the high demands for engineering skills already distinguished the US defense industry. Defense firms recognized that both individual and team skills were needed to effectively develop complex defense systems. That in turn required time and sustained effort. Companies consequently were reluctant to reduce their engineering force when projects were cancelled because of the time required to rehire personnel and rebuild critical skills. Also, shortages of engineers were already a long-term problem and remained so in later decades.³⁵
- > **DIFFICULTIES IN MEETING GOALS FOR COST, SCHEDULE AND PERFORMANCE:** Studies showed that firms often fell short of the initial goals for developing complex defense systems. For example, a study of twelve major programs during the period 1945–1960 showed that, on average, actual cost was 3.2 times predicted cost, and average development time was 1.36 times that originally predicted. By rough measures (e.g., speed, range or payload), performance also varied from initial goals by factors of 0.8 to 2.0. One 1957 report concluded that the lead time for full introduction of an advanced manned aircraft was eleven years.³⁶

³³ Scherer and Peck, *The Weapons Acquisition Process*, pp. 117–122, 156, 132–133, 158. In 1958 the top twenty-five companies included ten aircraft and eight electronics firms.

³⁴ *Ibid.*, p. 25. See also pp. 9, 45.

³⁵ *Ibid.*, pp. 170–182.

³⁶ *Ibid.*, pp. 19–45, 53–54. The authors also noted that in aircraft the technical uncertainties and the growing complexity of newer systems were a major reason for projects exceeding original estimates for schedule and cost. This included such factors as the technical challenges within individual parts of a system (e.g., new types of engines), the integration challenges across systems (e.g., between engine power and airfoil design), the physical constraints within which an overall system must fit (e.g., size, power and weight limits in an airplane), and the large number of components that had to be integrated (e.g., a World War II B-29 bomber contained 10,000 electronic components, but the 1950s B-52 had 50,000.)

Increasingly, the uniqueness of the products and services of the industry and the buying habits of the government were to separate the defense industry from others in the American economy.

- > **DIFFERENT CAPITAL REQUIREMENTS AND POTENTIAL PROFITS:** Because of the costs of large systems and the government's capacity to change its buying commitments, firms could not, in most cases, privately finance the development and production of weapon systems.³⁷ The government thus used progress payments to relieve firms of the burdens of financing new technology efforts.³⁸ However, companies could not control their profit levels as well as private-sector firms because the price of a weapon system was not set by market competition but, instead, was largely determined by reimbursement of costs.³⁹
- > **THE GOVERNMENT'S POWER AS A MONOPSONY BUYER:** The government was the only major buyer, which meant that, unlike most commercial market situations, the government could virtually dictate the characteristics, number and delivery of products or services. The government could decide whether a new weapon was needed, thereby giving it control over new product development, the seller could not offer a finished product which the buyer could either accept or reject, and the government could (and frequently did) change, reduce or cancel a project before its completion.⁴⁰

By the end of the 1950s many enduring characteristics of the defense industry were beginning to take forms that were to govern it for the next forty to fifty years. The barriers to entry and exit from the defense industry were rising. As one study noted, "It is especially significant that once firms entered the weapons industry, the process is not easily reversed."⁴¹ Increasingly, the uniqueness of the products and services of the industry and the buying habits of the government were to separate the defense industry from others in the American economy.⁴²

THE "MATURE" PERIOD: 1961–1990

From 1961 to 1990, the US defense establishment focused on the Soviet Union as the major challenge to American security and the principal indicator of the adequacy of the US military. The various classes of major systems that had begun gaining prominence from 1945 to 1960—jet aircraft, ballistic missiles, tanks and armored fighting

³⁷ Scherer and Peck, *The Weapons Acquisition Process*, pp. 57–60. See also Martin Meyerson, "Price of Admission into the Defense Business," *Harvard Business Review*, July–August 1967, pp. 111–123.

³⁸ *Ibid.*, pp. 214–215.

³⁹ *Ibid.*, pp. 53, 56–57.

⁴⁰ *Ibid.*

⁴¹ *Ibid.*, pp. 220.

⁴² By the 1960s, the US defense industry had also already evolved to the point that firms were often segmented into categories that still exist in 2007: weapon system primes, subsystems firms, parts firms, and materials firms (*Ibid.*, pp. 114–116).

vehicles, surface-to-air missiles, aircraft carriers, nuclear submarines, and reconnaissance satellites — continued to be central components of US military forces through 1990. Other systems and capabilities grew in importance. These included satellite communications, wide-area sensors, intelligence, command and control, precision weapons, and stealth. Electronics became increasingly vital as solid-state electronics, associated software, and architectural engineering led to advances such as the Global Positioning System (GPS), digital avionics, and greatly enhanced processing capabilities. The US military also began giving greater emphasis to operational art and joint operations and developed new approaches to combat such as “AirLand Battle” and precision strike. A related trend that influenced many system development efforts was greater attention to improving connectivity, standardization, interoperability, reliability, and maintainability.

Defense companies responded to these evolving shifts in the demands of their principal military customers, but, on the whole, the attractiveness of being part of the defense industry declined from 1961 to 1990. In part, this reduction in the desirability of supplying weapons and systems to the military resulted from factors that were internal to the government and the defense industry itself. However, it was also reinforced by at least four broader trends that were occurring in American industry.

The attractiveness of being part of the defense industry declined from 1961 to 1990.

- > **THE INCREASING STRENGTH OF THE US ECONOMY:** The years 1961–1990 witnessed major growth in consumer and industrial goods, the emergence of global markets, and increasing competition (and opportunities) to build businesses. Firms that had grown largely through defense spending during 1940s and 1950s sometimes moved into these growing commercial markets as variations of the technologies and products they had developed for the military found new sources of demand among consumers and businesses. Often these were companies whose underlying skills were in solid-state electronics, computers, and software. The growth of the economy during the 1961–1990 period created new industrial sectors and reduced the dominance of the defense sector, diminishing the defense industry’s attractiveness as a new business opportunity for commercial firms.⁴³
- > **THE GROWTH OF COMMERCIAL TECHNOLOGY:** Private-sector technology investment increased after 1960 at such a rate that it eventually exceeded the government’s levels.⁴⁴ For example, government purchases of semiconductors in the 1960s were about 50 percent of the total output. In 1972, the government’s share had dropped to 12 percent, and by 1979 it was 10 percent.⁴⁵ By 1990 some assessments

⁴³ The growth in the overall economy also led to a drop in the percentage of GNP devoted to national defense because the denominator of GNP grew faster than the numerator of defense spending.

⁴⁴ “Since 1981 private sector investment in R&D has outpaced government investment” (CSIS, “The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base,” p. 3).

⁴⁵ Saxenian, *Regional Advantage*, pp. 26, 178. By 1995, the Semiconductor Industry Association predicted that sales to DoD would be around 1 percent of all sales by US companies (William Perry, “Acquisition Reform: A Mandate for Change,” DoD, February 9, 1994 p. 4).

concluded that while “military production [is] immensely high-tech . . . for the most part defense is no longer leading the world’s technologies. Technological advance is happening much more quickly on the commercial side than on the military side. The flow of technology today is out of the commercial sector into the military.”⁴⁶ This reduced the government’s ability to access and control technology. It also provided other career choices for the nation’s best engineers and provided alternative markets for firms interested in technology-oriented industries.

- > **GROWING GOVERNMENT EXPENDITURES FOR NON-DEFENSE ACTIVITIES:** The great increase in non-defense spending in the 1960s that resulted from various domestic initiatives changed the political and budgetary dominance of defense spending within the US government. First, this change created alternative demands for government funds. Second, it created a host of government agencies and interest groups that competed against DoD and the defense industry for the federal government’s spending. Third, in the 1980s, when huge deficits created demands to cut government spending, the defense budget was a more readily accessible target for reductions than many domestic programs.⁴⁷
- > **THE INCREASING SOPHISTICATION OF MANAGEMENT:** Throughout the last half of the twentieth century, research into how and why businesses succeed or fail grew among universities, consulting firms, think tanks, and business firms themselves.⁴⁸ This focus on management was caused by a number of factors. One, of course, was the growth of business education. Today the MBA (master of business administration), which originated in the United States, is the second or third most awarded master’s degree. Other factors were the success of Japanese firms like Sony and Toyota in various markets, and the emergence of increasingly competitive markets in the United States and around the world. The results were a myriad of ideas,

⁴⁶ Price Waterhouse, “Aerospace/Defense 93 Mission: Change,” p. 60.

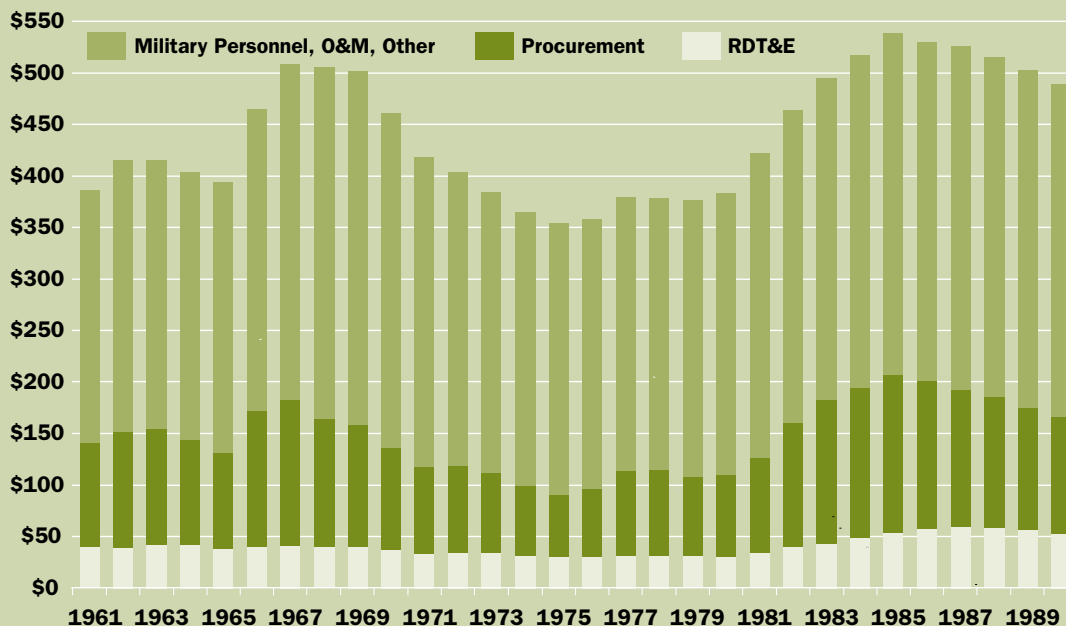
⁴⁷ The US national debt reached \$400 billion in 1980. By 1988, only eight years later, it was \$3.2 trillion, an eightfold increase. In the mid-1980s the government began passing a series of laws to reduce deficits that were \$200–300 billion annually (and would have been higher if the government included its borrowing from the Social Security fund). Efforts to cut spending included the passage of various laws as well as the use of maneuvers by administrations and the Congress to avoid recognizing the deficit, such as moving the last government payday from September 30 to October 1 and using emergency supplemental appropriations, which are not counted against deficits when enacting budgets into law. Most defense spending is “discretionary,” meaning that, unlike Social Security and other “entitlement” programs, its funding levels can be set annually and do not require changing underlying laws. This inherently makes it more vulnerable to annual changes.

⁴⁸ A good overview of the evolution of strategic thinking in business can be found in Richard P. Rumelt, Dan E. Schendel, and David J. Teece (eds.), *Fundamental Issues in Strategy: A Research Agenda* (Boston, MA: Harvard Business School Press, 1994), pp. 9–47. Introducing major new concepts of strategy emerged in the 1960s and 1970s with the work of firms like the Boston Consulting Group (BCG). New approaches to improving products and internal operations were triggered to some extent by the success of Japan in penetrating the American automobile and electronics markets in the 1970s. The impact of Japan on American management education has been likened to the impact of Sputnik on American engineering education in the 1950s.

concepts, and methods for improving efficiency (e.g., adopting quality improvements to eliminate manufacturing defects, or new inventory-control approaches such as lean manufacturing and just-in-time delivery); for strengthening competitive advantage (e.g., through increasing market segmentation, or employing time-based competition); and for developing new strategies for long-term success (e.g., focusing on core competencies, networking, or portfolio management). This outpouring of ideas began to shape the thinking and actions of defense firms, particularly as they evaluated the attractiveness of the defense industry and how to compete within it during the difficult times that emerged in the late 1980s, as the Cold War ended, and worsened during the 1990s as efforts were made to reap a “peace dividend.”

Over the years 1961–1990, the net change in defense spending was minimal (Figure 3). In contrast to the average annual TOA growth rate of 6.4 percent from 1948 to 1960, the defense budget grew only about 0.82 percent per year, on average, from 1961 to 1990. However, this 30-year period witnessed two cycles of much greater growth rates followed by contractions in the defense budget. The first cycle of rapid growth and subsequent contraction was associated with the Vietnam War and the second with the Reagan defense build-up. While RDT&E contracted somewhat at the end of

FIGURE 3. **DOD (051) RDT&E, PROCUREMENT, AND REMAINING TOA, 1961–1990**
(BILLIONS OF FY 2009 DOLLARS)



The years 1961 to 1990 were also notable for the expansion of control by OSD civilians over the RDT&E and procurement investments of the military Services.

these two cycles, procurement contracted even more. In the case of the drawdown at the end of the Vietnam War, for FY 1975 procurement fell to \$60 billion (in FY 2009 dollars), the lowest it had been since 1955.

The years 1961 to 1990 were also notable for the expansion of control by OSD civilians over the RDT&E and procurement investments of the military Services, including their practices for justifying, developing, and acquiring new weapon systems. Robert McNamara, who was defense secretary from January 1961 to February 1968, initiated some of the most lasting of these changes.⁴⁹ He appointed RAND's Charles Hitch as the OSD comptroller, and Hitch proceeded to impose the Planning, Programming, Budgeting System on the Pentagon's annual budget cycle. At the same time, Alain Enthoven, also from RAND, established the Office of Systems Analysis to begin using cost-effectiveness to make choices among alternative weapons programs. In addition, the government developed increasingly comprehensive review and monitoring practices to control the award of contracts and their oversight. The impact on companies was to lead them to expand their work forces and to implement special practices to respond to these regulations, to alter their daily activities to accommodate the day-to-day presence of government personnel in their organizations, and to become accustomed to providing the government with detailed cost and other proprietary data about their operations. The impact on industry was considerable and lasting. One firm found itself dealing with a DoD program containing "more than 600 people"; another noted that it was cutting back on inspectors in its manufacturing operations in all areas "except defense work"; and a third needing to have DoD representatives approve "all purchase orders . . . over \$5000."⁵⁰ In sum, over the decades of the Cold War, "the federal government and the Congress imposed standards, specifications, and regulations on defense industries that increased the divergence between the behaviors of companies performing defense-related work and those able to employ standard commercial practices," which resulted in the unintended but increasing segregation of defense and commercial operations.⁵¹

⁴⁹ "McNamara and his 'Whiz Kids' . . . were determined to impose much greater discipline and rationality on the overall defense planning and budgeting process. . . . McNamara's push to rationalize the procurement process was partly a response to technology and cost trends in the 1950s. . . . [They had] resulted in a dramatic escalation in R&D and procurement costs. . . . With costs rapidly mounting, defense planners concluded that the large number of . . . programs characteristic of the 1950s could no longer be sustained financially."—Mark A. Lorell, U.S. *Combat Aircraft Industry, 1909–2000: Structure, Competition, Innovation* (Santa Monica, CA: RAND, 2003), pp. 78–79.

⁵⁰ MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984–1987* (Cambridge, MA: The MAC Group, 1988), p. 33. The complexity of government practices in controlling awards reached major proportions. For example, in 1955 "the entire specification for the F-4. . . was documented in two pages. In 1980, the proposal for the C-17 . . . consisted of 92 books containing 13,516 pages and 35,077 pieces of art" (Ernst & Young, "The US Defense Industry Key Issues for the 1990s," 1989, p. 41).

⁵¹ CSIS, "The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base," pp. 15–16. For a sample of government policies affecting the defense industry during the 1960s and 1970s, see Jacques S. Gansler, *The Defense Industry* (Cambridge, MA: MIT Press, 1982), pp. 295–296.

The US defense industry itself went through major changes in the 1960s and 1970s that paralleled the increase in purchasing for the Vietnam War and the subsequent decline in spending as US participation ended. Conglomerates became interested in buying into the industry in the 1960s because of its large R&D levels, long production runs and counter-cyclical characteristics. In the mid-1960s firms incurred substantial levels of debt to expand “plant and tooling” to respond to the demands stemming from the war. When purchases fell rapidly after the war and interest rates climbed in the 1970s, many firms encountered significant cash flow problems. Several required assistance from the government to survive (e.g., loan guarantees to Lockheed). Not surprisingly, Wall Street became pessimistic about the companies and downgraded their stocks.⁵²

In light of these changes, in the 1970s many defense firms began seeking sales outside of DoD to reduce their overall dependence on defense contracts while, at the same time, protecting their existing defense programs. As military procurement declined, DoD encouraged foreign military sales (FMS) by the companies. DoD FMS spending grew from \$1.5 billion in 1970 to about \$12 billion by 1975 and remained between \$9 and \$13 billion for the rest of the decade. Across the top twenty-five US defense firms, the percentage of foreign defense sales rose from under 4 percent of revenues in 1970 to over 20 percent by 1976. To protect their existing defense sales, some firms also decreased their subcontracting in order to keep more revenue in-house. Finally, companies began to limit their exposure to defense spending. Some acquired firms in other industries,⁵³ and some isolated their defense businesses from their non-defense businesses.⁵⁴ The collective impact of all these actions was that the leading firms decreased their dependence on government spending, the subcontractor base declined, and the number of major builders of certain systems declined.⁵⁵ By 1980 many companies appear to have been wary of having defense revenues as a major part of company sales.

In the 1970s many defense firms began seeking sales outside of DoD to reduce their overall dependence on defense contracts.

⁵² There were differences of opinion among analysts of this period as to whether the defense industry was more or less profitable than commercial industries. For example, a 1965–1967 average of thirty-five defense firms concluded their ratio of profits to capital was lower than 208 commercial durable goods firms by 15.5–22.9 percent. A GAO study in the 1970s concluded that return on investment (ROI) was lower than for commercial industries (11.2 percent versus 15.4 percent). However, *Forbes* magazine concluded the return on equity (ROE) had been almost 4 percent better in the defense industry during the five year prior to 1978. In 1975 the Conference Board interviewed investment banks and found unanimous concern about low profits and high risks in the industry (Gansler, *The Defense Industry*, pp. 61–62, 138). In these analyses the government appeared to be more interested in measurement based on return on sales or return on investment; investment banks seemed more concerned about cash flow, which can be viewed as the ultimate determinant of solvency.

⁵³ For example, United Technologies bought Otis Elevator, and Raytheon bought Amana.

⁵⁴ For example, in 1977 Pratt & Whitney split its civilian and military jet engine business, leaving commercial in Connecticut and moving military to Florida (Gansler, *The Defense Industry*, p. 318).

⁵⁵ For example, the top twenty-five defense contractors went from almost 40 percent of their business in the defense area in 1958 to under 10 percent by 1975 (Gansler, *The Defense Industry*, p. 39). From 1968 to 1975, the number of subcontractors dropped from 6,000 to under 4,000 (*ibid.*, p. 129). Also, the number of major aircraft builders declined from fourteen firms in the 1950s, to nine in the 1970s, to seven in the 1980s.

The 1980s began
with major increases
in defense spending
by the Reagan
administration.

The 1980s began with major increases in defense spending by the Reagan administration. By 1985, more than two million industry jobs were added. However, several events then sparked a major change in the industrial base. First, defense spending began declining in 1985, reducing the overall revenues of companies. This decline was to continue unbroken until 1998, long enough to overcome any initial beliefs that the downward trend would reverse after a few years. Second, the government instituted policy and legal changes that altered the ability of companies to make profits even as their sales declined. These changes included cuts in progress payments, changes in tax laws, and demands that companies fund investments that the government had previously funded.⁵⁶ While periodic declines in DoD spending were an understandable cyclical aspect of being in the defense industry, these other actions aggravated the decline by affecting how the companies managed their internal operations in order to maintain profitability. They also highlighted the government customer's monopolistic power over companies. Third, parts of the DoD—in violation of the Defense Department's own policies—placed more and more of the risks of developing and producing systems on contractors, while still reserving the right to change requirements or alter production quantities.⁵⁷

Declining sales, difficulties in managing profitability and the transfer of more and more risk to defense firms combined to undermine the value of defense firms on Wall Street. In 1988, for example, a Defense Science Board study included the following observations:

Investors believe that defense industries operate in a highly unstable and excessively complex business environment characterized by high risk, restricted cash flow, and low returns.

Investors' skepticism has caused a virtual closure of the equity and debt markets to all but a few major contractors.

Companies struggle to raise their profitability in the short-term at a time when price-earning ratios in many defense sectors are the lowest in at least 25 years.⁵⁸

⁵⁶ From 1984 to 1987, DoD policy changes included limiting companies' ownership of data rights, changing cost sharing rules, reducing profit percentages, lowering progress payments, requiring companies to invest in special tooling, changing thresholds for unallowable costs, and altering when taxes had to be paid. The collective impact of these changes would have cut 1985 profits of a sample of firms by 23 percent, and for a sample of programs would have required the firms to raise \$8.5 billion (50 percent of their 1985 equity). (See MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984–1987*, pp. 8 and 9 for tables displaying these changes.)

⁵⁷ "The apparent increased use of fixed price-type development contracts and fixed price-type production commitment before development is a major risk factor contributing to capital market uncertainty concerning the industry. . . . [I]ndustry executives indicated that the Services continue to use (fixed price contracts) . . . The industry sees the use of such contracts coupled with request for fixed price-type production options before development is completed as a return to the Total Package Procurement era (of the 1960s and C-5A). . . . While broad DoD policy directives discourage their use, Service policy appears to encourage it." (Ibid., pp. 3, 32, 42)

⁵⁸ Defense Science Board (DSB), *The Defense Industrial and Technology Base*, Vol. I (Washington, DC: Office of the Under Secretary of Defense for Acquisition, October 1988), pp. 1, 15, 27.

Companies heavily involved in the defense business could not ignore these conditions. Beginning in the mid-1980s, their response was to embark on a set of actions that would alter the structure of the US defense industry. Companies began focusing more and more attention on improving their financial performance and making decisions that better served their investors' interests.⁵⁹

First, companies arrived at "overwhelming concurrence . . . that cost reductions and quality enhancements [were] essential for competitive survival."⁶⁰ Those embarking "on cost reduction programs . . . [included] Pratt & Whitney, Boeing, Lockheed, General Dynamics, Martin Marietta, and Rockwell."⁶¹ Companies also began importing from non-defense industries new management techniques such as "World Class Manufacturing (WCM), Total Quality Management (TQM), Activity Based Costing (ABC), Just-in-Time (JIT) inventory management, Manufacturing Resource Planning (MRP), Process Re-Engineering and Benchmarking."⁶² In doing so, defense firms were basically embracing trends toward more sophisticated management techniques that were emerging across the US economy.

Second, companies again began isolating their defense programs and, in some cases, stopped pursuing defense contracts. "[T]here are some members of the subcontractor and supplier portion of the industry who . . . [have elected] to eliminate or restrict their defense-related business. . . . Some very large manufacturers . . . [have segregated] older production lines for defense from new, higher technology commercial product lines."⁶³ Furthermore, "Allied Signal, IBM, and Motorola have all publicly stated that they would not expand their defense businesses. The Wall Street response to the Allied Signal announcement . . . was a 5% increase in the value of the stock."⁶⁴ Companies were becoming increasingly aware that their responsibilities to shareholders were at least equal in importance to their interests in developing new technologies or their commitment to national security.

Third, companies began exiting the defense industry. As a Defense Science Board (DSB) summer study noted in 1988:

Companies began focusing more and more attention on improving their financial performance.

⁵⁹ "If the defense industry is substantially more profitable than comparable industries with equivalent risks, why do defense stocks sell at a significant price/earnings discount to the SP 400? If the industry earns excessive returns, why do Wall Street analysts believe that any significant defense industry stock issue would have a large negative impact on the issuer's stock price? With such profitable business to pursue, why have several companies used their cash to repurchase stock?" (MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984-1987*, p. D-9).

⁶⁰ Ernst & Young, "The US Defense Industry Key Issues for the 1990s," pp. 29-30.

⁶¹ MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984-1987*, p. 36.

⁶² Price Waterhouse, "Aerospace/Defense 93 Mission: Change," pp. 28-30.

⁶³ DSB, *The Defense Industrial and Technology Base*, Vol. I, p. 12.

⁶⁴ *Ibid.*, p. 28.

[The first response of defense firms to the decline in defense spending] . . . includes the most dramatic type of corporate action: divestiture. Companies such as Eaton, Sperry, IC Industries, Goodyear, Gould, United Technologies, Lockheed, and Honeywell have all sold, or are in the process of selling, certain defense operations. For some, this has meant a complete withdrawal from defense contracting.⁶⁵

**During 1985–1988
ten of DoD’s top
sixty prime defense
contractors either
acquired, or were
acquired by, others
in the industry.**

Companies increasingly recognized that non-defense markets—which were growing, exploited technologies to develop new products, produced better financial rewards and served customers with less monopsonistic power—provided more attractive alternatives to their defense businesses. One result of these perceptions was industry consolidation. During 1985–1988 ten of DoD’s top sixty prime defense contractors either acquired, or were acquired by, others in the industry.

It is notable that these major changes in the defense industry predated the collapse of the Soviet Union. In spite of the continued importance of the USSR as the major military competitor, by the mid-1980s many corporations appear to have concluded that selling to the government was so much in conflict with their responsibilities to their shareholders that their defense businesses should be divested or isolated within their portfolio.⁶⁶ Moreover, managers appear to have begun adopting the modern management practices, which had the effect of focusing them more on the merits of their defense businesses as businesses and less on the value of building unique products or supporting national defense. The US government had made dealing with its departments and agencies so uncertain as to sales and revenue, so cumbersome in day-to-day operation, and so risky in terms of sharing responsibilities that the collapse of the Soviet Union only served to accelerate restructuring and consolidation processes that had already begun.

THE RESTRUCTURING PERIOD: 1991–2007

The collapse of the Soviet Union fundamentally changed the international security environment in which the US defense industry had operated for more than thirty years. The United States no longer faced a “near-peer” superpower rival whose nuclear forces posed an existential threat to America, and what remained of the Cold War’s bipartisan consensus on national security rapidly disappeared. As many analyses have

⁶⁵ Ibid., p. 27.

⁶⁶ These behavioral changes inside defense firms were neither coordinated nor conspiratorial. What is remarkable is that so many firms appear to have reached fundamentally similar conclusions about the difficulties of dealing with the government independently of one another. This suggests the industry had reached a mature stage in which enduring characteristics of the market had become established; firms not wanting to deal with those characteristics departed. The fact that the Cold War was still ongoing indicates how the power of these factors overwhelmed whatever broader responsibilities company leaders may have felt toward national security. It also suggests that, absent changes in these dominant customer characteristics, the range of potential futures for the industrial base is potentially more narrow than it might otherwise be.

documented, the largely unexpected and abrupt end of the Cold War sparked extensive debate within the US defense establishment about national security strategy and the types of military forces that would be needed in coming decades. This debate led to numerous formal government efforts, including the National Defense Panel (1997) and three Quadrennial Defense Reviews (1997, 2001 and 2005–06). The Persian Gulf War of 1991 and its sequel in 2003, along with Operation Allied Force in the Balkans (1999) and Operation Enduring Freedom in Afghanistan (2002), demonstrated the overwhelming power of the US military and its weaponry in conventional conflicts. However, the attacks of September 11, 2001 increased the focus on the threat of non-state actors, and combat in Iraq and Afghanistan raised, once again, the challenges of counterinsurgency warfare (albeit with the addition of suicide bombers and improvised explosive devices). Building the post-Cold War national security strategy, therefore, has proven to be a difficult, complex process whose outcome continues to be in doubt. Meanwhile, the demands for goods and services by the American military have continued to evolve, as has the defense industrial base supplying those goods and services.

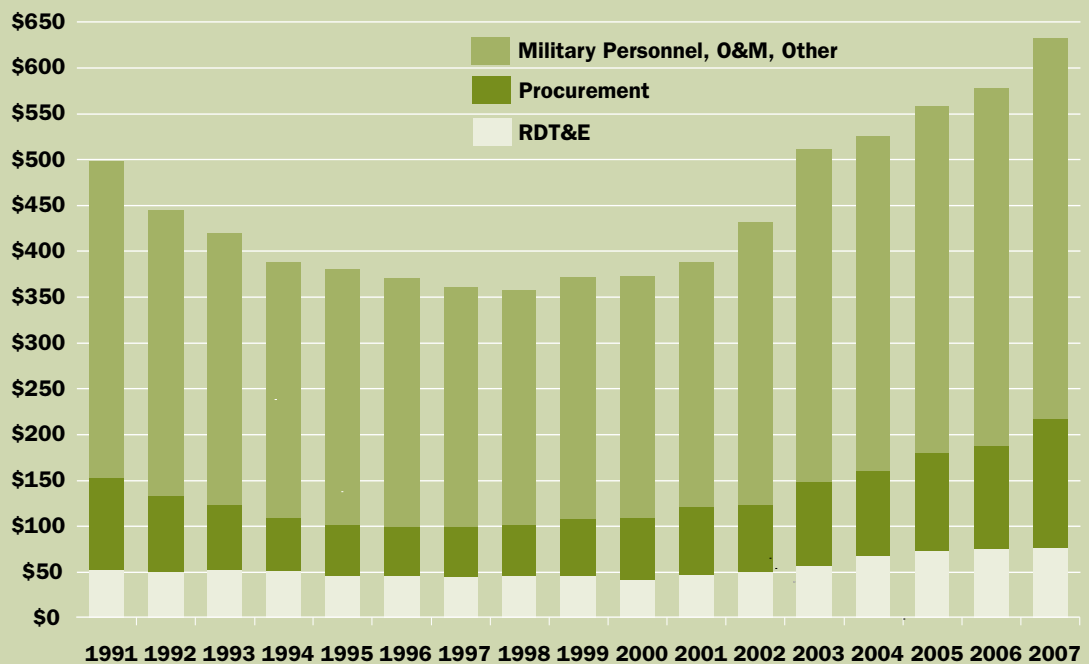
The rise of challenges quite different from those that dominated US national security during the Cold War, together with the desire for defense transformation and expensive combat experience in Afghanistan and Iraq, have altered the mix of systems and services demanded by the American military. In the absence of a major new strategic direction, certain products retained their importance, although their size, composition and growth rates often changed (e.g., demand continued for the continued development of satellites and launch vehicles, sensor systems, C2, combat aircraft, long range transport aircraft, surface combatants, and submarines).⁶⁷ The emergence of new warfighting concepts (Network Centric Warfare, Effects Based Operations, Cyberwar, etc.) and battlefield experience increased the military's emphasis on integrating capabilities across the diverse systems, war-fighting communities, and the military Services themselves. DoD's demands for precision weapons, unmanned systems, and counter-measure systems for force protection, to name a few, have all grown rapidly since 2001. The same is true in areas such as counter-terrorism systems, counter-mine and counter IED systems, security services, outsourced administrative services, and battlefield logistics support. In particular, irregular warfare operations in Somalia (1993), Afghanistan (2002–present) and Iraq (2003–present) have increased demands for weaponry that can be effective in complex ground combat environments, including urban terrain containing both combatants and non-combatants.

Building the post-Cold War national security strategy has proven to be a difficult, complex process whose outcome continues to be in doubt.

⁶⁷ Even the briefest survey of DoD's major acquisition programs argues that the US military Services still believe that the key to being a great power resides in leadership in domains such as air warfare, mechanized land combat, power projection, and "blue water" maritime power.

However, military spending for almost the entire decade of the 1990s did not indicate an enduring commitment to the development and procurement of systems that would seem to be important in the more complex world that was emerging (Figure 4). With the collapse of the Soviet Union as the dominant threat, the decline in defense spending that began in the mid-1980s continued through FY 1998 with the brief exception of a 1.2 percent uptick in FY 1991. The Reagan buildup peaked in FY 1985. From that point in time, DoD TOA generally declined under the administrations of Reagan and George H. W. Bush. Ignoring the FY 1991 uptick, this trend continued through FY 1998 during President Bill Clinton's administration. As usual, RDT&E did not decline as sharply as procurement. Indeed, the procurement figures in Figure 4 suggest that there is much truth to the perception that the 1990s was a "procurement holiday" for the military Services. Besides cutting back on purchases of major weapon systems, drawdowns occurred in force structure and personnel across both the military Services and the defense industry. As the Defense Conversion Commission observed in 1992:

FIGURE 4. DOD (051) RDT&E, PROCUREMENT, AND REMAINING TOA, 1991–2007
(BILLIONS OF FY 2009 DOLLARS)



DoD plans to reduce active duty end strength—the number of people in the services at the end of each fiscal year—from 2.2 million in 1987 (when the reductions began) to 1.6 million in 1997.

DoD plans to reduce civilian employment from about 1.1 million in 1987 to about 900,000 in 1997. At the end of 1992, DoD civilian strength totaled about 1 million, making the 1987–1997 reduction about 50 percent complete as of that time.

The Commission estimates that as many as 960,000 private sector jobs could be lost between 1991 and 1997 as a result of the drawdown. . . . As companies restructure to become more competitive, they have eliminated permanent jobs, not laid people off temporarily. In fact, the proportion of all unemployed workers who have permanently lost their jobs, rather than being laid off, was over 45% in October 1992, an all-time high.”⁶⁸

Department of Defense TOA began rebounding in FY 1999, finally reversing the long-term overall decline of the preceding thirteen years. As Figure 4 makes clear, the upward trend in DoD TOA received further reinforcement by supplemental funding for the wars in Afghanistan and Iraq. Figure 4 includes supplemental funding over fiscal years 2001–2007 totaling \$568 billion (in current dollars).⁶⁹ As a result, from FY 1998 to FY 2007, DoD TOA rose at an average annual rate of over 7.4 percent. The average growth rate exceeds even the 6.4 percent in average annual growth in DoD TOA for the fiscal years 1948–1960.

Nevertheless, the current period of growth in US defense spending has not overcome the pessimistic outlook about defense that emerged in the 1990s.⁷⁰ Even after 9/11, fundamental and increasingly partisan debate continued over defense strategy, and the government’s acquisition practices remained largely unaltered from those established decades earlier and further exacerbated by end of the Cold War. These practices included altering program funding from one year to next; awarding and evaluating programs largely based on costs; creating very large programs that would continue for decades, thereby reserving the revenues to the incumbent firms; making changes in requirements after development—or even production—had begun; and maintaining intricate oversight and control of defense firms’ daily activities.⁷¹ As a recent DoD acquisition study noted, “although the operational environment faced by

The government’s acquisition practices remained largely unaltered from those established decades earlier and further exacerbated by end of the Cold War.

⁶⁸ Defense Conversion Commission (DCC), *Adjusting to the Drawdown* (Washington, DC: DCC, December 1992), pp. 52, 59, 61.

⁶⁹ Amy Bleasco, “The Cost of Iraq, Afghanistan, and Other Global War on Terror Operations Since 9/11,” Congressional Research Service, updated 16 July 2007, pp. CRS-3, CRS-4.

⁷⁰ The indicators of future defense spending recovery were somewhat evident in the early 1990s, but at what time in the future it would occur was unclear (i.e., for how long would the defense budget decline?) Neither Wall Street nor shareholders would tolerate decades-long declines in revenues and profits in anticipation of a recovery, particularly in an area (defense systems) undergoing the disruptive changes of the end of the Cold War.

⁷¹ The longevity persistence of these practices despite major changes in military demands, buying volumes, technology-change rates, and structure of the US defense industry testifies to the strength of the bureaucratic and political practices that sit between the demands of the military and the suppliers of systems and services.

Defense companies remain skeptical that DoD acquisition is likely to evolve into a more desirable or commercial-like sector.

the U.S. Armed Forces has changed significantly since the Cold War, the system that we use to design, develop and deliver the necessary systems has not changed.”⁷²

Given the duration and continuance of such practices, it is not difficult to see why defense companies remain skeptical that DoD acquisition is likely to evolve into a more desirable or commercial-like sector. Certainly fundamental improvements appear doubtful. For example, by the 1990s the decline in the frequency of major new programs and the increasing ratio of RDT&E to procurement made the few major new programs “must-wins” for companies. Losing a major competition could force a firm to exit a part of the defense market or even the industry entirely. This potential threat to a company’s survival has encouraged risky bids that, once the program has been awarded, can severely challenge both the government and its contractors to meet the original cost, schedule, and performance.

In fairness, once it became apparent that the Cold War was winding down, the Defense Department did take some steps to deal with the defense industry’s looming overcapacity. Recall that as early as the fall of 1989, the Joint Staff under General Colin Powell began exploring substantial force-structure and personnel cuts to all the military services over a five-year period.⁷³ The Base Force that President Bush forwarded to Congress in February 1991 proposed reducing the US Army to twelve active and six reserve divisions, the US Air Force to fifteen active and eleven reserve tactical fighter wings, the US Navy to 451 ships (including 12 aircraft carriers), and active military personnel to around 1.6 million.⁷⁴ In light of reductions of this magnitude, in April 1992 the Bush administration formed a Defense Conversion Commission (DCC) to assess how reductions in defense spending would affect the economy and to suggest how to “assist the transition of Department of Defense personnel and those in the defense industry to non-defense work.”⁷⁵ The commission, chaired by David J. Berteau, concluded that the financial viability of the twenty-five largest DoD prime contractors was not at risk: these companies would probably “survive the drawdown and . . . therefore be available to help meet emerging DoD needs.”⁷⁶ However, anticipating that the Defense Department would grow increasingly dependent on commercial firms, particularly for surge capacity, the Defense Conversion Commission recommended that “**efforts to foster commercial-military integration be strengthened, expanded, and accelerated considerably** [emphasis in original].”⁷⁷ As first steps toward implementing this recommendation, the DCC recommended “a thorough

⁷² Kadish et al., *Defense Acquisition Performance Assessment Report*, p. 6.

⁷³ Lorna S. Jaffe, *The Development of the Base Force 1989–1992* (Washington, DC: Joint History Office, Joint Chiefs of Staff, July 1993), pp. 14–15.

⁷⁴ *Ibid.*, p. 44.

⁷⁵ David J. Berteau et al, transmittal letter to Secretary of Defense Richard Cheney accompanying the Defense Conversion Commission’s report, December 31, 1992.

⁷⁶ Defense Conversion Commission (DCC), *Adjusting to Drawdown*, Washington, DC, December 1992, p. 18.

⁷⁷ *Ibid.*, p. 23.

revision of those procurement laws and regulations that constitute significant barriers to integrating military and commercial manufacturing,” to include requiring that DoD use commercial specifications, standards, and buying practices except for those cases when there was a compelling need for military-unique practices.⁷⁸

The strongest impetus for downsizing the US defense establishment, however, came after the election of President William Clinton, who appointed former House Armed Services Committee chairman Les Aspin as Secretary of Defense (SecDef). Aspin, his Deputy Secretary of Defense William Perry, and John Deutch, Aspin’s under secretary for acquisition, then proceeded to assess the defense industry’s over-capacity in conjunction with the Bottom-Up Review that eventually reduced force structure and end-strength somewhat below even Powell’s Base Force.⁷⁹ In the wake of their assessment of the industrial base, Aspin invited the chief executives some fifteen leading defense firms to drop by the Pentagon for dinner. Once dinner was over, the group repaired to Aspin’s briefing room to hear Perry’s sobering analysis of the situation. To the surprise of the industry leaders, Perry revealed that the Defense Department “had no intention of paying ballooning overhead costs as companies tried to preserve their headquarters and corporate aircraft fleets, even as their factories and labs disappeared.”⁸⁰ Instead, Perry stated that he, Aspin, and Deutch expected that “half of the companies represented at the meeting would not exist in five years.”⁸¹

Norm Augustine, who represented Martin Marietta at the meeting, claims to have christened the event “The Last Supper,” a sobriquet that stuck.⁸² Aspin’s meeting with industry executives sparked a period of intense consolidation and shrinkage throughout the US defense industry. With the exception of BAE’s American subsidiary BAE Systems, Figure 5 shows selected transactions — acquisitions and, in a few cases, divestitures — by the leading defense firms in the US market. Boeing, Lockheed Martin, Northrop Grumman, General Dynamics, and Raytheon are the five US companies that managed to survive the Last Supper period of industry contraction. Indeed, in looking at Figure 5, it is not difficult to see why the 1990s have come to be seen as a bout of government-backed “merger mania” by industry observers.⁸³

By and large, the US government played little role in how the industry chose to restructure itself, at least until 1998 when the US Justice Department forced Lockheed Martin to abandon its bid to buy Northrop Grumman. For the most part, the government reviewed each proposed merger or acquisition serially, usually in isolation from

Aspin’s meeting
with industry
executives sparked
a period of intense
consolidation
and shrinkage
throughout the US
defense industry.

⁷⁸ Ibid., pp. 23, 24.

⁷⁹ Les Aspin, *Report of the Bottom-Up Review*, DoD, October 1993, pp. 29–30. The Army, for example, ended up with only ten active divisions instead of the Base Force’s twelve.

⁸⁰ Norm Augustine, “The Last Supper, Revisiting: Meeting Ignited Inevitable Consolidation,” *Defense News*, June 16, 2006.

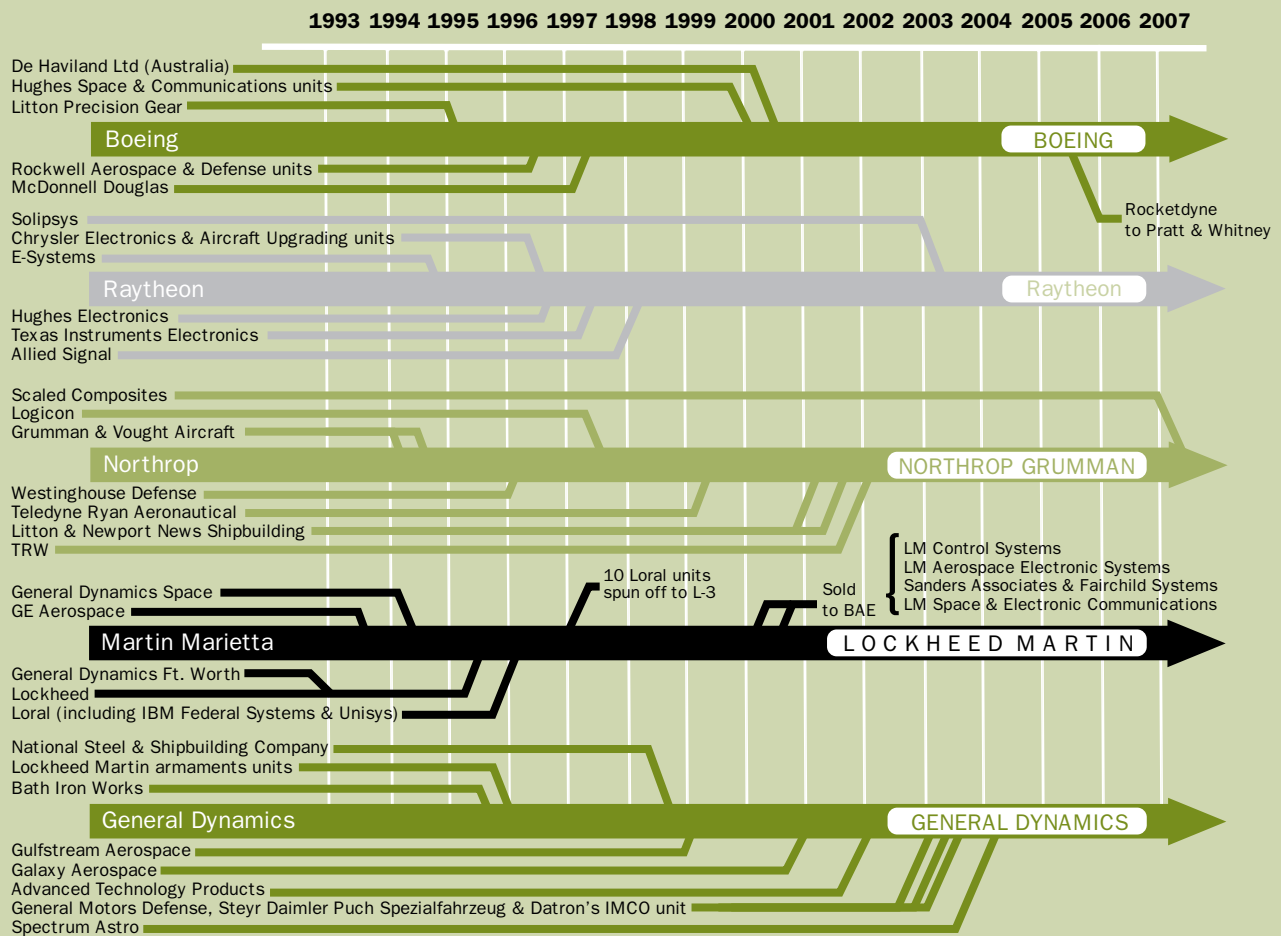
⁸¹ CSIS, “The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base,” p. 20.

⁸² Augustine, “The Last Supper, Revisiting: Meeting Ignited Inevitable Consolidation.”

⁸³ Michelle Ciarrocca, “Northrop Grumman and TRW Merger: Sealing the Deal,” July 29, 2002, p. 1, online at <<http://www.fpiif.org/pdf/gac/0207merger.pdf>>.

its impact on the defense industry as a whole. Firms might be forced by government concerns to spin off a small part of their business to make a much larger acquisition. Until 1998, mergers that reduced the supplier and component providers to just two firms were approved. For example, the government approved the mergers of Northrop and Grumman in 1994 and of Lockheed and Martin Marietta in 1995. But in 1998 the government stopped the merger of Northrop Grumman and Lockheed. Evidently, the Last Supper set top-level goals for reducing the industry's overcapacity without having thought through what sort of industrial structure the Defense Department wanted or how best to achieve that structure.

FIGURE 5. THE CONSOLIDATION OF US DEFENSE MANUFACTURING, 1993–2007*



* Acquisitions of professional-services and information-technology (IT) firms have been mostly excluded. Exceptions include Logicon, E Systems and Solipsys. For consolidation diagrams including professional services and IT, see Pierre Chao, et al., *Structure and Dynamics of the U.S. Federal Professional Services Industrial Base: 1995–2005* (Washington, DC: CSIS, May 2007), pp. 75–86. BAE, a British-Italian defense prime with a US subsidiary, is not shown except for units it acquired from Lockheed Martin in 2000. The heavier lines indicate acquisitions of larger defense firms.

Given the US government's attitude, the 1990s were also a period in which defense companies were forced to think strategically about their long-term positions in the defense industry (e.g., whether to remain in the industry; if so, in what segments; and how to change their mix of businesses accordingly). Their thinking was influenced by a number of factors besides Aspin's Last Supper and Justice Department concerns. One consideration was the great success General Dynamics (GD) had enjoyed in 1991–1992 from selling all but a few of its major businesses.⁸⁴ This success demonstrated that great value could be gained for shareholders and raised the specter that firms not engaging in portfolio changes could be targeted by others seeking to generate such wealth. Second, investment bankers encouraged a large volume of mergers and acquisitions because these transactions were a source of substantial fees and commissions.⁸⁵ Third, there was the increase in cash that built up within individual companies as they cut employment, closed facilities and ended programs in the 1980s and 1990s. This extra cash gave them buying power, or increased their value as an acquisition target.

As suggested by the GD example in the early 1990s, the consolidation took several paths. Some companies sold off their businesses, continuing a trend that had begun in the 1980s: "A number of leading technology and industrial companies have exited the direct defense marketplace."⁸⁶ Some — a few of which were destined to become the leading firms in the restructured industry — bought pieces of other companies or entire companies. Indeed, some firms made acquisitions to consolidate their positions only to be subsequently acquired themselves. In the aerospace sector, by 2000 "some forty different companies, in whole or in part, were consolidated into three: Lockheed Martin, Boeing and Raytheon."⁸⁷ By 2002, with Northrop Grumman's acquisition of TRW, the US defense industrial base had consolidated into the five giant firms. Figure 6 depicts the major industry players still standing as of 2007, including the US component of BAE.

The 1990s were a period in which defense companies were forced to think strategically about their long-term positions in the defense industry.

⁸⁴ "GD in 1991–1992 sold major divisions. Its market valuation climbed 113% in 1991 and its stock rose 80.5% in 1992. GD management decided that they will be better off selling most of their defense assets, and because they've done it first, they've reaped the best value. . . . The rest of the companies are looking at GD somewhat ruefully. 'How come they're doing so well, and we're not? We're being good citizens, we're investing, we're going for the right sort of product.' The fact is that GD found another approach, based on the strategy that if you harvest instead of investing, you raise your returns substantially." (Price Waterhouse, "Aerospace/Defense 93 Mission: Change," pp. 23–25, 59)

⁸⁵ Competition to buy firms in some cases led companies to spend more money than they might have in the past. The bidding of several companies for a firm — called the "auction" by investment bankers — increased its price (hence the term "auction"). For example, see Northrop's purchase of Grumman in 1994 or Raytheon's purchase of Hughes in 1997. In some case this "overpaying" was criticized by investors and identified as reasons for the poor financial performance of a company for several years into the future. On the other hand, the strategic value could outweigh the near term financial impact. Overpayment could be worth it if a firm was buying the last major company in a sub-industry, buying a company that would lead to entering a new market, or buying a company that would lead to a much powerful position in the overall defense market (e.g., elevating a firm into the top ten companies).

⁸⁶ Phil Odeen, "Preserving a Healthy and Competitive U.S. Defense Industry to Ensure Our Future National Security," final DSB Task Force briefing, November 2000, Slide 12.

⁸⁷ CSIS, "The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base," pp. 10–11.

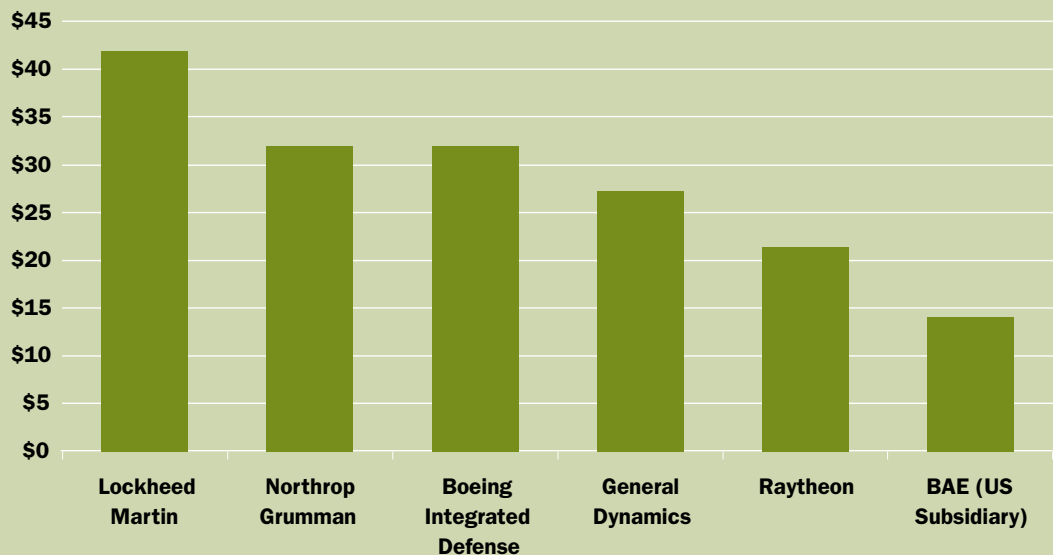
The national defense industries in Western Europe underwent similar consolidation:

The European Union has sought to rationalize procurement strategies by allowing for the consolidations of national champions into supranational regional champions. Thus EADS, BAE Systems, Thales and Finmeccanica have emerged as the big four producers of defense equipment in Europe . . . [These] four firms are increasingly entangled in a complex web of partnerships, licensing agreements, joint ventures and other forms of collaborations. According to Mattis Axelson, EADS, BAE Systems, and Thales have “the sales and breadth of capabilities that are comparable to the leading US defence companies and each is based on a complex network of cross-border ownership structures and joint venture.”⁸⁸

Nations worldwide have been inclined to establish national champions to supply their defense needs. The European portion of BAE has come to play this role in Great

⁸⁸ Peter J. Dombrowski, Eugene Gholz, and Andrew L. Ross, *Military Transformation and the Defense Industry after Next: The Defense Industrial Implications of Network-Centric Warfare* (Newport, RI: Naval War College, Newport Paper Number 18, 2002, p. 25.

FIGURE 6. 2007 SALES OF DOD'S TOP SUPPLIERS*
(BILLIONS OF US DOLLARS)



* When Boeing's commercial sales are included, its total revenues in 2007 were over \$66 billion. Total BAE sales in 2007 came to around \$31 billion. Figure 6 omits smaller US defense firms such as Textron, whose portfolio includes Bell Helicopter and Cessna Aircraft, but whose revenues are around \$11 billion.

Britain.⁸⁹ Nations have also been inclined to invest preferentially in domestic providers in order to build a defense industry, as has been the case in South Korea. These tendencies reflect a natural desire to ensure national security, protect local employment, and build technologically advanced domestic industrial capabilities. In the 1990s, however, these tendencies tended to make it difficult for American defense firms to sell equipment to foreign militaries due to the growing capabilities of foreign defense giants like BAE.⁹⁰

In light of all these changes stemming from the Cold War's end, by the late 1990s it was becoming evident that the US defense-industrial base was "entering a new paradigm, an era of rapid technological change (often commercially driven) smaller production runs and fewer new starts and an increasingly international business base."⁹¹ As a DSB task force observed in November 2000:

DoD traditionally relied on a largely defense-unique industrial base comprised of dozens of suppliers and technology leaders. In the future, the Department must increasingly access the commercially driven marketplace, in which the Department competes with other business segments for technology, investment, and human capital.⁹²

As the twenty-first century dawned, the US industrial base was still in a state of transition to the new paradigm. Many companies faced financial challenges that had eroded their value to shareholders and investors:

- > There were few opportunities for growth unless companies could increase market share or expand overseas sales despite tough competition and excessive export controls.
- > Profitability was just over one third that of industries such as pharmaceuticals and semiconductors, and return on investment had declined since 1987.
- > Cash flow, long a strength of the US defense industry, had weakened for most companies.
- > Consolidations had created higher debt/equity ratios for some defense firms, resulting in lower credit ratings.

⁸⁹ Since there are programmatic "firewalls" between the BAE parent and its US subsidiary, the latter could be considered more of an American defense firm than a European competitor.

⁹⁰ For example, see "BAE Systems Defender of the Realm"; *The Economist*, October 20, 2007, p. 76; "Europe Begins Long Road to Collective DITB," *Defense News*, May 21, 2007, p. 18; "S. Korea Arms Industry Emerges as Global Power," *Defense News*, July 16, 2007, p. 34; "Britain to Revamp Its Industrial Strategy" and "India's Biggest Defense Program Takes New Twist," *Defense News*, July 9, 2007, pp. 6, 10.

⁹¹ Odeen, "Preserving a Healthy and Competitive U.S. Defense Industry to Ensure Our Future National Security," Slide 7.

⁹² *Ibid.*, Slide 6.

Three areas in which the choice of suppliers has markedly narrowed are combat aircraft, armored fighting vehicles, and naval combatants.

- > The market capitalization of US defense companies had suffered significant losses even beyond those of most other “old economy” firms.
- > Innovative R&D was down and R&D profits were sharply constrained by DoD’s retention of the Cold War approach of having the companies “get well on production.”
- > Key personnel were leaving defense firms or retiring while the recruitment and retention of high-quality technical and management talents was becoming very difficult.⁹³

Over the period 1980–2005, the US aerospace and defense sector had lower returns than its peers in other industrial sectors such as pharmaceuticals, semiconductors, and chemicals. In 1999, the market valuations of the top American defense firms trailed all but a few of the top twenty-five US companies, and the volatility of the defense market, when actually measured, was higher than commonly thought.⁹⁴ Even though the 2000 DSB task force was less concerned with the profitability of US defense firms per se than with changes that would “enable DoD and its critical technology supplies to provide best value solutions for America’s fighting forces and taxpayers,” the financial position of the American defense industry after the Cold War was not what it had been in earlier post-World War II eras.⁹⁵

THE US DEFENSE INDUSTRY TODAY

Structural changes in the defense industry from the mid-1980s to the present, together with the US government’s actions affecting the industry, reduced the number of firms capable of competing in any one defense product or service area; further, the size and scope of surviving firms changed along with the relationships between these firms and the US government.⁹⁶ The general result has been to restrict the Defense Department’s choice of suppliers for major programs to, at most, two or three of the prime contractors in Figure 6, depending on the weapon system involved. Three areas in which the choice of suppliers has markedly narrowed are combat aircraft, armored fighting vehicles, and naval combatants.

⁹³ Odeen, “Preserving a Healthy and Competitive U.S. Defense Industry to Ensure Our Future National Security,” Slides 9–11.

⁹⁴ Pierre Chao, “GEIA Strategic Planning Forum: The Key Strategic Opportunities and Challenges Facing the Defense Industry,” March 1, 2007.

⁹⁵ Odeen, “Preserving a Healthy and Competitive U.S. Defense Industry to Ensure Our Future National Security,” Slide 7.

⁹⁶ An excellent overview of these subjects can be found in Alexander W. Vacca, *Evolution of the Defense Industry and Contracting Environment: A Historical and Structural View* (Los Angeles CA: Northrop Grumman Corporation, January 2008). Many of the points in this section have been drawn from Vacca’s analysis.

- > **MANNED, FIXED-WING COMBAT AIRCRAFT:** The 1990s saw aircraft primes such as Martin, General Dynamics, McDonnell Douglas, North American and Rockwell International absorbed into two major firms, Boeing and Lockheed Martin. These consolidations created a duopoly of manned aircraft manufacturers. Lockheed appears to be the leader in high-performance combat aircraft, having won both the F-22 and F-35 programs while Boeing produces only the F-18E/F (due to end production in 2011–2012). Boeing leads in large support aircraft (e.g., the C-17 and the KC/RC-135 series of tankers and surveillance aircraft), but the KC/RC-135 aircraft have not been produced for decades and the C-17 is at the end of its production run. Northrop Grumman, however, is not yet out of the running as a third supplier of advanced combat aircraft. In February 2008 Boeing lost the competition for a new aerial-refueling tanker to Northrop Grumman, teamed with the European Aeronautic Defence and Space Company (EADS).⁹⁷ Subsequently, Boeing protested the Air Force's decision, GAO's audit of the selection process supported the protest, and the Air Force has announced that the contract will be re-competed. Northrop Grumman's last prime combat aircraft program was the B-2, which began full-scale engineering development in 1983, only delivered twenty-one of the stealth bombers to the Air Force.⁹⁸ Despite this setback — as well as the loss of the Advanced Tactical Fighter competition that led to the F-22 in 1990 — today Northrop Grumman has become the leading prime for DoD's unmanned air combat vehicle developments.
- > **ARMORED VEHICLES:** In the 1990s lead US producers of armored vehicles such as Chrysler Defense, General Motors Defense, Teledyne Vehicles and United Defense were absorbed by General Dynamics and BAE Systems' American subsidiary. General Dynamics produces the Army's M1 main battle tank and leads in the development of the Army's Future Combat Systems (FCS), which includes a number of new land combat vehicles. GD has also acquired foreign manufacturers of armored fighting vehicles to build a worldwide presence in this product market. BAE produces the US Army's standard armored personnel carrier, the M2 and M3 Bradley. Like GD, BAE has sought to build a worldwide presence in armored vehicles, but has had some acquisitions blocked by local governments (e.g., the United Kingdom refused to permit BAE to buy Alvis, which had already acquired Vickers). Thus, a duopoly appears to exist in this segment of the defense industry, although a number of companies have teamed to bid for the lighter weight armor vehicles to protect soldiers from improvised explosive devices (IEDs) in Iraq.

⁹⁷ EADS' total sales in 2007 came to over 39 billion euros (about \$57.5 billion).

⁹⁸ The Air Force initially envisioned a production run of 132 B-2s. But in January 1992, President Bush stopped production at twenty airframes. Congress later provided money to convert a B-2 test vehicle into a twenty-first B-2A.

- > **SHIPBUILDING:** The number of US shipyards did not decline significantly during the defense contraction in the 1990s. “Until 1995, the Big Six shipyards—Avondale, Bath Ironworks, Electric Boat, Ingalls, NASSCO [National Steel & Shipbuilding Company] and Newport News Shipyards—were owned by six different firms”; today, these six yards are now owned by just two firms, General Dynamics and Northrop Grumman.⁹⁹ As a result, one firm, Northrop Grumman (NG), produces all Nimitz-class aircraft carriers, NG and GD share the production of nuclear submarines, NG leads the development of next-generation surface combatant, and GD leads in the development and production of large amphibious ships. The Navy has attempted to instill more competition in shipbuilding through its Littoral Combat Ship (LCS) program, but General Dynamics is one of the competitors, Lockheed Martin the other, and both companies are teamed with shipyards they do not own for the LCS.

The number of US defense firms capable of developing and producing major platform or weapon systems has, in many areas, declined to three or less. By one tally, from 1990 to 2000 the number of fixed-wing aircraft developers dropped from eight to three, surface-warship developers from eight to three, tactical missile makers from thirteen to three, and tracked combat vehicle developers from three to two.¹⁰⁰ These consolidations have made the government’s ability to hold viable competitions increasingly difficult, particularly for an acquisition system in which source selections are based almost entirely on meeting individual program requirements as opposed to taking into account the broader issues of sustaining a competitive, innovative industrial base. Government responses aimed at attracting more builders have included shifting major missions such as surveillance and even air-to-surface attack from manned to unmanned platforms, moving to smaller satellites to increase launch options as well as reduce costs, and developing smaller warships as the Navy did in the case of LCS. In addition, the Defense Department has been more willing to award contracts to non-US providers, as has happened in the case of helicopters and with the Air Force’s efforts to recapitalize its tanker fleet.¹⁰¹

Consolidation in the US defense industry since the Cold War’s end has also produced surviving firms of unprecedented size as measured by sales. Currently the restructured Lockheed Martin, Northrop Grumman, and Boeing’s Integrated Defense

⁹⁹ Dombrowski et al., *Military Transformation and the Defense Industry after Next*, p. 32. GD owns NASSCO, Bath Ironworks, and Electric Boat. NG acquired Ingalls and Avondale when it bought Litton Industries, and then acquired Newport News in 2001.

¹⁰⁰ Ibid., p. 22.

¹⁰¹ The cost and schedule changes in LCS suggest that, as useful as such approaches might be, they do not necessarily resolve some of the enduring unique characteristics of developing and producing systems for the US military. New companies may be unfamiliar with the subtle design requirements, unexpected changes in programs and other factors that characterize government practices and have been inculcated into defense firms over decades of experience.

sector have annual sales over \$30 billion, while the annual revenues of General Dynamics and Raytheon exceed \$20 billion.¹⁰² Managing such large and complex enterprises have presented its leaders with very difficult challenges, including:

- > Integrating the different operating styles of the acquired companies as well as their product lines.
- > Reducing costs by eliminating facilities and personnel in order to achieve the returns that had been forecasted to justify making the acquisitions.
- > Capturing additional market share or new business to sustain growth rates.
- > Making decisions about how to participate in separate businesses that could number 50 or more in a company.

Since the early 1990s these factors have increasingly drawn senior leadership further away from their individual preferences for particular types of systems (or businesses) and more towards managing their companies to produce the financial results demanded by their shareholders. Moreover, since the growth targets many of these managers have set for their companies exceed the growth rates in their underlying businesses, the firms have become intensely competitive in order to increase market share.

Many companies have come to view themselves as enterprises whose mission is to deliver products and services that enhance profits and shareholder value, much as commercial firms do. This change in self-image partly reflects the strategic and financial challenges the surviving defense firms have faced in navigating their way through the difficult consolidation period, and partly reflects continuing exposure to sophisticated management ideas. For example, while companies have disliked the intrusiveness of the government's day-to-day presence in their operations, they have also come to recognize that these practices are valuable obstacles to other firms entering their businesses or product lines. Increasingly, people in government and elsewhere have called for defense companies to act more like commercial firms in the belief such behavior would enhance efficiency and innovation. This view was the main motivation behind Defense Secretary William Cohen's Defense Reform Initiative (DRI) in 1997. While the DRI emphasized reforming the Department of Defense rather than DoD's industrial base, its underlying rationale was to emulate commercial best practices:

... DoD has labored under support systems and business practices that are at least a generation out of step with modern corporate America. DoD support systems and practices that were once state-of-the-art are now antiquated compared with the systems and practices in place in the corporate world, while other systems were developed in their own

¹⁰² Nevertheless, the largest US defense firms are small companies compared to other major American firms. The total sales of the defense firms shown in Figure 6 come to less than half of Wal-Mart's \$387.7 billion in 2007.

defense-unique culture and have never corresponded with the best business practices of the private sector. This cannot and will not continue.

This Defense Reform Initiative reflects the insights of numerous business leaders who have restructured and downsized their corporations and not only survived but thrived in a rapidly changing marketplace. One major corporation whose top leadership team generously spent an afternoon with Deputy Secretary Hamre and our defense reform task force has adopted the motto “Strength with Speed,” emphasizing that winning in the new era depends as much on the ability to respond quickly to new threats and opportunities as on the ability to overpower competitors head-on. US military forces have learned the same lessons, but they will not reach their full and necessary potential unless the business side of DoD marches in lock-step.¹⁰³

The relationships
among defense
firms, as well as
between the firms
and the government,
have also changed.

On the one hand, the cost reductions and contraction of the industrial base since the 1980s have certainly supported the enthusiasm for adopting commercial best practices. On the other hand, by 2008 some of the less attractive aspects of this orientation have also appeared. These less desirable consequences include: “no holds barred” competition between defense firms that has sometimes put winning contracts ahead of all other considerations; being less willing to divert potential profits to more speculative R&D; and focusing on near-term profitability.

The relationships among defense firms, as well as between the firms and the government, have also changed. Several decades ago there was a certain order to the structure of companies. Some were prime platform builders, some were subsystem providers, and some were component providers. Platform builders had some subsystem businesses, but often went to other firms for most subsystems. The Defense Department largely dealt with the platform providers, although, since the 1960s, it has dealt more and more directly with subsystem builders—a trend reflecting the sensible desire for standardizing subsystems across platforms. Also, the institution of large system integrators (LSI) introduced opportunities for non-platform builders to be the interface between the government and other companies, although many LSIs were also platform builders.

With the consolidation, the structure of defense firms and how they compete has become more complex. Now major firms are often LSIs, platform builders, subsystem providers, and component providers in various mixes. For example, Lockheed Martin is an LSI without being an in-house platform provider for the Navy’s LCS program, an LSI with in-house platform capabilities as the F-35 prime contractor, and a subsystem provider in electronic warfare and precision targeting pods for combat aircraft. Other large defense firms (Boeing, Northrop Grumman, General Dynamics, and Raytheon) provide other combinations of platform, subsystem, and component capabilities. Moreover, because of the post-Cold War industry consolidations, these major firms are teamed or linked across many programs and seldom fully separated. Lockheed Martin, for example, is tied to Boeing in space launch vehicles and to

¹⁰³ William S. Cohen, *Defense Reform Initiative Report*, November 1997, “Message from the Secretary.”

Northrop Grumman on the F-35 program. The futures of the firms are intertwined in complex alliances, teams, and prime or supplier contracts.¹⁰⁴

The overall result is that the government now deals with companies that have a mix of vertical and horizontal capacities and of cross-company ties. Companies may be able to build ships, submarines, armored and light combat vehicles, but also be able to build major subsystems for their platforms. Depending on the program, companies may see the need to pick another firm as a supplier because of ties to that firm in other businesses, and not because that firm provides the best subsystem or component. Consequently, the government has to broaden its scope in awarding contracts if it wants to shape the future structure of the industry. For example, instead of just asking which product or service provides best value or lower cost, the government may have to ask if a subsystem is being given to an in-house provider to drive out a competitor from that subsystem market. DoD may also need to monitor component supplier contracts to insure a viable competitive base is maintained at the subsystem and component tiers of the industrial base.¹⁰⁵

Not surprisingly, the consolidation of the American defense industry since the 1980s has raised a number of questions about the government's approach to sustaining an efficient, responsive, and innovative industrial base. Perhaps the first question is the degree to which the government understands American industry. Why, for example, did it permit segments of the defense industry to consolidate into two major suppliers, a situation in which the withdrawal of either company from defense would result in a monopoly? Acquisitions are corporate actions a government can prevent. But the decision of a corporation to exit the defense business is an action the government cannot control. Did the government intend to create supplier duopolies and monopolies, or have these arisen due to inattention or a failure to think through the long-term consequences of DoD's actions? Ultimately, what do the appearance of defense duopolies and monopolies suggest about the DoD's view of the value of competition?

Second is the question of whether the government intended to signal that some segments of the defense industrial base are less important than others. If, for example, Unmanned Aerial Vehicles (UAVs) are destined to replace manned combat aircraft, the decrease in companies able to design and develop manned systems could be understandable; if lightly armored, wheeled vehicles are to replace tracked platforms such as M1 tanks and armored personnel carriers, then similar reductions in the number of armor vehicle manufacturers could be acceptable. Did DoD's support for consolidation in these segments signal its belief that it intended to reduce or end the use of manned combat aircraft, armored vehicles or certain naval combatants, and thus no longer needed a set of viable competing firms?

Did the government intend to create supplier duopolies and monopolies, or have these arisen due to inattention or a failure to think through the long-term consequences of DoD's actions?

¹⁰⁴ There are still firms that specialize in specific segments of the defense industrial base (e.g., Harris in communications and Rockwell Collins in avionics).

¹⁰⁵ The government also needs to be concerned that a subsystem being offered may not be the best of its type (e.g., the best targeting system) because the overall rating scheme for evaluating bids may enable a less effective system to be acceptable and still create a winning composite score.

From the mid-1980s through 2007, a number of major American companies have chosen to leave the defense industry but no major non-defense firms have chosen to enter it.

Third is the question of the degree to which these consolidated companies with many defense businesses will remain committed to specific product lines. For example, exiting a business in manned aircraft, armor vehicles or ships is not as great a threat to corporate survival when those businesses are just one of many in the corporation's portfolio.¹⁰⁶ In the competition for scarce R&D dollars and the best engineers and managers within today's defense giants, these firms are also more likely to invest in businesses with a more optimistic future (e.g., UAVs, sensors, communications, command and control, satellites, and electronic subsystems) than in those with seemingly few future opportunities.¹⁰⁷ To what extent did the government think about how a diversified portfolio of businesses would affect the willingness of the surviving defense firms to remain in particular product lines?

As a final observation on the US defense industry today, from the mid-1980s through 2007, a number of major American companies have chosen to leave the defense industry but no major non-defense firms have chosen to enter it. This may be acceptable if the government is seeking a specialized industry in which firms are uniquely configured to respond to its demands (and dependent upon it). On the other hand, if commercial technology is increasingly important to US national security, this unwillingness of American industry — for whatever reasons — to participate should be a cause for concern. Also, if the government believes that at some time in the future it may have to rely on rapidly building military capabilities by tapping commercial industry, the barriers to doing that may be as high as they were in the late 1930s, and the implications just as severe.¹⁰⁸ The government competes for the attention of American

¹⁰⁶ While businesses within these firms may maintain an enthusiasm for the systems they build (as has been said, for example, of people who build warships and aircraft), ultimately the willingness of their corporation to sacrifice shareholder interests and opportunities is limited. Moreover, the number of separate businesses these firms encompass can now number forty or fifty or more. Given such a wide range of businesses, top managers are somewhat driven to look at the businesses as a portfolio or mix of enterprises. This naturally leads them to concentrate on high-level issues like financial returns, potential future value, risks, and the demands on company resources. Desires to pursue specific technologies or systems can be pushed aside by the demands for overall corporate performance. This changes the dynamic of what the government can demand — directly or subtly — of these corporations. The government's power to influence how much investment is made, where it is made, what technologies are developed, etc. have all been altered in the past several decades.

¹⁰⁷ In certain cases where firms have substantial commercial business (e.g., in commercial aviation) they may even chose to divert funds and the most skilled personnel to those non-defense businesses.

¹⁰⁸ For example, after World War I the government instituted multiple investigations of companies that had supplied aircraft. In the 1920s and 1930s it also instituted practices such as forcing fixed price contracts and awarding to one manufacturer the design another company had self-funded to develop. Senior military officers even bragged that they had forced firms to lose money. Consequently, in the years leading up to 1941, aviation companies refused to build additional capacity even when asked to do so by the most senior of government leaders, and slowed the mobilization effort. See Irving B. Holley, Jr., *Buying Aircraft: Materiel Procurement for the Army Air Force (United States Army in World War II)* (Washington, DC: Center of Military History, December 1964), pp. 290–304. See, also, Jacob A. Vander Meulen, *The Politics of Aircraft Building: An American Military Industry* (University of Kansas Press, 1992), pp. 172–207 for an analysis of these mobilization difficulties, which could be attributed as much to aspects of industry-government relations as to the time required to bring new plant capacity on line.

industry against all the other opportunities available in the market place. Over the last couple decades years it appears to have been losing that competition.



CHAPTER 2 > **DEFENSE INDUSTRY PERFORMANCE**

There appear to be no comprehensive assessments of the performance of the US defense industry as a whole, particularly with respect to the government's need to sustain an adequate industrial base over the long term. Most evaluations focus on specific weapon systems and programs. Direct and indirect evaluations of various aspects of industry performance can be derived from: studies of its delivery of products and services; statements of government officials and industry observers, including GAO and the Congressional Research Service; assessments of the industry by government boards, panels, and commissions (Defense and Service science boards, the 2007 Defense Performance Assessment, etc.); DoD-funded and private think-tanks (RAND, CSBA, CSIS, etc.); Wall Street analyses; and interviews with knowledgeable individuals both inside and outside the industry. Table 1 summarizes these varied observations and assessments in four categories: overall support of military strategy, delivery of products and services, preservation of the industrial base, and industry operations. Each category is then explored in more detail in its own section.

INDUSTRY SUPPORT OF US MILITARY STRATEGY

Since World War II, the United States' military strategy has emphasized exploiting technological superiority to deter war, win conflicts, and shape the behavior of other nations, allies as well as adversaries, during peacetime. Against this criterion, the defense industry has to be given high marks for its contributions to national defense. Of course, the United States had the resources to pursue a strategy that sought, as much as possible, to substitute technology and equipment for the blood of its warriors. Since the 1940s, the United States has outspent all other nations with the exception of the Soviet Union from 1970 until the early 1980s. Since the Cold War ended, the US military has been able to outspend all actual or prospective rivals by even wider margins, although this fact must be balanced against its greater commitments.

Significant portions of the US military have been engaged in combat operations more or less continuously since 1991.

Granting these caveats, the United States has nonetheless outdone other nations in the development of superior systems in most important arenas of military competition. Today, US nuclear submarines, surface combatants, tactical combat aircraft, bombers, main battle tanks, reconnaissance satellites and navigation satellites are the leaders in their respective classes. In underlying areas such as low-observables technologies, submarine quieting, acoustic detection, digital signal processing for a range of applications, active electronically scanned arrays, near-real-time sensor-to-shooter targeting connectivity, and all-weather guided munitions, the defense industry has given the US military substantial leads, many of which have been sustained over periods of decades.

These advantages, while important, should not be construed as suggesting that superior weaponry and technology in and of themselves win wars. In the aftermath of the American defeat in Vietnam, all the US military Services committed themselves

TABLE 1. INDUSTRY PERFORMANCE SUMMARY

AREAS OF STRONG PERFORMANCE	AREAS OF WEAK PERFORMANCE
Overall Support of Military Strategy	
> Supplying systems that support the military's strategic, operational, and tactical concepts (e.g., deterrence, precision attack, ballistic missile defense, reconnaissance and surveillance, etc.). > Exploiting technological innovation to help DoD achieve tactical, operational, and strategic advantage, including shaping enemy and allied behaviors. > Responding to unanticipated needs (e.g., GPS-aided munitions, laser-guided weapons, UAVs, etc.).	> Difficulties in developing and producing systems to solve unplanned combat challenges that significantly affect military strategy (e.g., vehicle protection against IEDs and counter-guerilla systems). > Increasing difficulties in ensuring US leadership in key current and future defense technologies as those technologies spread overseas or emerge in non-defense industries.
Delivering Products and Services	
> Providing systems that perform well in combat operations: the M1, F-117, B-2, Infrared Countermeasures (IRCM), Joint Direct Attack Munitions (JDAM), F-22, etc. > Innovating in technologies and systems to meet new customer demands (e.g., LCS modules, FCS architectures, signal processing, and integrated avionics). > Producing and modifying platforms to achieve long service lives (e.g., the B-52 and aircraft carriers). > Creating entirely new technologies or systems such as satellite reconnaissance and stealth aircraft.	> Persistent inability to deliver major programs on cost and schedule. > Intermittent failures or terminations of major projects because of engineering or management shortfalls (e.g., the Future Imagery Architecture and the Aerial Common Sensor programs). > Difficulty in integrating very complex individual systems or collections of systems within initial performance goals for cost and schedule.*

* The capability of the United States to build complex systems and systems-of-systems is considered by many to be a source of long-term advantage over other nations. For example, there is no design handbook of practices to guide engineers and managers in developing such complex systems as FCS, or in implementing network centric warfare. These are in many ways first-of-a-kind systems, and engineers and managers must learn from trial-and-error experience. Indeed, the difficulties that DoD and companies have had in developing systems this complex — and the large-scale integration experience gained from doing so — are seen as barriers to matching US military capabilities.

to long-term investments to improve the tactical competence of their war fighters. Arguably, this “revolution in training affairs” during the 1970s and 1980s produced more improvement in the fighting power of US forces than did any other development between the Vietnam War and Operation Desert Storm in 1991, including the 1986 Goldwater-Nichols Department of Defense Reorganization Act. Moreover, starting in 1991 with Desert Storm, the benefits of well-trained soldiers, sailors, marines and airmen equipped with superior weaponry became hard for even the most casual observers of military affairs to miss. In conventional combat at least, Desert Storm and subsequent high-intensity operations in Afghanistan and Iraq have witnessed overwhelming American victories with minimal US casualties compared to the Korean War or Vietnam. Today there are growing concerns about the improving military capabilities of other nations, but even these worries rest more on the perception that US margins of superiority may be shrinking rather than on the loss of superiority altogether. It is the narrowing of US margins of advantage, and not the prospect of outright military inferiority, that is of concern.

AREAS OF STRONG PERFORMANCE	AREAS OF WEAK PERFORMANCE
<i>Sustaining Industry Capabilities</i>	
> Consolidating in response to government guidance. > Reducing employment, facilities and other costs in response to market declines. > Providing openings for small niche system and technology companies (e.g., UAVs, small satellites, etc.). > Competing internationally to capture new technologies and systems and reduce DoD's costs. > Creating special organizations (e.g., Lockheed Martin's Skunk Works) that develop and produce innovative systems in classified programs or in small numbers (e.g., the U-2 and CORONA reconnaissance satellites).	> Reductions in the number of competitors in sub-markets, leading to oligopolies or monopolies. > Losing technical capabilities and engineering depth as experienced people leave the work force and facilities are closed. > Strong barriers to entry in many segments. > Declining numbers of lower-tier suppliers. > Limited capacity to increase production rates or reduce the time required to deliver systems. > Declining ability to compete against commercial industry in attracting best engineering talent. > Difficulties incorporating commercial technology.
<i>Industry Operations</i>	
> Companies managing their businesses to meet the financial and other performance expectations of their shareholders. > Companies incorporating modern operational and strategic management practices from the non-defense industries in order to improve the delivery of products and services, company performance and company ability to compete.	> Insufficient R&D by some firms because of focus on near-term financial performance. > Engaging in excessively competitive actions (e.g., underbidding projects and contesting losses), leading to program delays and cost overruns. > Failures to comply with laws and regulations leading to project delays and incurring public distrust of both government and industry.

Of course, this impression of the US defense industry's ability to support American military strategy is not without blemishes. The defense industry has exhibited shortfalls in at least two areas. First, in certain cases other nations — including the former Soviet Union — have produced weapon systems offering comparable, or even superior, tactical performance at substantially lower unit costs than their US counterparts. Most often mentioned in this regard are small arms, mortars, air defense guns and surface-to-air missiles. For instance, the 7.62-millimeter Kalashnikov AK-47 assault rifle, initially adopted by the Soviet army in 1949, was simple and inexpensive to manufacture yet provided legendary ruggedness and negligible failure rates. By comparison, when the American 5.56-mm XM16E1 (renamed the M16 upon adoption by the US Army) entered service in Vietnam in 1966, reports of jamming and malfunctions in combat surfaced almost immediately, and modifications of the rifle were needed to overcome these deficiencies. Even today, assault rifles of the Kalashnikov family are estimated to constitute one fifth of the worldwide supply of firearms and are found in “practically every theatre of insurgency or guerrilla combat.”¹⁰⁹ Similarly, the premier US fighter of the Vietnam era, the technologically more advanced McDonnell Douglas F-4, cost four times more than the Soviet MiG-21, but the smaller, lighter MiG was a superior dogfighter in horizontal-plane, turning fights, especially at higher altitudes.¹¹⁰ To defeat the MiG-21's superior turning ability, F-4 crews had to master the more difficult techniques of maneuvering in the vertical plane so that they could take advantage of the F-4's superior thrust-to-weight and raw power.¹¹¹ In the early 1970s, comparisons such as these led some observers to wonder whether the United States might be pricing itself out of the competition with the Soviets by emphasizing technologically sophisticated but more expensive weaponry.¹¹² While US combat experience during major operations in 1991, 2001–2002, and 2003 against Iraqi, Taliban, and al Qaeda forces suggest that the United States produces some of the world's best weaponry, the unit-acquisition price of the F-22, which is over \$300 million per jet, has limited the buy to 175 operational aircraft. Along these same lines, the US Navy's recent decision to limit the planned buy of seven DDG-1000 Zumwalt-class

¹⁰⁹ Phillip Killicoat, “Weaponomics: The Economics of Small Arms,” CSAE WPS/2-006-13, Department of Economics, Oxford University, September 2006, p. 3. Available online at <http://www-wds.worldbank.org/external/default/WDSCContentServer/IW3P/IB/2007/04/13/000016406_20070413145045/Rendered/PDF/wps4202.pdf>.

¹¹⁰ Frank W. Ault, “The Ault Report Revisited,” *The Hook*, Spring 1989, p. 36.

¹¹¹ Walter J. Boyne, “Route Pack 6,” *AIR FORCE Magazine*, November 1999, pp. 59–60. “At altitude, the MiG-21 could outfly the F-4 in almost all flight regimes. It had spectacular acceleration and turning capability. At lower altitudes, the F-4s used their colossal energy in vertical maneuvers that offset the MiGs' turning capability, for they lost energy quickly in turns at low altitudes.” (Walter J. Boyne, “MiG Sweep,” *AIR FORCE Magazine*, November 1998, available online at <<http://www.airforce-magazine.com/MagazineArchive/Pages/1998/November%201998/1198sweep.aspx>>).

¹¹² As Andrew Marshall observed in 1970, “there is a real question as to whether or not the U.S. is on the way to pricing itself out of the military competition with the Soviets, or at least severely handicapping itself through a defective weapons acquisition process, high cost day-to-day operating practices, etc.” (A. W. Marshall, “Net Assessment of U.S. and Soviet Force Posture: Summary, Conclusions and Recommendations,” National Security Council paper, 1970, declassified, pp. 2–3.

destroyers to the first two ships due to unit prices over \$3 billion only reinforces longstanding concerns about the ballooning unit costs of advanced US weapon systems.¹¹³

Second, the American defense industry has also been unable to develop technologies and systems to alleviate some of the most pressing challenges of ground combat, such as jungle warfare, urban combat, guerrilla or irregular warfare and peacekeeping. More than 80 percent of all US military personnel killed in combat during the last fifty years have been in the ground forces of the Army and Marine Corps.¹¹⁴ Of course, industry's inability to achieve much greater survivability for American soldiers and marines may stem more from the inherently complex, messy nature of ground combat than from a failure to exploit emerging technologies or design better equipment. Nevertheless, this vulnerability, which insurgents and suicide bombers have exploited in Iraq and Afghanistan, has been a significant constraint on US foreign policy and flexibility since the 9/11 attacks on the World Trade Center and the Pentagon; until technologies or weapons capable of eliminating Clausewitzian friction are discovered — which seems highly unlikely even in principle — inflicting casualties on US forces will continue to be a viable stratagem for America's enemies.¹¹⁵

PRODUCT AND SERVICE PERFORMANCE

While the overall performance of US military technologies and weapon systems has been excellent, the industry has failed, on more than one occasion, to provide systems with the promised capabilities, or only done so after following delays, increased costs, or both. Recent examples of major program failures stemming from cost overruns, schedule slippage, or performance include termination of the National Reconnaissance Office's (NRO's) Future Imagery Architecture program,¹¹⁶ termination of Army-Navy Aerial Common Sensor, and the scrapping of the Coast Guard's Deepwater program to produce the first new coastguard cutters in more than three decades.¹¹⁷ It is

¹¹³ Bettina H. Chavanne, "U.S. Navy Cancels DDG-1000 Destroyer," *Aerospace Daily & Defense Report*, July 24, 2008.

¹¹⁴ Robert Scales, *Yellow Smoke: The Future of Land Warfare for America's Military* (Lanham, MD: Rowman & Littlefield Publishers, 2003), p. 83.

¹¹⁵ Barry D. Watts, *Clausewitzian Friction and Future War* (Washington, DC: National Defense University Press, rev. ed. 2004), McNair Paper 68, pp. v–vii, 85–90.

¹¹⁶ Philip Taubman, "Failure To Launch: In Death of Spy Satellite Program, Lofty Plans and Unrealistic Bids," *The New York Times*, November 11, 2007, online at <http://www.nytimes.com/2007/11/11/washington/11satellite.html?_r=1&pagewanted=1&oref=slogin>. See, also, Edmund Nowinski and Robert J. Kohler, "The Lost Art of Program Management in the Intelligence Community," *Studies in Intelligence*, Vol. 50, No. 2, 2006, online at <https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol50no2/html_files/index.html>. Nowinski, who had been a top spy satellite expert at CIA, became Boeing's program manager for FIA after retiring from federal service.

¹¹⁷ Earlier examples of major program terminations include the Navy's A-12 attack aircraft, the Army's Crusader self-propelled artillery system, and RAH-66 Comanche attack helicopter.

The dominant criticism of the weapons and systems produced by the defense industry is that programs either cost too much to start with, or their costs increase during development and production.

difficult to assess the full extent of these various program shortfalls because they can often be dealt with by government actions such as making available additional funding available, altering requirements to avoid acknowledging shortfalls, or stretching out programs until technical problems have been resolved. Moreover, program terminations—the most glaring manifestation of acquisition difficulties—can also be chosen by the government to release funds for other uses or because products are no longer needed. In the case of FIA, however, the government’s assessment of the two proposals was surely questionable. Whereas Boeing’s proposal for producing a new generation of electro-optical and radar-imaging reconnaissance satellites was evidently superior to Lockheed Martin’s, the government’s judgment about Boeing’s ability to match LM’s four decades of experience and success in this area appears, in hindsight, to have been poor. As then-NRO director Keith Hall later said about the selection of Boeing, “I shouldn’t have allowed it to go further.”¹¹⁸

The dominant criticism of the weapons and systems produced by the defense industry is that programs either cost too much to start with, or their costs increase during development and production. Studies by the government and others have identified a number of causes, including overly optimistic bidding in proposals, errors in engineering and management, government changes in performance requirement, and the inherent complexity of advanced military capabilities that “stretch the boundaries” of proven technology. For example:

- > As much as 40 percent of program cost overruns can be correlated to changes in annual buys imposed by top-level members of the DoD/Executive branch or Congress. These factors are generally beyond the control of government or industry program managers.¹¹⁹
- > Significant percentages of cost overruns result from discrepancies or shortfalls in the program’s initial baseline requirements. The need for such changes can be legitimate responses to evolving threats and enemy capabilities. They can also reflect bureaucratic difficulties such as the lack of coordination or foresight within the government or contractor team. To cite a current example, the troubled VH-71 program to field a new presidential helicopter has reportedly suffered nearly 2,000

¹¹⁸ Taubman, “Failure To Launch: In Death of Spy Satellite Program, Lofty Plans and Unrealistic Bids.” Nowinski and Kohler observed in 2006 that the government no longer has staff sufficiently knowledgeable to manage programs like FIA, preferring to allocate these responsibilities to the prime contractor. In fairness, though, the acquisition system is less tolerant of early failures today than in was in the 1960s. The first return of KH-1 CORONA film capsule in August 1960 was preceded by twelve failures.

¹¹⁹ Changes in the annual funding of programs can increase costs for a number of reasons. Reasons include: spreading fixed costs across fewer units; having to order parts that cannot yet be installed; constraining the ability of contractors to buy components in large quantities at lower prices; and buying more in later years after inflation has discounted program dollars. Moreover, cutting funding may negate contractual provisions and provide companies the opportunities to negotiate their way out of being charged for overruns. More than half of the costs of a program are “period costs” that do not vary in the short term. For example, the cost of a design facility and the salaries of a design team are inflexible. When the government stretches a program from two years to three years, such period costs are incurred for an additional twelve months.

requirements changes.¹²⁰ In the case of the LCS, the US Navy attributes at least some of the cost growth in the “sea frames,” to which modular “plug-and-play” mission packages would be added, to “an underestimation of the cost impact of applying new Naval Vessel Rules . . . specifying the construction standards for the ship.”¹²¹ Companies have little control over these sorts of requirements changes. However, cost and schedule problems can also occur when prime contractors fail to flow down all requirement to their subcontractors as apparently happened in the case of SBIRS (Space-Based Infrared System) High.¹²²

- > Design and manufacturing experience among companies has declined over the past few decades because of the decreasing frequency of new starts, cutbacks in existing programs, retirements from the work force, and reductions in company laboratories and other facilities. With declining manufacturing experience and truncated productions runs, it has become more difficult for companies to estimate accurately the costs of producing major systems over the course of multi-year production runs. For example, one tendency has been to overestimate the savings during production as efficiency improves due to learning from one unit to the next. Learning-curve theory, originally based on aircraft production experience during the 1930s and late 1940s, holds that as the number of units produced doubles, the recurring cost per unit decreases at a fixed rate or constant percentage.¹²³ Optimistic assumptions about manufacturing learning curves present an obvious temptation to low-ball production costs.

¹²⁰ Gayle S. Putrich, “New Presidential Helicopter on Hold,” *Marine Corps Times*, December 21, 2007.

¹²¹ Ronald O’Rourke, “Naval Littoral Combat Ship (LCS) Program: Background, Oversight Issues, and Options for Congress,” Congressional Research Service (CRS) RL33741, updated May 23, 2008, pp. CRS-3 and CRS-14. The Navy hopes to procure a total of 55 LCSs for shallow-water antisubmarine warfare, mine countermeasures, countering small boats, and intelligence, surveillance, and reconnaissance (*ibid.*, p. CRS-3). Congress funded six, but LCSs 3-6 have been cancelled.

¹²² The SBIRS High program is the culmination of several attempts to develop and deploy a follow-on to the highly successful Defense Support Program (DSP) satellites. First orbited in the 1970s, the DSP satellites used an infrared (IR) sensor to detect heat from missile and booster plumes against the earth’s background from 22,300-mile geosynchronous orbits to provide warning of Soviet missile launches. SBIRS High, however, added additional missions to DSP’s primary role of missile-launch warning. Whereas DSP just covered the shortwave IR spectrum, SBIRS High was to cover the midwave and see-to-ground bands as well. When the program was restructured in August 2002 following a breach of the Nunn-McCurdy 25-percent limit on increases in the program acquisition baseline, 94 requirements changes had been made in the program (GAO, “Defense Acquisitions” Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns,” GAO-04048, October 2003, p. 13).

¹²³ Stacy S. Azama, “Teaching Note: Application of Learning Curve Theory to Systems Acquisition,” *Defense Systems Management College*, June 2000, p. 1. The concept of the learning curve was introduced to the aircraft industry by T. P. Wright in 1936. The phenomenon was based on the observation that unit production costs decrease over time as people and organizations involved in the repetitive manufacturing of an airplane, automobile, etc. learn to work faster, develop more efficient assembly techniques, or find other process improvements. An 85 percent learning curve means that Unit 2 will cost 85 percent of Unit 1 to manufacture, Unit 4 will cost 85 percent of Unit 2, Unit 20 will cost 85 percent of Unit 10, etc. For more recent research on how firms learn, see Kim B. Clark and Takahiro Fujimoto, *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry* (Cambridge, MA: Harvard Business School Press, 1991), Chapter 7.

- > Since at least the 1960s, US companies have been inclined to over-promise and underbid on major defense programs in order to win competitions. The decline in new starts since the 1980s seems to have accentuated this problem, giving rise to the term “dysfunctional competitions.” As a Defense Science Board task force observed in 2000, the “remaining defense-focused companies are competing for fewer new major programs, limiting their growth potential and making each new program a ‘must win’.”¹²⁴ The result has been lower margins, greater risk, and more cost overruns in major defense programs. Here both the industry and government are at fault—the former for being unable to resist underbidding programs, and the latter for not exercising more control over major competitions.

Controlling acquisition costs has been an enduring problem.¹²⁵ Studies of a number of aviation programs during the 1945–1960 period found that overruns exceeded projected costs by 200 percent. In the 1960s overruns were on the order of 150 percent, while in the 1970s in certain cases overruns had declined to 110–120 percent. A 1993 RAND study of over 150 programs covering most types of weapon systems concluded that “cost growth has fluctuated around 20 percent since the mid 1960s” and, perhaps more significantly, “little improvement has occurred over time.”¹²⁶

An argument can be made that overruns are inherent in any major development effort exploiting cutting-edge technology. DoD and Congressional oversight discourages including enough additional funding in the original cost estimate to cover overruns of the magnitude observed in the past. Moreover, just in terms of software content, today’s defense programs tend to be more complex than those of the 1960s or 1970s. Many are also “systems of systems,” which substantially increases the sheer complexity of large-scale engineering and system integration, all of which must be done within large organizational networks of suppliers, government participants, and

¹²⁴ Odeen, “Preserving a Healthy and Competitive U.S. Defense Industry to Ensure Our Future National Security,” Slide 12. “The nature of the defense business, with a single customer and large infrequent programs, encourages ‘desperate’ competitions. If an aircraft company does not bid on, for example, the Advanced Tactical Fighter (ATF) or the Advanced Tactical Aircraft (ATA), it may not have an opportunity to bid on another fighter aircraft for twenty years. . . . Literature is replete with examples of industries in which competition continued . . . under circumstances where the majority of (if not all) competitors were producing inadequate returns.” (MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984–1987*, p. 21). See, also, Kadish, et al., *Defense Acquisition Performance Assessment Report*, pp. 52–53. For descriptions of how such destructive competitions can occur in other industries, see Joseph L. Bower, *When Markets Quake: The Management Challenge of Restructuring Industry* (Cambridge, MA: Harvard Business School Press, 1986).

¹²⁵ Historians correctly observe that overruns in military systems date back to the beginning of the republic.

¹²⁶ J. A. Drezner, J. M. Jarvaise, R. W. Hess, P. G. Hough, and D. Norton, *An Analysis of Weapon Systems Cost Growth* (Santa Monica, CA: RAND, 1993), p. xiii. This report was based on the System Acquisition Reports (SARs) and consequently focused on the larger of DoD programs. It also provided breakdowns of growth rates by military Service and program types.

large design teams.¹²⁷ A further challenge is coordinating the program's development across a variety of organizations.¹²⁸ Consequently, controlling costs is likely to remain difficult as long as major defense programs push the boundaries of design, technology, and capabilities and, as a result, demand advanced engineering, novel processes, and sophisticated management skills.

It is notable that neither the US government nor the defense industry appears to have embarked on a long-term, continuous-improvement effort to control acquisition cost growth. Episodically, the government has tried various techniques including cost-sharing formulas for overruns, fixed-price contracting (including fixed-price engineering developments¹²⁹), and acquisitions based on "Best Value" or "Cost as an Independent Variable (CAIV)." Little success in curbing costs has been achieved. Indeed, the problems may have grown worse since the 1990s. The Government Accountability Office's latest survey of major defense acquisition programs (MDAPs) indicated that from FY 2000 to FY 2007 acquisition cost growth increased from 6 percent to 26 percent across the portfolio, and average schedule slippage grew from sixteen months to twenty-one months.¹³⁰ The current data on cost growth, therefore, is worse than the roughly 20 percent RAND found in the 1960s. Further, of the ninety-six programs in GAO's FY 2007 portfolio, not one "had proceeded through system development meeting the best practices for mature technologies, stable design, and mature production processes."¹³¹ Although the government bears considerable responsibility for this situation, the defense industry is probably equally guilty. From the standpoint of containing cost overruns and schedule slippages, not all defense companies have sufficiently embraced state-of-the-art commercial management

Neither the US government nor the defense industry appears to have embarked on a long-term, continuous-improvement effort to control acquisition cost growth.

¹²⁷ One can see similar complexity and cost overruns in many large non-defense developments. Obvious examples are Boston's Big Dig, the Hubble Space Telescope, Airbus' A380 airliner, Boeing's 787 Dreamliner, and the National Air and Space Administration's Space Shuttle.

¹²⁸ Many cost increases in systems emanate not from the technology challenges, but from the management challenges. For example, within a single large program the complexity of managing suppliers includes more than simple contracts specifying products and delivery dates. It now involves assigning to suppliers major portions of development and production, which entails worrying about the suppliers' long term financial condition, their ties to other firms, international linkages, and whether the suppliers' engineers, design processes, manufacturing facilities, workforce, and sub-component providers are capable of performing according to the requirements set forth in the contract.

¹²⁹ In the case of the ill-fated A-12 program, the Navy insisted on a fixed cap for engineering development that was about a billion dollars below the estimates of the Northrop-Grumman team. Consequently, Northrop ultimately refused to submit a best-and-final offer for the program at or under the Navy's cap. However, given the state of low-observables technology during the late-1980s and the rigors of the operating environment aboard Navy aircraft carriers, the A-12 was an unusually ambitious program.

¹³⁰ GAO, "Defense Acquisitions: Assessments of Selected Weapon Programs," p. 7. GAO's FY 2000 portfolio contained 76 MDAPs.

¹³¹ Ibid., p. 4.

Three of the more salient concerns are surge capacity, maintaining technological leadership, and participating in international defense trade.

techniques such as Six Sigma¹³² or other quality-improvement practices. Indirect evidence indicates at least some attention has been paid to this problem: managers have been relieved of their assignments and industry chief executive officers have spoken about making changes. However, no enduring solution seems to have been found. Perhaps, as some have suggested, the absence of effective efforts to better control cost and schedule stem from the simple fact that the existing acquisition system has, on the whole, produced superior weaponry, and those with vested interests in its product are reluctant to risk major changes.¹³³ Another possibility is that changing requirements make cost and schedule control much more difficult to achieve in defense programs than in commercial product developments.

SUSTAINING THE INDUSTRIAL BASE

Growth in the size of the top US defense firms in recent decades, along with the structural changes due to post-Cold War consolidation, suggest that the defense industry does respond to government guidance and changes in their markets. The shrinkage of the defense industry since the mid-1980s is evidence that, like any economic sector, it contracts as customer demand declines. Indeed, the defense industry actually moved faster than the government in the early 1990s, releasing well over a million workers and closing a number of facilities before the government had taken actions of a similar scale. Then, after Aspin's Last Supper, the industry responded to government guidance that some defense firms needed to exit the business. The resulting consolidations reduced the number of independent firms, reshaped the defense industry, and further reduced facilities, tooling, employees and other aspects of operations. To this extent, one can argue that both government and industry took some fairly dramatic steps to sustain a viable industrial base for the altered challenges of the early twenty-first century. However, these changes have also given rise to a number of concerns about the defense industry's capacity to meet future defense needs. Three of the more salient concerns are surge capacity, maintaining technological leadership, and participating in international defense trade.

In the case of surge capacity, changes in the defense industry since the early 1990s have accentuated earlier concerns that the industry lacks the capacity to develop new

¹³² Six Sigma is a business management strategy, originally developed by Bill Smith at Motorola in 1986. Today Six Sigma enjoys widespread application in many sectors of commercial industry. Originated as a set of practices to improve manufacturing processes, Six Sigma has been extended to other aspects of business as well. Distinguishing characteristics of Six Sigma include a clear focus on achieving measurable and quantifiable financial returns, and making decisions based on verifiable data rather than on assumptions or guesswork.

¹³³ Major restructuring of the existing system would risk changing the balance of power among the various constituencies with a stake in defense acquisition—the military Services, defense companies, Congress, the administrations, and DoD agencies.

systems very quickly, or to surge production in response to high levels of combat attrition or sudden shifts in the international security environment.¹³⁴ Studies indicate that this surge problem has existed for decades.¹³⁵ Maintaining excess production capacity is expensive, and the government has generally been unwilling to bear the costs of doing so (with the notable exception of shipbuilding). In addition, some US prime contractors are now down to sole-source suppliers for the majority of components and subsystems they buy rather than make, and there is some dependency on foreign suppliers.¹³⁶ A major constraint on industry's capacity to surge output has also been the ordering and manufacturing of new machine tools for production lines and the ordering of subsystems from suppliers. Tools and subsystems can require years to produce. Stockpiling them is both expensive (because they are finished items, not raw materials) and makes them vulnerable to obsolescence.¹³⁷ Absent government support, both modern management practices and shareholder demands for profitability dictate that firms should eliminate excess capacity and avoid stockpiling.

Second, industry consolidation and shrinkage has raised concerns that US defense firms may not be able sustain the technological leadership needed for national security.¹³⁸ Commercial R&D began outpacing defense R&D in the 1970s. Some studies have concluded that the private sector's sophistication and rates of progress have exceeded the government and defense industry, and that commercial R&D is making militarily useful technology available to allies and adversaries, thereby narrowing the equipment advantages long enjoyed by the US military. Moreover, many believe that the costs of developing new technologies within the defense industrial base have grown over the years at a much more rapid pace than the government's or companies' investment rates. Consequently, even in the face of continued spending on R&D, both the US government and its defense industry have had to reduce the number of new

Absent government support, both modern management practices and shareholder demands for profitability dictate that firms should eliminate excess capacity and avoid stockpiling.

¹³⁴ For an example of how demands for the same materials by multiple programs can also limit surge capacity, see "Will MRAPs Take U.S. Ships' Steel?" *Defense News*, July 30, 2007, p. 3.

¹³⁵ See Gansler's 1982 *The Defense Industry*.

¹³⁶ Industry interview by George E. Pickett.

¹³⁷ A commercial example of successful inventory management in the face of obsolescence is provided by Dell Computer. By not assembling a computer until it has been ordered, Dell avoids maintaining large stockpiles of microprocessors, which have been obsolesced by next-generation processors every eighteen to twenty-four months since the 1960s.

¹³⁸ The record of the government and industry in producing technological innovations has, on the whole, been excellent. They laid much of the groundwork for personal computers: Xerox's PC development was based on employing people who had worked at the Defense Advanced Research Projects Agency (DARPA). Similarly, the World Wide Web evolved out of the ARPANet whose packet-switching technologies originated in a RAND effort to develop distributed command-and-control for communications in the aftermath of a nuclear attack (Paul Baran, "On Distributed Communications: I. Introduction to Distributed Communications Networks," RAND, RM-3420-PR, August 1964, p. iii). Commercial aviation has also drawn extensively on jet engines, composite technology and digital avionics developed by DoD and its defense industry. Satellite communications and navigation originated from the defense establishment. Major technology advances have also been made in low-observable aircraft, electronic warfare systems, submarine capabilities, sensors, command-and-control systems and combat information processing.

The shift of technological innovation to commercial firms argues that both the defense industry and the US government need to become more astute in tracking commercial technological advances and utilizing them.

projects in which they invest.¹³⁹ The net impact is that the scope of the government's pursuit of, and leadership in, technology has declined. At the same time, accelerating technological progress in non-defense technologies has improved the chances that more and more nations will be able, should they so choose, to narrow many gaps in military capability vis-à-vis the United States.

Reversing the situation requires increased investments by government and defense firms, smart choices in those investments, and more effective government encouragement of companies' R&D. Various studies have called for increasing government R&D funding. Regardless of the increases that have occurred in recent years (see Figure 4), the shift of technological innovation to commercial firms argues that both the defense industry and the US government need to become more astute in tracking commercial technological advances and utilizing them. In addition, because not all emerging technologies can be pursued, R&D investment decisions for defense should be increasingly shaped by a sense for specific areas of potential military advantage.¹⁴⁰ Finally, the US government probably needs to change some less obvious aspects of its behavior towards R&D among defense companies. For example, DoD managers have discouraged companies from investing their internal research and development (IR&D) funds directly into the development of military programs insofar as doing so increases programs costs. Instead, they have encouraged firms to use IR&D to support government programs and, with fewer large programs to pursue, firms have focused more and more of their IR&D on supporting their efforts to win future programs. Thus, as defense budgets declined during the 1990s, contractors not only have had less IR&D funding, but they have begun "diverting a significant percentage of these monies to the pursuit of future line-items in the defense budget."¹⁴¹

The third concern stemming from post-Cold War industry consolidation centers on the growing technological sophistication of other nations together with international trade in advanced weaponry. On the one hand, the US government would like to restrict the flow of militarily useful technologies and systems from the United States while, at the same time, limiting the dependence of the US military on overseas suppliers. On the other hand, selling American systems and weapons overseas lowers their costs to the US taxpayer and spurs innovation, but tends to create overseas competitors to US defense firms. Foreign sales can also be subtle tools of US

¹³⁹ This last point is difficult to prove due to the lack of reliable trend data on *comprehensive* technological change from the 1950s to the present as contrasted with advances in specific technologies such as microprocessors. However, interviews with engineers and managers in the industry show universal agreement that the cost of a technological advance has increased faster than R&D funding. It is unclear what the causes are. Guesses range from greater complexity of the problems being addressed to the difficulties of generating new advances in an already mature industry.

¹⁴⁰ While non-defense industries are undoubtedly spreading militarily useful technology, the unique demands of military systems for high end performance may mean that state of the art systems will still be based on non-commercial advances.

¹⁴¹ Donald A. Hicks, memorandum to the chairman of the DSB, in *Defense Science Board Task Force on Globalization and Security* (Washington, DC: Office of the Under Secretary of Defense for Acquisition & Technology, December 1999), p. 2.

defense strategy to increase the dependence of other nations' forces and industries on the United States. Balancing these risks and benefits has, over the past several decades, led to policies and procedures that seem to have been successful in promoting US sales overseas in areas such as tactical fighters. But the Department of State's International Traffic in Arms Regulations (ITAR)¹⁴² have also hampered the flow of non-critical items and technologies overseas, thereby hindering US companies from competing in foreign markets. As a result, in areas such as satellites, overseas buyers have turned increasingly away from US firms even for components. For instance, in 2005 EADS Sodern in France announced that the company was phasing out US suppliers of satellite control and positioning systems because of ITAR.¹⁴³ More recently, European officials have indicated they hope to avoid any American content in Galileo, a European version of the US Global Positioning System. The reason is that, under the State Department's zealous interpretation of the rules, virtually all satellite components are deemed "munitions" until proven otherwise, which induces unpredictable delays for foreign manufacturers seeking American content in their commercial satellites.¹⁴⁴ This hobbling of US aerospace firms in non-military overseas markets is likely to continue without some overhaul of ITAR and thus encourage the development of increasingly advanced indigenous military capabilities in Europe, China, and other countries.

ITAR has also led to problems in joint weapon developments with allies. In late 2005, ITAR restrictions caused British politicians to threaten withdrawal from the F-35 Joint Strike Fighter (JSF) program over ITAR restrictions. While the United States eventually reached agreements over the transfer of JSF technology with Britain, Australia, and other allied participants in the program, the controversy revealed that ITAR could pose problems for the joint development of advanced military weapon systems even with America's closest allies.¹⁴⁵

The role of international trade in advanced weaponry and military systems is likely to continue to be a difficult one for the American defense industry. Many US companies have established foreign subsidiaries, bought major interests in foreign companies, and expanded marketing and subcontractor operations overseas. Foreign

Many US companies have established foreign subsidiaries, bought major interests in foreign companies, and expanded marketing and subcontractor operations overseas.

¹⁴² The control of the permanent and temporary export of defense articles and services from the United States, and the temporary import of these items into the country, are governed primarily by 22 U.S.C. 2778 of the Arms Export Control Act.

¹⁴³ Peter B. de Selding, "European Satellite Component Maker Says It Is Dropping U.S. Components Because of ITAR," Space News, posted June 13, 2005, online at <http://www.space.com/spacenews/archive05/Sodern_061305.html>. For earlier examples of foreign companies moving away from US suppliers, see Arvind Parkhe, "U.S. National Security Export Controls: Implications for Global Competitiveness of U.S. High-Tech Firms," *Strategic Management Journal*, Vol. 13, No.1, January 1992, p. 47.

¹⁴⁴ "Earthbound," *The Economist*, August 23, 2008, p. 66. A 2007 survey of around 200 space companies conducted by the Air Force Research Laboratory "cited export controls as the highest barrier to foreign markets" (*ibid.*, p. 67).

¹⁴⁵ "Britain Formally Signs F-35 Production Phase MoU [Memorandum of Understanding]," *Defense Industry Daily*, December 14, 2006, online at <<http://www.defenseindustrydaily.com/britain-formally-signs-f35-production-phase-mou-02870/>>.

firms, in turn, have done likewise in an effort to gain shares of the US defense market. However, strong tensions exist between the intense competitiveness of the market and the protectionist policies of the US government. An increasing concern is that US defense firms will be excluded from competing in overseas markets—less because militarily sensitive systems are involved but because the bureaucratic barriers such as ITAR are too onerous. As already indicated, some major foreign companies are developing systems with no US components just to avoid these constraints. US firms have exited competitions because the buying nation has required guarantees not possible under US licensing practices.¹⁴⁶ It is one thing to control trade for national security purposes; it is another to create situations in which government bureaucratic practices can be used against US companies for competitive advantage.

INDUSTRY OPERATIONS

A basic conflict exists between the efficiency of the US defense industry and its surge capacity.

A number of studies have indicated that US defense companies have mounted efforts during the past several decades to improve the efficiency of their operations. The adoption of computer-aided-design (CAD) software has been crucial to designing stealth aircraft such as the B-2, the outer surfaces of which are smooth, continuous curves rather than the flat-plate approach of the F-117. Computer-aided-manufacturing (CAM) processes such as 5-axis machining have greatly improved precision and efficiency. Together CAD/CAM has enabled separate companies to manufacture major portions of a combat aircraft independently and have them fit together during assembly without shims.

Turning to management practices, many US defense firms have incorporated techniques such as strategic supplier management, better processes to coordinate development and production, advanced inventory management, activity-based costing, and even aspects of Six Sigma quality control. In many cases, these efforts have responded to the government's desire to see the industry reduce costs and improve performance. In others cases, the companies have viewed such initiatives as a means of winning programs and improving profits. As already indicated by GAO's recent comparison of cost and schedule growth in portfolios of major acquisition programs in FY 2000 and FY 2007, improved strategic management techniques imported from commercial businesses have not had any discernible success across large numbers of programs. Moreover, a problem with efficiency improvements is that they discourage setting aside substantial reserve capacities. Thus, a basic conflict exists between the efficiency of the US defense industry and its surge capacity.¹⁴⁷

¹⁴⁶ See, for example, "Turkey Increasingly Shuns U.S. Weapons," *Defense News*, July 16, 2007, p. 36.

¹⁴⁷ A broad concern among companies is that the government's primary focus is on specific programs and products, not on processes or comprehensive portfolios of programs. Yet, process is the essence of many improvement efforts in companies. For example, while defense companies may want to collect data and manage a manufacturing process across many products, the government still wants costs allocated and efficiency measured at the individual product level.

Studies of the US defense industry also indicate that major concerns exist about sustaining sufficient competition within the industrial base to encourage innovation and constrain costs. Some observers are concerned that not having competition throughout the life of a program means giving up the most effective means of controlling costs. Others believe that competition at least through prototype is critical to avoiding major developmental and production risks. Many are also concerned that dysfunctional competitive behavior is occurring because of the small number of major new programs. For example, companies that have lost the competition for a major program have grown more inclined to contest the award and, as a result, delay the start of a program important to military effectiveness.¹⁴⁸ The latest instance was Boeing's successful protest of the Air Force's award of the new aerial tanker program to Northrop Grumman teamed with Airbus. After the GAO supported Boeing's protest, the Air Force decided to re-compete the program.

Looking back, the defense industry consolidations of the 1990s suggest the federal government will have to take a more active role in managing the competitive structure of the industry than it has until now. Some parts of the defense industrial base are highly competitive in terms of the numbers of companies that can offer the military Services the products they seek. In many of these cases — UAVs, robotic systems, networks, wide-area sensors, lasers, logistics, and administrative support — the product areas may well see increased demand in the future. Other business areas are ones in which competition is very limited but managed closely by the government — for example, shipbuilding and launch vehicles.¹⁴⁹ Still other defense product areas are in a period of transition in which the number of viable competitors is declining. Reduction of the supplier base to one or two firms may not be troublesome if substitutes are available or foreign firms can compete.¹⁵⁰ In the case of fixed-wing combat aircraft, moving toward unmanned platforms could offset the decline in companies able to design and produce manned fighters or bombers. The point is that as the number of

Major concerns exist about sustaining sufficient competition within the industrial base to encourage innovation and constrain costs.

¹⁴⁸ See, for example, Amy Butler, "Win or Whine? Defense Contractors Build Bid Protests into Their Business Strategies," *Aviation Week & Space Technology*, September 10, 2007, p. 48–50. In 2008, the commander of Air Force Materiel Command, General Bruce Carlson, suggested levying fines on corporations that file "inappropriate" protests of contract awards ("Washington Outlook," *Aviation Week & Space Technology*, February 18, 2008, p. 36).

¹⁴⁹ For example, the Navy negotiated the transfer of shipbuilding programs between General Dynamics and Northrop Grumman. The first company would build more destroyers while the second would build amphibious ships. Each gave up ships to the other ("Navy Realignment Shipbuilding Jobs of Northrop, General Dynamics," *The Wall Street Journal*, June 18, 2002, p. B10.).

¹⁵⁰ For example, in the area of manned aircraft, a recent DoD study concluded that "Boeing's future participation in the fighter/attack and transport segments is questionable. With the announcement of the C-17 program shutdown coupled with the end of the F/A-18 production in FY11, the industrial base infrastructure at Long Beach, CA, and St. Louis, MO, may have insufficient business to continue in place." (Department of Defense, *Annual Industrial Capabilities Report to Congress*, March 2008, p. 61). This confirms a long-term trend towards fewer aircraft design companies that RAND identified in the 1990s. If Boeing were to exit the fighter aviation market over the next decade, arguably only one major prime would remain: Lockheed Martin. Whether or not this would be in the best interests of US national security, with the suppliers down to one or two firms, the government's approach to managing acquisitions in this area needs to be different.

viable competitors drops to three or fewer firms, the government has as much vested interest in the existence of the firms as it has in selecting the best products; how the government manages competitions and programs has to change. Competition and government management in sub-industries of two or three firms are substantively different from that in sub-industries with four, five, or more competitors.

Finally, the industry has to consider the ethical aspects of its operations. The lapses that have occurred seem to fall into several categories. First and foremost are the violations of laws and regulations. The more publicized of these, such as Darlene Druyun's involvement with Boeing while still serving as the civilian chief of Air Force acquisition, have resulted in firings, prison sentences, large corporate fines, removal of programs, and suspensions of entire divisions from government contracts.¹⁵¹ Companies have responded by changing management, improving processes, and instituting practices to prevent such reoccurrences. But there have also been inadvertent violations, and both the government and the industry seem to have developed approaches aimed at catching and rectifying these violations.¹⁵² Overall, the firms in the industry appear to have behaved no worse—and in many cases probably better—than their counterparts in other industries.¹⁵³ However, the public visibility of national defense and the intimate role of the government in the industry as a consequence have made lapses highly newsworthy.

¹⁵¹ Druyun retired from her position overseeing Air Force acquisition in December 2002 and went to work for Boeing. In the fall of 2003 Boeing fired Druyun amid investigations by the Justice Department, the Pentagon, and Congress into “whether she improperly or illegally entered into talks with a Boeing executive about a job while championing a multibillion-dollar Air Force contract to lease tanker aircraft from the company” (George Cahlink, “Fallen Star,” *Government Executive*, February 15, 2004). In December 2003, Boeing chairman and chief executive officer Philip Condit resigned in large part because of Druyun's hiring. She was subsequently convicted of violating federal conflict-of-interest laws and served nine months in a federal prison.

¹⁵² For example, controlling exchanges of information across borders has become more difficult in the past ten years as company level communication systems have enabled many levels of engineers and managers to use email across US and overseas subsidiaries. Technology transfer rules apply even to communications among low level engineers. Violations occur if exchanges have not been approved beforehand, regardless of whether an exchange passed relevant information. Companies and the government have worked together to correct minor errors. See, for example, “Standards for Secure Exchanges,” *Defense News*, June 25, 2007, p. 30.

¹⁵³ “Outright dishonesty, for example, is extraordinarily rare . . . but when it occurs its impact is particularly devastating” (Augustine in Kadish, et al., *Defense Acquisition Performance Assessment Report*, p. vii).

CHAPTER 3 > INFLUENCING THE FUTURE

US DEFENSE INDUSTRIAL BASE

The international security environment the United States faces in the early twenty-first century is quite different from the superpower-dominated, bi-polar structure of the Cold War era. As Soviet theorists foresaw in the early 1980s, the American development of conventional guided munitions and associated targeting networks has given rise to reconnaissance-strike complexes whose potential in terms of target destruction now approaches that of nuclear weapons.¹⁵⁴ Since the 1950s, technological advances have also increased exponentially the amount of death and destruction that small groups of dedicated terrorists can inflict.¹⁵⁵ There is also reason to anticipate that technological progress, particularly in biotechnologies, may give rise to dramatically new military challenges in the future. Finally, while major wars between great powers have not occurred for the last sixty years, the incentives of lesser powers to acquire nuclear weapons to offset US dominance in conventional military power have increased substantially, as the North Korean and Iranian nuclear programs indicate.

The US-Soviet competition during the Cold War was the impetus for the establishment of a large, peacetime US defense industrial base for the first time in the history of the United States. That industrial base became a pillar of US military power and contributed to the outcome of the Cold War. It will surely continue to be an essential component of American military power and national security in the decades ahead.

As this report has shown, since the early 1990s the US industrial base has undergone considerable contraction and consolidation in response to decreased demand for its goods and services. In all likelihood, the industry will undergo further changes in the years ahead as firms enter or exit, expand or contract, merge with others, or

¹⁵⁴ Marshal N. V. Ogarkov, "The Defense of Socialism: Experience of History and the Present Day," *Красная Звезда* [Red Star], May 9, 1984; trans. Foreign Broadcast Information Service, *Daily Report: Soviet Union*, Vol. III, No. 091, Annex No. 054, May 9, 1984, p. R19.

¹⁵⁵ Martin Shubik, "Terrorism, Technology, and the Socioeconomics of Death," in *Comparative Strategy*, October–December 1997, pp. 406–408.

The federal government has several paths it could take with regard to influencing future changes in its industrial base.

otherwise modify their involvement in providing goods and services to the US military Services. Some of these changes can be expected to occur regardless of whether the US government modifies its acquisition policies and practices, the weapons and military systems it buys, or how it develops and procures them.¹⁵⁶

The federal government, including the Defense Department, has several paths it could take with regard to influencing future changes in its industrial base. The path of least resistance would be for the US government to limit itself to purchasing the military goods and services it needs while leaving it to the defense firms to make whatever adjustments their managers deem necessary to remain profitable. Obviously this *laissez-faire* approach, like that of Aspin's Last Supper, would be neither be proactive nor aim at any specific future structure for the American defense industry.

Alternatively, the government could seek to shape the industry with active policies aimed at making the industrial base more responsive to the unfolding national-security challenges of the twenty-first century. This second path would be an extraordinary challenge for both the US government and the defense industry. It would require, especially on the government's side, changes in policies and practices that have become firmly established by decades of political, bureaucratic, and legislative behavior. The remainder of this chapter offers some suggestions that might be pursued should the government decide to adopt a more active role regarding the defense industry's future structure. These suggestions are not the only ones that the federal government could adopt. They do, however, surface some of the major impediments to any major restructuring of the current industrial base.

Whatever changes may occur in future US security needs and associated national security strategies, an enduring feature of both will surely be increasing uncertainty and risk. Over the past half century, knowledge of advanced weapon technologies has proliferated around the globe and become more widely accessible to small states and even non-state groups. No longer are the nations of the developed West and the former Soviet Union in a position to dominate R&D or maintain effective control over the more important military technologies and capabilities. Electro-optical and radar-imaging satellite reconnaissance are cases in point. Once the exclusive domain of the United States and the Soviet Union, these capabilities have become part of the global commons. The same is true of precision location-and-navigation information from the US Global Positioning System (GPS) and the Russian GLONASS. Coupled with the proliferation of cheap inertial guidance, precision engagement is likely to become accessible even to radical groups such as Hezbollah or small terrorist cells. Moreover, while the United States currently retains the world's preeminent military, spending almost as much on defense as all other countries combined, its resources

¹⁵⁶ For example, a firm may exit an entire business, and do that quickly and with little warning to the DoD. Just as the government surprised the industry by quickly installing changes in profitability in the span of a few years during the 1980s, companies can effectively surprise the government and change the competitive landscape by exiting rapidly.

are finite and increasingly stretched by ongoing operations in Iraq and Afghanistan. At the same time, current enemies and future adversaries have every reason to seek “asymmetric” ways of countering American military preeminence. Further, population growth, globalization, and climate change appear to be putting growing pressure on the planet’s resources, increasing the prospect of international conflicts over resources in future decades.

What all this suggests is that the future security environment is far less certain and predictable than it was during the Cold War, and that this trend is likely to persist for the foreseeable future. To mention one major uncertainty, will the great powers choose to use terrorism against each other? As C. Dale Walton argued in 2007, if even one of the great powers chooses to be reckless in its use of terrorist proxies against its peers, “this could lead to catastrophic terrorist attacks and significantly increased prospects for great power war.”¹⁵⁷ Whether the great powers will exercise suitable restraint remains to be seen.

PRINCIPLES FOR DEALING WITH INCREASED UNCERTAINTY AND RISK

Assuming that the United States does not choose to withdraw from the world, there is every reason to think that the country’s leaders — regardless of which political party controls the White House or the houses of Congress — will seek to retain its position as a leading military power. However, uncertainty about the specific national security and defense strategies to pursue, or what military forces and weaponry may be best support those strategies, is almost certain to grow. This prospect makes coping with the increased risk of picking the wrong strategies or forces a central and enduring challenge for the Defense Department and its industrial base in the twenty-first century. Given the limits on defense resources — construed to encompass not just defense budgets but manpower and the attention of the nation’s political leaders as well — there are some broad principles that the government could follow regarding the defense industrial base to ameliorate uncertainty and risk in the international defense environment:

- > **MAINTAIN DOMINANCE IN CRITICAL AREAS OF MILITARY CAPABILITY.** The United States is currently the world leader in undersea warfare, long-range power projection, control of the air, and the military use of space. These areas should not be allowed to atrophy so long as they remain critical. On the other hand, this does not mean that all existing military forces, systems, and technologies should be

There is every reason to think that the country’s leaders will seek to retain its position as a leading military power.

¹⁵⁷ C. Dale Walton, “Not Only Islamism: Great Power Politics and the Future of Terrorism,” *Comparative Strategy*, Vol. 26, No. 1, January 2007, p. 21.

preserved.¹⁵⁸ The goal is to retain leadership in vital capabilities, not to continue investing in legacy forces and programs of declining utility.¹⁵⁹

- > MAKE HEDGING INVESTMENTS IN CAPABILITY AREAS WHERE THE CONSEQUENCES OF UNDER-INVESTING COULD BE SEVERE. Robotics, lasers, and biotechnologies for human physical and cognitive enhancements are all areas in which capabilities sufficiently disruptive to undermine current weaponry and ways of fighting could emerge. The challenge for the United States is to invest enough to avoid being surprised.
- > DESIGN AS MUCH FLEXIBILITY AND CAPACITY FOR ADAPTATION OR EXPANSION INTO WEAPONS AND FORCES AS POSSIBLE. The history of US military practice is replete with examples of systems and platforms being procured with specific uses or missions in mind and eventually being adapted to different uses and missions. The venerable B-52 bomber was procured as a strategic-nuclear delivery platform but within the last decade has been used for the direct support of ground forces. During the Cold War American nuclear attack submarines were designed first and foremost to sink enemy naval combatants but perhaps had their greatest utility as intelligence platforms. In light of growing uncertainty and risk, this sort of flexibility and adaptability is likely to be even more crucial in the future, but such capacities have rarely been sought during weapons development. Note, though, that the desired flexibility and adaptability depends as much, if not more, on the underlying intelligence, skills, and mindsets of the US military as it does on designers and engineers in defense companies. At the same time, top-quality engineering talent, processes, and tools within the companies will also be needed.
- > EMPHASIZE UNDERLYING TECHNOLOGIES AND CAPABILITIES APPLICABLE ACROSS MANY AREAS OF POTENTIAL IMPORTANCE. Software has become an increasingly ubiquitous and critical component of modern weapon systems. By the late 1990s, IBM/Loral was maintaining approximately two million lines of code for the Space Shuttle's flight control system. The F-35 JSF will have "about six million lines of code in the airplane and another six million in the simulator, plus about three million in associated systems."¹⁶⁰ Turning to military capabilities, the US military has been moving steadily toward networked systems. They require both secure

¹⁵⁸ For example, the importance of orbital space does not mean that the continued use of large launch vehicles for large satellites is appropriate. Similarly, the importance of controlling the airspace over battlefields does not mean this capability will have to be provided primarily by manned fighters in the future. A mix of unmanned platforms and long-range weapons could one day become the better approach.

¹⁵⁹ The bureaucratic challenge remains getting the military Services to agree on a reasonably short list of capabilities sufficiently critical to US military power now and in the foreseeable future so as to warrant preferential investment. Efforts to reach such agreement in the wake of the 2001 strategy view conducted by the Office of Net Assessment for defense secretary Donald Rumsfeld failed.

¹⁶⁰ John A. Tirpak, "The F-35 Steps Out," *AIR FORCE Magazine*, April 2003, p. 50.

data links and software. Like software, networks are an underlying capability in which the US military should seek to stay ahead of competition. In both areas, however, much of the leading-edge development is occurring in the commercial world.

- > **DIVEST CAPABILITIES AND SYSTEMS WHOSE FUTURE UTILITY APPEARS TO BE DIMINISHING.** One reason the OSD officials elected to cancel the Army's Crusader program in the spring of 2002 had to do with the choice between investing \$8–10 billion in fielding some 490 new self-propelled howitzers or, instead, putting the money into fielding guided artillery rounds that could be utilized by all the 155-millimeter howitzers throughout the Army and the Marine Corps. Ultimately OSD opted for precision rounds rather than a small number of new howitzer platforms. Similarly, as lethal as attack helicopters have been in past combat, their survivability when within reach of low-altitude air defenses is increasingly questionable. On the night of March 2, 2002, four AH-64 Apache helicopters were only able to mount a single sortie each due to the damage inflicted by withering small-arms and rocket-propelled grenade fire from Taliban and al-Qaeda fighters in the Shaki-Kot Valley of southern Afghanistan. Subsequently, on March 23, 2003, 30 Apaches of 11th Helicopter Regiment mounted a "deep" attack on Iraq's Medina Division. While the damage done to Medina was "fairly minimal," one Apache was shot down and virtually all of the aircraft returned with battle damage, including hits on sixty-two rotor blades, seven fuel cells, eight engines, and six canopies.¹⁶¹ Given the growing ability of fixed-wing aircraft with guided munitions to carry out these kinds of "deep attacks" without being engaged by low-altitude air defenses, one cannot help but wonder about the continuing efficacy of Army aviation in this role. As RAND's David Johnson has argued, "the two systems the Army has for striking deep—the AH-64 Apache helicopter and the Army Tactical Missile System (ATACMS)—have not shown themselves to be as effective as fixed-wing aircraft in conducting deep operations."¹⁶²

These principles could provide important elements of a long-term defense strategy. Overall they suggest moving toward a US defense establishment with greater variety, flexibility, adaptability and speed of reconfiguration even if reliance on large platforms and systems persists. Perhaps more consideration should be given to smaller buys of systems with shorter service lives in order to incorporate higher rates of technology change. If at least some US defense programs move in this direction, shorter acquisition cycles and faster rates of response to changing circumstances could become more commonplace.

¹⁶¹ Michael E. Gordon, and Bernard E. Trainor, *Cobra II: The Inside Story of the Invasion and Occupation of Iraq* (New York: Pantheon, 2006), pp. 279–280.

¹⁶² David E. Johnson, *Learning Large Lessons: The Evolving Roles of Ground Power and Air Power in the Post-Cold War Era* (Santa Monica, CA: RAND, 2007), p. xi.

SHAPING VERSUS STRUCTURING THE DEFENSE INDUSTRY

The industry is a complex beast that has defied the analyses and best recommendations of numerous commissions, panels, and other groups that aspired to improve its functioning and performance by altering its structure.

Having offered these suggestions, however, one hesitates to prescribe any explicit future structure for the US defense industry. The industry is a complex beast that has defied the analyses and best recommendations of numerous commissions, panels, and other groups that aspired to improve its functioning and performance by altering its structure. Virtually all past efforts to grasp the complexity of the US defense industrial base or dramatically overhaul it have failed to achieve appreciable change for the better. The dynamism that industrial and defense firms have demonstrated in the past decades suggests the US government, rather than trying to impose a specific structure on industry, should prefer one in which companies are free to enter, exit, grow, reconfigure, innovate and compete to meet the needs of the military services and national security.

After all, the historical record since World War II indicates that even the best-intentioned efforts of government leaders and industry observers to push the defense industry in particular directions have suffered from simplistic attitudes and assumptions about the nature of modern defense firms and their businesses. Throughout the 1990s, for example, US political leaders and defense industry analysts “called for replacement of a defense industrial base separated from commercial industry with a single, integrated industrial base that would serve multiple customers.”¹⁶³ Such advice, however, seems to have overlooked the unique requirements and government-imposed constraints that pervade major weapons programs. The barriers to entering the defense business are substantial, but the reverse is true as well, as the firms that tried to follow this advice quickly discovered. Thus, the leading US defense firms that did try to expand into commercial businesses had little success and most abandoned such efforts. While commercial-military integration may have some benefit for inexpensive, low-end, simplified acquisition-threshold products and subcomponent purchases, Peter Dombrowski, Eugene Gholz, and Andrew Ross concluded in 2002 that, for primary weapon systems, the evidence suggests that military customers “need not and should not rely on commercial-military integration.”¹⁶⁴

The implication of these observations is that the US government should encourage defense firms to move in directions likely to make the industrial base even more of a strategic asset than it has been in the past while stopping short of trying to impose a specific structure on the defense industry. Having political leaders and government bureaucrats, however well intentioned, endeavor to structure the defense industry appears unwise — especially for a republic that prides itself on a market-driven economy. In the end, the logical culmination of strong government efforts to dictate a structure for the US defense industry would be an arsenal system. But, with weapons

¹⁶³ Dombrowski, et al., *Military Transformation and the Defense Industry after Next*, p. 26.

¹⁶⁴ Ibid.

of any complexity, arsenals and arsenal-like systems have largely fallen out of favor in the United States since World War II due to problems keeping pace with technological change and, in some cases, the perceived superiority of commercial sources.¹⁶⁵ Take the Mark-14 torpedo developed during the 1930s by the US Navy's Newport Torpedo Station.¹⁶⁶ Operational experience and testing in the Pacific after the Japanese attack on Pearl Harbor revealed that the Mark-14 ran ten to eleven feet deeper than its set depth, its magnetic-influence exploder was defective, and its contact detonator was prone to failure when the torpedo's impact angle approached ninety degrees—the perfect shot.¹⁶⁷ The comparison with industry performance in designing torpedoes during World War II is striking. Work on what became the successful Mark-24 acoustic-homing torpedo began with a meeting at Harvard University on December 10, 1941, convened at the request of the National Defense Research Committee (NDRC) under Vannevar Bush to explore the possibility of such a weapon. Only seventeen months later, in May 1943, Western Electric and General Electric, in conjunction with Bell Telephone Laboratories at Murray Hill and the Harvard University Sound Laboratory, had not only produced a working torpedo but the weapon had scored its first combat kill against a German U-boat.¹⁶⁸

In light of such experience, the choice between government arsenals and for-profit defense firms does not appear to be a difficult one. After World War II, the NDRC's success in harnessing scientists and industry to develop everything from the Mark-24 to airborne radars, the B-29, the proximity fuse, and the atom bomb argued strongly for preferring defense firms and national laboratories to government arsenals for all but the simplest munitions and military-end items. That choice still appears to have been the wiser one, notwithstanding all the problems with defense acquisition discussed in this report. Among other things, the US military-industrial complex that emerged during the 1950s contributed to the development of modern digital computers, successfully orbited the first reconnaissance satellites, put a man on the moon, made stealthy aircraft practical, and played a pivotal role in developing the Worldwide

¹⁶⁵ Currently the United States still has two active arsenals: the Rock Island Arsenal in Illinois and the Watervliet Arsenal in New York (Colonel Joseph W. Albright, "Is There a Future for the Arsenal System: A Discussion of a Methodology for Determining the Viability and Efficiency of the Arsenal System," US Army War College research paper, March 2000, p. 2). Only six of the fifteen manufacturing arsenals that have existed during US history survived past World War II. Rock Island and Watervliet are focused on materiel for field artillery cannons and howitzers. Modern, guided field artillery munitions such as ATACMS and the Guided MLRS (Multiple Launch Rocket System) are produced by Lockheed Martin.

¹⁶⁶ The Newport Torpedo Station was established in 1869 as a development and experimentation facility under the Navy's Bureau of Ordnance. While it acquired manufacturing capabilities for explosive, electric al equipment, and torpedoes, it was not, strictly speaking, an arsenal.

¹⁶⁷ Clay Blair, Jr. *Silent Victory: The U.S. Submarine War against Japan* (New York: Bantam Books, 1975), pp. 20, 160, 274–278, 292, 413–415, 437–438.

¹⁶⁸ Frederick J. Milford, "U.S. Navy Torpedoes," Pt. 4, "WW II Development of Homing Torpedoes 1940–1946," *The Submarine Review*, April 1997, pp. 72–73.

Major change
in an industry
whose dominant
characteristics have
been established
over many decades
is neither likely
to be easy nor to
occur overnight.

Web.¹⁶⁹ It is extremely difficult to envision such innovations emerging from de facto government arsenals such as the Newport Torpedo Station.

Does this mean that the US government should continue the “hands off” approach to the defense industry of Aspin’s Last Supper? Reflection upon the evidence in the preceding two chapters suggests that there are some more modest objectives that federal government agencies and the Defense Department could pursue to nudge the defense industrial base toward becoming an even greater source of US strategic advantage in the future than it was during the 20th century without going so far as to try to impose a specific structure, much less moving in the direction of an arsenal system. The remainder of this chapter will, therefore, discuss three areas in which sensible government policies, if steadfastly pursued, might strengthen the American defense industrial base.¹⁷⁰

Keep in mind, though, that major change in an industry whose dominant characteristics have been established over many decades is neither likely to be easy nor to occur overnight. As in other sectors of the US economy, defense companies have developed their own approaches to customers, products, internal operations, and suppliers. Moreover, in the case of the defense industry, the role of political compromises involving the services, OSD, Congress, and, in some instances, the White House have probably been more pervasive than in many other industrial sectors. Thus, the areas in which the government might choose to pursue more enlightened policies aimed at strengthening the defense industry base—especially as a source of enduring strategic advantage—are not amenable to simplistic or one-time solutions. Instead, they tend to be areas in which the government and industry will need to work together to achieve any appreciable improvements.

ACCESSING COMMERCIAL TECHNOLOGIES, CAPABILITIES, AND PRODUCTS

Over the past several decades, the US defense industry has matured as a largely separate industrial sector with its own unique customers, products, bidding and

¹⁶⁹ In the case of computers, in the late 1940s the Naval Research Laboratory funded the Massachusetts Institute of Technology’s Servomechanisms Laboratory to design the Whirlwind computer. When the Air Force set out to build the SAGE (Semi-Automatic Ground Environment) air defense system, a then-little-known company, International Business Machines (IBM), got the contract to produce the SAGE AN/FSQ-7 computers using the Whirlwind design. Building these computers taught IBM how to design and manufacture first generation computers; Whirlwind was also the inspiration for the first modern minicomputer, Digital Equipment’s PDP-1, which served as the template for the entire PDP line of computers, and influenced all early microcomputer designs (Rick Smith, “MIT Whirlwind Computer Block Diagrams,” University of St. Thomas, online at <<http://www.cs.stthomas.edu/faculty/resmith/r/whirlwind.html>>).

¹⁷⁰ In other industries this difficulty of instituting major changes has been the subject of much study. For example, Joe Bowers’ Bower, *When Markets Quake* describes the difficulties a capital intensive worldwide industry has faced when embarking on a major “re-engineering” of its structure and operations—even when most firms were losing money, and the response time was measured in decades.

contractual practices, and financial incentives. A number of former defense firms have chosen to exit the defense business for opportunities in commercial sectors, others have been absorbed into the surviving companies through mergers and acquisitions, and the leading defense firms have, of course, chosen to remain in the industry and master its unique attributes. While some small firms have entered seeking chances to grow, in recent decades virtually no large, established commercial firms have entered the defense industry and become major defense contractors.¹⁷¹ One result has been the creation of duopolies and monopolies for many military weapons and systems. Recall that the nation's six ship-yards are currently owned by two companies, General Dynamics and Northrop Grumman. The result is that today, the barriers to the entry of commercial firms into the defense business are probably higher than they have ever been, and this limits the government's supplier and purchasing options, particularly for major weapon systems.

In the twenty-first century, the lion's share of research and development, innovative ideas, engineering skills, and technologically advanced products resides in commercial firms rather than government-funded enterprises. Consider R&D in the United States. In 1954, the year after the Korean War ended, the federal government funded almost 54 percent of R&D compared with less than 44 percent by commercial industries; in 2006, the latest year for which the National Science Foundation has published data, federal government funding of R&D had dropped to less than 28 percent whereas industry's share had grown to over 65 percent.¹⁷² DoD currently accounts for about half of federal government R&D.¹⁷³ The shift in research from DoD to commercial firms argues that, as time goes on, national security will require greater access to commercial companies, their technologies, and the skills of their workforce. More generally, DoD will want to tap technology and capabilities from all sources — foreign as well as domestic, commercial as well as defense related.¹⁷⁴

The barriers to the entry of commercial firms into the defense business are probably higher than they have ever been.

¹⁷¹ L-3 Communications was formed in 1997 from ten former Loral business units then owned by Lockheed Martin. L-3 went public in 1998 and, by 2007, had revenues of nearly \$14 billion. Its business consists mainly of supplying command, control, communication, intelligence, surveillance, and reconnaissance (C3ISR) systems and products, avionics and ocean products, training devices and services, instrumentation, and space and navigation products to DoD, the Department of Homeland Security, US intelligence agencies, aerospace contractors, and commercial telecommunications and wireless customers.

¹⁷² National Science Board (NSB), *Science and Engineering Indicators 2008* (Arlington, VA: National Science Foundation, January 2008) NSB 08-01A., p. O-22 and data table O-33b, "National R&D by funding sector: 1953–2006." The NSB's industrial sectors are: (1) radio, television, and communications equipment; (2) motor vehicles; (3) pharmaceuticals; (4) instruments, watches, and clocks; (5) office, accounting, and computing machinery; and (6) all services (ibid., p. O-15). Interestingly, the NSB notes that there is no "defense industry" category in the industry classification system used by the federal government, which means that approximate estimates of defense-related R&D is the best that can be done (ibid., p. 4–20).

¹⁷³ Ibid., p. 4–25.

¹⁷⁴ In 2002, nearly 66 percent of worldwide R&D was concentrated in North American and Europe, and another 30 percent in Asia (NSB, *Science and Engineering Indicators 2008*, p. 4–26).

Top managers
of commercial
companies may
be put off by
the political and
bureaucratic
complexity of
working with the
government as
both a regulator
and buyer.

One approach to addressing the need to access commercial technologies, capabilities, and products would be to encourage the entry of commercial firms into the defense industry. Even just lowering the barriers to entry, however, will be a challenge insofar as it would require the government to make some fundamental changes to the bureaucratic obstacles and red tape with which it confronts companies seeking defense contracts. A 2006 RAND study of the statutory and regulatory constraints on DoD acquisition identified no less than seventeen burdensome areas.¹⁷⁵ Changes to this situation would probably include: rationalizing the statutory and regulatory burden; finding ways to make the intrusion of government program officials in company operations less onerous; demonstrating a long-term commitment to protecting company proprietary knowledge; reducing requirement changes during development; and limiting frequency and magnitude of changes in the quantities of major systems it ultimately buys. In 1983, the Air Force originally planned to procure 132 B-2s; then, Defense Secretary Richard Cheney reduced the buy to seventy-five stealth bombers in 1990, and less than two years later President Bush ended production at twenty aircraft. Similarly, as of 2008 it appears that the Air Force will only take delivery of 175 operational F-22s, whereas the number advertised to industry in the late 1980s was 750 planes. These examples suggest that even if the Defense Department actually begins making changes to its buying practices to encourage the entry of commercial firms, there would still remain the issue of whether the leaders of these firms are willing to trust the military Services and other defense agencies to keep their programmatic promises in the long run. Top managers of commercial companies may be put off by the political and bureaucratic complexity of working with the government as both a regulator and buyer.¹⁷⁶ Finally, leaders of commercial firms contemplating entry into defense programs may also be personally deterred by the legal and financial risks of being drawn into Washington political struggles. At best, one suspects that enticing new commercial companies to enter the defense business will be a long, hard slog, even if US defense budgets remain at their current high levels.

An interesting question is whether government efforts to entice new commercial entrants to the defense business should focus on attracting additional prime contractors or concentrate more on the supplier base. Bringing in smaller firms to expand the supplier base appears, at least on the surface, to be more attractive given the large annual costs a prime like Lockheed Martin must bear to retain the engineering overhead to design combat aircraft or satellites. However, the industry consolidations of the 1990s have tended to produce large prime contractors containing acquired business units that can provide subsystems and components to one another. For instance,

¹⁷⁵ Jeffrey A. Drezner, Raj Raman, Ivor Blickstein, John Ablard, Melissa A. Bradley, Brent Eastwood, Maria Falvo, Dikla Gavrieli, Monica Hertzman, Darryl Lenhardt, and Megan McKernan, *Measuring the Statutory and Regulatory Constraints on DoD Acquisition: Research Design for an Empirical Study* (Santa Monica, CA: RAND, 2006), pp. xi–xiii

¹⁷⁶ See, for example, “Home Depot Snubs U.S. Contracts,” *The Wall Street Journal*, June 18, 2002, p. B10.

Northrop Grumman is the sensor sub-contractor to Lockheed Martin on the SBIRS High program. Moreover, whereas the government has made some efforts in the past to manage the major US defense firms, the sub-contractor base has traditionally been left to the larger firms to manage for themselves through their own contracts. For US government officials to embark on an explicit program to broaden the defense supplier base in order to gain greater access to commercial technologies and products would be a venture into unknown territory.

Given the widely assumed benefits of greater competition in defense programs, another possible way of helping US defense firms gain greater access to the commercial world would be to find ways to reduce the obstacles to the flow of commercial technologies and knowledge from foreign firms into the defense industry. The current regime for regulating that flow has been criticized repeatedly for its long delays, bureaucratic difficulties, and sometimes petty enforcement decisions by US officials. The political obstacles are obviously substantial and reinforced by the legitimate need to prevent the transfer of advanced American technologies to potential adversaries. The barriers to gaining access to foreign commercial technologies and products may only grow worse as other nations invest in developing their own protected defense industrial base. Partial steps toward improving the current US barriers to technology transfer from overseas lie in formulating better policies, streamlining associated regulatory procedures, and improving their execution. Steps in these directions may not eliminate the political constraints, but they would at least be a move in the right direction. For the United States, the entry of foreign suppliers into the American market might add additional sources of competition, provide the government access to “best of type” systems, improve interoperability with allies, and assist in shaping alliances. For US companies, the improvement in policies, procedures, and execution might improve their competitiveness overseas.¹⁷⁷ The long-term result could be a more global Western defense industry encompassing primarily North America and Europe.

The entry of foreign suppliers into the American market might add additional sources of competition, provide the government access to “best of type” systems, improve interoperability with allies, and assist in shaping alliances.

LOW-VOLUME PRODUCTION VERSUS SURGE CAPACITY

The principles offered earlier for dealing with the greater uncertainty and risk inherent into the future security environment suggest that the US defense industry needs to become better able to develop weapon systems customized to meet specific needs and produce them in relatively low quantities without sacrificing cost or efficiency. Growing needs for force structure variety, capacity for adaptation, and greater speed of adaptation as adversaries’ capabilities evolve argue that long production runs of

¹⁷⁷ For example, in the past Turkey has demanded contractual access to US technology before access could be approved by the US government. Controversy is now occurring over initiatives by other nations to develop new systems entirely devoid of American components in order to bypass any such US restrictions. Current US policies for regulating foreign involvement in defense programs are, therefore, encouraging the development of “policy free” designs as opposed to “best performing” ones.

Might today's
defense firms
benefit from
migrating their
business models
toward a greater
capacity to
produce smaller
numbers of
more specialized
systems?

uniform products are likely to become less and less frequent, including for major platforms such as combat aircraft, naval combatants, and land-combat systems. Historically, however, long production runs have tended to be the most reliable and largest sources of profitability for defense firms.

Might today's defense firms benefit from migrating their business models toward a greater capacity to produce smaller numbers of more specialized systems? After all, the industry has some experience with low-volume production of tailored systems. The early U-2, SR-71, and F-117 are all examples of platforms that were built in relatively small numbers to meet very specific mission needs. In the F-117's case, the program was developed in the "black" world, meaning that Air Force did not even acknowledge its existence until 1988, five years after it entered service. For this reason, the Air Force's program office was about one-tenth that of most other fighter programs, and keeping development in the black has been viewed as having benefited cost and schedule. However, in 1996 RAND examined the program's applicability as a model for the streamlined acquisition of other systems, but concluded that its broader applicability was limited due to the special circumstances surrounding the F-117 development.¹⁷⁸ Moreover, because the initial buy was to be only twenty aircraft and production began before the design had matured, extensive modifications were necessary in production and the unit acquisition cost was roughly a hefty \$180 million each (in FY 2008 dollars).¹⁷⁹ Past experience with specialized-requirement, low-volume production of advanced weapon systems is, therefore, mixed at best. It is conceivable that modern computer-aided design and manufacturing techniques could make industry migration toward increasingly customized developments and limited production runs more feasible than it has been in the past. Moving in this direction might even increase competition within the industry because the government could offer more new starts or even enter different lots of the same system into the competition. In the final analysis, however, company decisions to begin moving toward this model would undoubtedly be weighed against profitability.

A tension possibly affecting the wisdom of encouraging the US defense industry to migrate toward a low-volume, tailored-requirement production model is the desire for an industrial surge capability that could turn out large numbers of weapons and systems should the need arise. During World War II, the United States created 89 divisions of all types.¹⁸⁰ The years 1942–1945 saw the United States produce over

¹⁷⁸ Giles K. Smith, Hyman L. Shulman, and Robert S. Leonard, "Application of F-117 Acquisition Strategy to Other Programs in the New Acquisition Environment," RAND, MR-749-AF, 1996, pp. xiv–xv.

¹⁷⁹ Smith, Shulman, and Leonard, "Application of F-117 Acquisition Strategy to Other Programs in the New Acquisition Environment," p. 40. Five F-117 test vehicles were built and 59 operational aircraft produced for the Air Force. The Air Force retired the F-117 from active service in 2008.

¹⁸⁰ Alan L. Gropman, *Mobilizing U.S. Industry in World War II* (Washington, DC: National Defense University Press, 1996), McNair Paper 50, p. 42.

90,000 fighters and bombers, including 12,761 B-17s and 18,481 B-24s.¹⁸¹ The underlying rationale for mobilization and production on these scales was, of course, combat attrition. During World War II, the US 8th Air Force in Europe lost in excess of 6,500 B-17s and B-24s.¹⁸² Since the Cold War ended, the US military has not experienced combat-attrition rates remotely comparable to those experienced from 1941 to 1945 or even to those of the Vietnam conflict. Barring the now unlikely resurgence of major conventional war between great powers, the need for the defense industry to be able to surge production to accommodate large-scale mobilization will probably remain remote. Moreover, it costs significant amounts for defense firms to maintain excess production capacity. The fact is that the Defense Department long ago ceased to be willing to pay for such capacity, and has even been inclined to penalize contractors inclined to do so if it increased the unit costs of weapon systems. Consequently, while surge capacity for mobilization generally runs counter to the desire for shorter production runs of more specialized systems, neither DoD nor industry seems inclined to invest in surge-production capabilities.

Moreover, given the far greater complexity of modern weaponry, surge would be considerably slower today than it was during World War II. In 1944, American industry averaged the production of 96 bombers and 107 fighters *a day*. The Air Force has recently been building twenty F-22s a year, and JSF production rates are not planned to exceed 150 aircraft a year. In 1997 the National Defense Panel questioned “the applicability of traditional mobilization structures,” recommending that DoD “should scrub through programs and reconstitute policy and programming requirements to eliminate unnecessary cost associated with obsolete mobilization concepts.”¹⁸³ In short, there are reasons for thinking that notions of mobilization based on experience in World War II are probably due for rethinking.

There are reasons for thinking that notions of mobilization based on experience in World War II are probably due for rethinking.

GOVERNMENT MANAGEMENT AND BUYING PRACTICES

The US government in general and the Department of Defense in particular can exercise influence on the defense industrial base in a number of ways. Most of these have to do with either government management or buying practices. These practices include:

¹⁸¹ Ibid., p. 96; Major Nannette Benitez, “World War II War Production—Why Were the B-17 and B-24 Produced in Parallel?” Air Command and Staff College, March 1997, p. 1.

¹⁸² Roger A. Freeman with Alan Crouchman and Vic Maslen, *Mighty Eight War Diary* (New York: Jane’s, 1981), p. 8. More than one in six of 8th Air Force’s bomber losses were due to non-combat accidents.

¹⁸³ National Defense Panel, *Transforming Defense: National Security in the 21st Century*, December 1997, p. 77.

- > ALTERING BROAD DEFENSE REQUIREMENTS IN RESPONSE TO CHANGES IN THREAT CAPABILITIES AND THE INTERNATIONAL SECURITY ENVIRONMENT. Since the Cold War ended, the US Navy has increased its interest in littoral operations, as evidenced by the introduction of the Littoral Combat Ship. An even more consequential change, flowing from 9/11, is the November 2005 DoD Directive (DoDD) that established declared stabilization, security, reconstruction, and transition operations leading to sustainable peace as a “core U.S. military mission.”¹⁸⁴
- > CONTROLLING THE MERGER AND ACQUISITION OF COMPANIES BY US DEFENSE firms as well as influencing the building of alliances and formation of teams within the industry and the access of foreign firms to the US defense market and military technologies.
- > INTRODUCING NEW MANAGEMENT PRACTICES THAT ALTER GOVERNMENT-INDUSTRY RELATIONS OR REQUIREMENTS THAT AFFECT SYSTEM DESIGNS. Recent examples include using private-sector Lead System Integrators (LSIs)¹⁸⁵ to execute large, complex acquisition systems such as the Army’s Future Combat Systems and the Coast Guard Deepwater development, and growing emphasis in defense programs on design standards for interoperability, standardization, and the use of commercial best practices.
- > MAKING CHANGES IN BUDGETING AND FUNDING PRIORITIES. Examples include President Bush’s decision to end B-2 production at twenty aircraft, or the rapid growth in UAVs for real-time battle-space reconnaissance since 2001. A less obvious and longer-term instance of changing government priorities in defense acquisition is the declining importance of platforms compared to precision-guided munitions (PGMs) and the growing importance of sensor networks compared to PGMs.
- > AFFECTING THE COMPETITIVENESS OF ACQUISITION PROGRAMS BY CHANGING the frequency of opportunities (especially new starts), managing potentially dysfunctional competitions, maintaining parallel providers, and sustaining some degree of competition over the life of major programs by such techniques as qualifying second sources and competing later lots.

¹⁸⁴ DoDD 3000.05, “Military Support for Stability, Security, Transition, and Reconstruction (SSTR) Operations,” November 28, 2005, p. 2.

¹⁸⁵ LSIs have been “strongly criticized by some observers because of costs and schedule overruns, and the potential for possible conflicts of interest” (Valerie Bailey Grass, “Defense Acquisition: Use of Lead System Integrators (LSIs) — Background, Oversight Issues, and Options for Congress,” CRS, March 26, 2007, p. CRS-1).

- > CHANGING THE METRICS FOR SOURCE SELECTION AND PROGRAM PERFORMANCE. Examples include taking into account the long-term effects on the defense industry of a given program award or making total ownership cost (TOC) a key performance parameter (KPP).¹⁸⁶
- > AFFECTING THE INTERNAL OPERATIONS OF DEFENSE FIRMS. Ongoing illustrations are the imposition of special reporting and accounting systems on defense programs, requiring onsite presence by government program officials, restrictions on the overseas sales of particular weapons, and the government's handling of industry proprietary knowledge.

These are all areas in which the federal government has considerable leverage over the current and future shape of the US defense industry. Enlightened changes in and more consistent use of these sources of influence could enable the Department of Defense to make the American defense industry an even greater source of competitive advantage than it was during the twentieth century. Defense firms, as we have seen, do respond to what weapons and military systems the government buys and to how the government develops and procures them. Companies also respond to trends in underlying technologies and system engineering, to the behavior of industry competitors, and to the demands of their top executives and shareholders or owners. In this regard it is worth recalling that while the United States failed to field genuine reconnaissance strike complexes or national missile defenses before the Soviet Union collapsed, both engendered widespread despair within the Soviet General Staff regarding the USSR's prospects for continuing to hold up its end of the military competition with the United States. That is why, after 1983, constraining President Reagan's Strategic Defense Initiative to erect defenses against Soviet ballistic missiles became "the single most important object of Soviet diplomacy and covert action" as well as evidence of "the desperate need to modernize the economy if the Soviet Union was to remain a militarily competitive superpower."¹⁸⁷

The means to shape the US defense industry for the better in the years and decades ahead are not any great mystery—particularly if the government and industry manage to work together towards an industry structure beneficial to both. However, given the absence of perceptible progress over many decades in better controlling cost and schedule in major defense acquisition programs, it is difficult to avoid the conclusion that the political, economic, bureaucratic, and technical obstacles to making the defense industrial base an even greater source of advantage in the future than it has been in the past are considerable. Critics have been inclined to attribute lack of

¹⁸⁶ For a discussion of TOC and KPPs, see Michael W. Boudreau and Brad R. Naegle, "Total Ownership Cost Considerations in Key Performance Parameters and Beyond," *Defense Acquisition Review Journal*, February–March 2005, pp. 108–121.

¹⁸⁷ Robert M. Gates, *From the Shadows: The Ultimate Insider's Story of Five Presidents and How They Won the Cold War* (New York: Touchstone, 1996), p. 539.

improvement principally to the companies' desire to protect profits and markets together with the internal bureaucratic difficulties of changing large organizations; but defense companies are no different from companies in any other industry. Like their commercial counterparts, they respond to changes in their customers' desires and the market environments in which they operate. However, unlike commercial sectors that can be allowed to go the way of the dinosaurs, the US defense industrial base is a pillar of American military power. From this perspective, primary responsibility for ensuring that it remains a source of competitive advantage would seem to rest with the government.



CONCLUSION > **STRENGTHENING THE INDUSTRIAL BASE**

The US federal government, including the Department of Defense, has a number of broad paths it could pursue with respect to the future structure of the defense industrial base. First, the government could, as it has in the past, limit itself to influencing the industry through what goods and services it buys, leaving it to the defense companies themselves to respond to changes in the government's demands for their products. This path would require the least amount of change in the government's traditional behavior toward the industry. The structure and capabilities of the defense industrial base, including consolidation decisions, would be left to the companies to work out for themselves.

A second alternative, involving occasional government oversight of industry decisions, would be to veto industry mergers and acquisitions deemed unacceptable for whatever reason. During the 1990s, the US government did veto some proposed mergers to retain some degree of competition between prime contractors. The government did not, however, go so far as to prescribe specific mergers. While this approach does influence the future shape of the defense industry, it has not been applied very consistently and may require more understanding of the industry than most government officials have so far demonstrated. Worse, the 2006 National Security Strategy of the United States makes no mention at all of the US defense industrial base or the role it might play in the nation's security.

A third alternative would require the federal government to use its product preferences, buying practices, and industrial policies to alleviate the impediments to the type of industry political leaders and government bureaucrats desire. This sort of reshaping of the incentives for defense companies could reshape the industry in ways likely to increase its value as a source of strategic advantage without necessarily prescribing what the defense industrial base should be. However, this path would require disparate government stakeholders to reach some degree of consensus on the desired industry capabilities and structure, which is unlikely. It would also demand relatively

The US federal government's approach to the defense industry since it emerged as a permanent part of the peacetime economy in the 1950s has predominantly been a combination of laissez-faire policies and benign neglect.

fundamental improvements in the government's understanding of the defense business and behavior toward the industry. Both requirements appear to call for levels of thought and commitment not widely seen in the public sector.

The last option would be to begin a return toward government arsenals. Doing so might well result in the defense industrial base government officials believe is in the best interests of the United States. However, there is little evidence that the creativity and technological innovation that has made the US defense industry a source of enduring strategic advantage since the 1940s would persist under an arsenal system. Moreover, movement down that path would not be likely to increase the defense industrial base's access to commercial technologies, knowledge, and products.

In retrospect, the federal government's approach to the defense industry since World War II has mostly been a mixture of the first two alternatives. Now and again there has been consideration of embracing an approach more along the lines of the third alternative—a fundamental revision of the government's product preferences, buying practices, and industrial policies. By and large, the political will to do so on any consistent or sustained basis has yet to materialize. Consequently, the US federal government's approach to the defense industry since it emerged as a permanent part of the peacetime economy in the 1950s has predominantly been a combination of laissez-faire policies and benign neglect.

Of course, government policies and actions are not the only influences on the future shape of the US defense-industrial base. The companies themselves can affect the industry's structure and capabilities through the strategic business decisions their managers make about whether to close down under-performing segments of their defense businesses, move top engineering and managerial talent into commercial product lines, or even exit the defense industry altogether. Cash is a liquid asset, and defense firms can use their profits to return dividends to their stockholders, to enter commercial businesses, sustain their existing military product lines and capabilities, or to try to win new defense programs. Especially in the 1960s when President John Kennedy challenged the country to put a man on the moon before the end of the decade, most defense firms were infused with a palpable sense of commitment to national goals that transcended profits. The defense industry was also able to attract some of the very best scientific and engineering talent coming out of American universities and colleges. The situation is considerably different today. If the leading executives of American defense firms were to begin to concentrate more single-mindedly than they have in the past on profit-and-loss, it is far from clear that the United States would have the defense industry it needs in coming decades, much less one that remains a major source of long-term strategic advantage for the United States.

The overriding conclusion that emerges from these observations is that to ensure the United States has the strong, innovative defense industry the nation will almost certainly require for the foreseeable future, the federal government will need to develop a more consistent, thoughtful, longer-term, active strategy for influencing the

defense industrial base. Doing so will not be easy; if there is one clear message that emerges from the preceding chapters it is the sheer difficulty of shaping the US defense industrial base for the better given the many uncertainties about future defense needs, the greater complexity of twenty-first century threats to American national security compared to the monolithic Soviet threat during the Cold War, the absence of anything approaching a bi-partisan political consensus on national security strategy, and the prospect that Congress may do more to hinder rather than help substantial changes in the government's approach to the defense industry.

The first step toward developing a more enlightened and active approach to the US defense industry will be for the National Security Council (NSC) and the Department of Defense to begin thinking seriously about the problem. The challenge, once again, is far broader than merely trying to reduce cost overruns or schedule slippage in individual defense-acquisition programs. Nor is it one that can be addressed with a one-time fix. A sustained effort over many administrations will be required, including incremental adjustments as circumstances and the security environment change. The foremost problem, though, is that the US government has yet to undertake the hard thinking about the industrial base issue. If one examines US national security or defense strategy documents, or the last three Quadrennial Defense Reviews (QDRs), there is almost no mention of the industrial base. The latest QDR does not use the word 'company' once, and the word 'industry' has but a single occurrence, that reference being in the context of the observation that, to build a larger, transformed, recapitalized naval fleet, affordability will need to be improved and stability provided for the shipbuilding industry.¹⁸⁸ The word "business" occurs seventeen times, but all these references concern the need to improve the efficiency and speed of DoD's internal operations by adopting commercial best practices.¹⁸⁹ Worse, neither the NSC's 2006 *The National Security Strategy of the United States* nor the Pentagon's 2008 *National Defense Strategy* contain a single reference to the defense industrial base or the role it might play in national defense. Indeed, in July 2008, a DSB task force on the defense industrial base concluded that there is "a critical need" for DoD, working with industry, to "establish a National Security Industrial Vision . . . to ensure realization of an improved Customer/Supplier relationship."¹⁹⁰ Prior to this report, however, it appears that the 1997 report of the National Defense Panel was the last time the importance of the defense industry was discussed in a major government paper on US national strategy. Among other points, the NDP pointed out that given the degrees of industry consolidation, the DoD needed to "take appropriate measures" to ensure that the smaller number of large contractors with diverse and extensive technological

The first step toward developing a more enlightened and active approach to the US defense industry will be for the National Security Council (NSC) and the Department of Defense to begin thinking seriously about the problem.

¹⁸⁸ DoD, *Quadrennial Defense Review Report*, February 2006, p. 48.

¹⁸⁹ Ibid., pp. 63, 65, 69.

¹⁹⁰ Jacques Gansler, memorandum to the chairman of the DSB, in *Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to Address the Coming Crisis* (Washington, DC: Office of the Under Secretary of Defense for Acquisition, July 2008), p. 1.

Are there viable alternatives? One that emerges from looking at the business literature is the possibility of shifting the primary emphasis from cost- to time-based metrics.

capabilities remained “subject to adequate competitive forces, a key to efficiency and innovation.”¹⁹¹

These observations indicate that the federal government has given little heed over the last decade to the National Defense Panel’s recommendation that greater thought and attention needed to be paid to the health of the US defense-industrial base.¹⁹² This conclusion raises the following question: What sorts of considerations might plausibly go into the development of a more consistent, thoughtful, longer-term strategy for ensuring that the US defense-industrial base continues to be a source of American advantage in the future? Based on the history and evidence in this report, a number of suggestions come to mind.

The first concerns the longstanding emphasis in acquisition practices and regulations on the costs of individual programs as the primary metric for managing and evaluating the development and procurement of military goods and services. The acquisition system focuses on the costs of individual weapons and end items such as the F-22 or the JSF, rather than on broader capability areas such as air-to-ground strike or fixed-wing tactical air power as a whole. To a considerable extent, this focus is understandable. It reflects the federal government’s responsibility as the steward of the taxpayers’ dollars. It also reflects the widespread belief that costs measured in dollars provide a comprehensive measure for judging the performance of acquisition programs. Indeed, the latter belief has been institutionalized in the GAO’s charter to evaluate the use of public funds in order to provide analyses, recommendations, and other assistance to help Congress make sound oversight, policy, and funding decisions.

Nevertheless, as the GAO’s own latest analyses of MDAP portfolios have shown, this single-minded emphasis on the costs has not succeeded in stemming cost growth or schedule slippage across large numbers of major defense programs.¹⁹³ Are there viable alternatives? One that emerges from looking at the business literature is the possibility of shifting the primary emphasis from cost- to time-based metrics.¹⁹⁴ Many aspects of moving to time-based metrics in defense acquisition were also recommended in the 2007 *Defense Acquisition Performance Assessment Report*:

¹⁹¹ NDP, *Transforming Defense*, p. 74.

¹⁹² The one DoD organization explicitly charged with thinking about the structure, organization, and performance of the defense-industrial base, including its capacity for efficient military production in peacetime and increased output in emergencies, is the Industrial College of the Armed Forces (ICAF) at Fort Lesley McNair. However, ICAF, like the Defense Acquisition University, is primarily a mid-level educational institution, not a source of industrial policy for the federal government. Both ICAF and the Defense Acquisition University fall under the Pentagon’s Under-Secretary of Defense for Acquisition, Technology, and Logistics.

¹⁹³ Again, see GAO, “Defense Acquisitions: Assessments of Selected Weapon Programs,” GAO-08-467SP, March 2008.

¹⁹⁴ For essays on various aspects of time-based competition in commercial businesses, see Carl W. Stern and George Stalk, Jr. (eds.), *Perspectives on Strategy from the Boston Consulting Group* (Hoboken, NJ: Wiley & Sons, 1998), pp. 159–178.

... Our assessment is that the culture of the Department is to strive initially for the 100 percent solution in the first article delivered to the field. Further, the “conspiracy of Hope” causes the Department to consistently underestimate what it would cost to get the 100 percent solution. Therefore, products take tends of year to deliver and cost far more than originally estimated.

There is a need to shift to Time Certain Development and make “schedule” a Key Performance Parameter. Developmental programs must change their focus to deliver useful military capability within a specified time (nominally no more than six years for major platforms) from Milestone A.¹⁹⁵

Time Certain Development enforces evolutionary acquisition by making time the focus of the up front requirement statement. Capabilities could be upgraded over time as technologies mature and operational requirements become clearer. Time Certain Development differs from prior attempts at valuing time to market, such as evolutionary acquisition and spiral development in that a maximum number of years is mandated, the start and end dates are defined, and the driving processes (requirements, budget, source selection, etc.) are revamped to support it.¹⁹⁶

While the DAPA endorsement of Time Certain Development does not explicitly mention increasing the frequency of new program starts, a nominal six years from Milestone A to production decision certainly implies the likelihood of new starts occurring more often than they have in recent decades. The prospect of program termination, should it fail to deliver on time, would also contribute to shorter development times and more frequent new starts.

Shifting from cost-based to time-based metrics has other advantages. Time is easier to understand than cost and less subject to abuse through artful ways of presenting costs. Government program managers and contractor executives alike might well be more resistant to endless requirements changes because acquiescing would endanger meeting schedule. Possible policies like banning major modifications during the first year after program award might also reduce the amount of gamesmanship on both sides regarding requirements, budgets, and bids.

A time-based approach to acquisition offers other advantages. Greater uncertainty about who the US military may fight next, and where conflicts are to take place, is likely to be a dominant feature of the future security environment for decades to come. In such circumstances, committing to acquisition programs as lengthy as that of the F-22 risks fielding systems whose utility has been eroded by changes in the kinds of conflicts confronting the United States or the capabilities and operational concepts

Time is easier to understand than cost and less subject to abuse through artful ways of presenting costs.

¹⁹⁵ Milestone A is the point in an acquisition program at which approval is sought from the Milestone Decision Authority to move from concept refinement into technology development (see Figure 7). The purpose of the concept refinement phase is to develop a Technology Development Strategy (DOD Instruction 5000.2, “Operation of the Defense Acquisition System,” May 12, 2003, p. 5). This phase is guided by the Initial Capabilities Document and an Analysis of Alternatives (AoA), which evaluates the performance, operational effectiveness and suitability, and estimated costs of alternative systems to meet a mission capability. The Milestone B decision moves an acquisition program into system development and demonstration, and the Milestone C decision transitions it into production and deployment.

¹⁹⁶ Kadish et al., *Defense Acquisition Performance Assessment Report*, pp. 48, 49–50.

of prospective adversaries. Lengthy acquisitions drive up program costs, jeopardize the numbers ultimately procured due to growth in unit costs, and, because the new systems arrive later than expected, aging systems have to be retained in operational service longer than planned. A time-based approach, if properly implemented, would ameliorate these problems. In addition, by enabling the US military to field new systems more often than in the recent past, the force structure should, at any point in time, contain a richer mix of advanced systems, thereby making it more difficult for adversaries to counter US capabilities.

Time-based acquisitions could also benefit the defense industrial base in several ways. While development times and the length of production runs would tend to decrease, more frequent new starts would benefit design teams and make losing a given competition less of a threat to a company's survival, whether in specific product lines or the defense business in general. Presumably, the government's adoption of time-based acquisitions would incentivize more companies to remain in the defense industry by offering new business opportunities more frequently than in the past, and would possibly attract commercial companies to the defense market. After all, time-based competition has helped commercial firms such as Honda, Toyota, Federal Express, and McDonald's to stay ahead of their competitors. It could yield similar benefits for the Department of Defense—particularly in the sense of strengthening the industrial base.¹⁹⁷

Another suggestion that could help the US government begin crafting enlightened policies toward the US defense industry is to give the concept of capabilities-based approach to defense more than mere lip service. The 2001 QDR argued that a "capabilities-based model—one that focuses more on how an adversary might fight than who the adversary might be and where a war might occur—broadens the strategic perspective" by requiring the US military to identify the needed capabilities "to deter and defeat adversaries who rely on surprise, deception, and asymmetric warfare to achieve their objectives."¹⁹⁸ However, the QDR report published in 2006 did not add much substance to the original idea, confining itself to stating that "capability portfolios" for future forces—"joint ground, special operations forces; joint air; joint maritime; tailored deterrence; combating WMD; joint mobility; ISR and space capabilities; net-centricity; and joint command and control"—had been identified.¹⁹⁹

In between the 2001 and 2006 QDRs, the Office of the Secretary of Defense (OSD) made revisions to the acquisition system. New versions of DoD Directive 5000.1, "The Defense Acquisition System," and DOD Instruction 5000.2, "Operation of the Defense Acquisition System," were signed in May 2003, and the previous service-specific requirements-generation process was replaced by the Joint Capabilities Integration

¹⁹⁷ George Stalk, Jr., "Time—The Next Source of Competitive Advantage," *Harvard Business Review*, July–August 1988, pp. 45–46.

¹⁹⁸ DoD, *Quadrennial Defense Review Report*, September 30, 2001, p. 14.

¹⁹⁹ DoD, *Quadrennial Defense Review Report*, February 2006, p. 41.

and Development System (JCIDS) in June 2003.²⁰⁰ Nevertheless, the new JCIDS requirements process, the DoD acquisition system, and the Planning, Programming, Budgeting, and Execution (PPBE) system remain fixated on individual programs and their costs rather than on capability portfolios. Nor is there any appreciable evidence of a shift toward a time-based approach such as DAPA's Time Certain Development. Presumably, a capabilities-based approach would encourage acquisition decisions to be made with an eye toward broad military needs rather than individual systems, and this perspective could, over time, encourage government officials to pay more attention to ensuring that the industrial base supplying those capabilities remains an enduring source of advantage for the United States. Unfortunately, DoD's endorsement of a capabilities-based approach appears, so far, to be mostly rhetoric. The substantive changes to longstanding acquisition practices, directives, instructions, and regulations that concentrate remorselessly on individual programs and costs have yet to materialize.

In fairness, the requisite changes would require agreement—or at least acquiescence—from more stakeholders than those in OSD, the Joint Staff, the military Services, and the combatant commands. From the vantage point of the Defense Department, the three key processes that must work together in concert to deliver the capabilities required by American warfighters are: JCIDS, the acquisition system, and the PPBE system.²⁰¹ Funding levels, however, are monitored and sometimes set by the Office of Management and Budget (OMB), and ultimately have to be authorized and appropriated by the Congress. Further, the companies have facilities and workers in many Congressional districts and states, which means they can exert influence on specific programs. For example, in the 1996 Defense Authorization Act, Congress removed the cost cap on the B-2 program and added \$493 million to convert the first flying test article, Air Vehicle 1, into a twenty-first stealth bomber even though the president had terminated the program in 1992 at twenty aircraft.²⁰² What this example illustrates is that changes to defense acquisition as fundamental as moving to a rigorously enforced time-based approach would require buy-in from diverse power centers scattered across at least two branches of the federal government. Or, put another way, the formal defense acquisition system shown in Figure 7 is just a piece of the overall political and bureaucratic problem of institutional change in how the government acquires military goods and services and oversees the defense industrial base.

Changes to defense acquisition as fundamental as moving to a rigorously enforced time-based approach would require buy-in from diverse power centers scattered across at least two branches of the federal government.

²⁰⁰ Anne Marie Squeo, "Rumsfeld Moves To Strip Services of Power To Set Equipment Needs," *The Wall Street Journal*, May 19, 2003. Officially, the JCIDS process was created to support the statutory requirements of the Joint Requirements Oversight Council "to validate and prioritize warfighting requirements" (Chairman of the Joint Chiefs of Staff Instruction 3170.01F, "Joint Capabilities Integration Development System," May 1, 2007, p. 2).

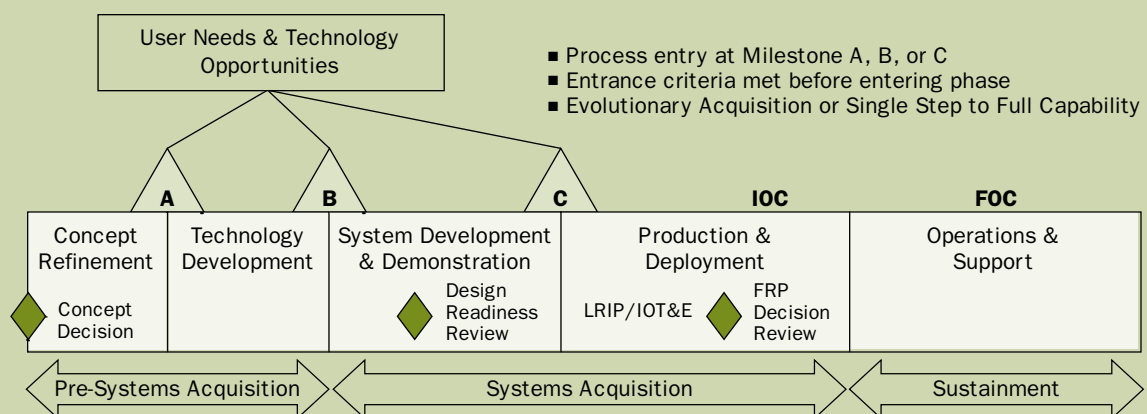
²⁰¹ CJCSI 2170.01F, "Joint Capabilities Integration Development System," pp. 1–2.

²⁰² GAO, "Air Force Bombers: Options to Retire or Restructure the Force Would Reduce Planned Spending," GAO/NSIAD-96-192, September 1996, p. 20.

Today, developing weapons and military systems involves numerous players and power centers: DoD and industry executives and their staffs, government and industry program managers, individual legislators and their staffs, Senate and House committees and their staffs, and, in the case of programs such as the multi-national JSF, participating allies. Given the varied and often conflicting motivations of all these participants, it is hardly surprising that the existing collection of arrangements and practices has exhibited extraordinary resistance to fundamental change since the onset of the Cold War.²⁰³ Despite recurring calls for, and attempts at, reform, many perverse behaviors have persisted even though they have been repeatedly identified as root causes of cost overruns and the delayed delivery of systems to the warfighters. For example, the US military Services continue to make extraordinary demands for the performance of individual weapon systems, run competitions that incentivize companies to underbid costs or make technologically unrealistic promises on performance, alter or add requirements after development is underway, and downplay the risk that major cost overruns or schedule slippage will be encountered even when data

²⁰³ The call of Gansler's July 2008 DSB task force on the industrial base for DoD, even if in conjunction with industry, to establish a National Security Industrial Vision ignores Congress.

FIGURE 7. THE FORMAL DOD ACQUISITION MANAGEMENT SYSTEM*



* DOD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003, p. 2. IOC = Initial Operational Capability; FOC = Full Operational Capability; LRIP = Low Rate Initial Production; IOT&E = Initial Test and Evaluation; and FRP = Full Rate Production. For the August 2005 version of this management framework that reveals its full complexity, see <<http://www.dau.mil/pubs/IDA/chart%20front.pdf>>.

suggest otherwise.²⁰⁴ In addition, the government as a whole is inclined to deviate from expected funding levels from one year to the next and reduce production quantities, especially once costs begin to rise. These deeply entrenched behavioral patterns do little to strengthen the industrial base.

As mentioned in the introduction, by DAPA's count there have been no less than 128 studies aimed at addressing these problems with the US defense acquisition system. Many of the recommendations made over the years have been adopted, but they have had little, if any, long-term success in controlling costs and schedule.²⁰⁵ Current arrangements and practices have produced some of the world's best weapons. But they have also evolved to give the major stakeholders enough of what each wants to undermine the incentives for fundamental change. Consequently, beyond the recommendations that the government embrace a time-based approach, and focus more on broad capabilities than on individual programs in isolation, one is reluctant to offer many other suggestions for fear of doing more harm than good. Take the Total System Performance Responsibility (TSPR) policy implemented during the 1990s. The policy was adopted in response to DoD's awareness that the government's capability to lead and manage space acquisition programs had deteriorated. Once implemented, though, TSPR had the perverse effect of so eroding the authority of "program managers and other working-level acquisition officials" that it "reduced their ability to succeed on development programs."²⁰⁶ The recommendations of politicians and industry observers during the 1990s that defense companies should push into commercial markets are another example of guidance that simply did not work. For these reasons, offering a lengthy list of "fixes" to the acquisition system, most of which can be found in earlier studies, does not seem especially wise, however well intended the suggestions may be.

Nevertheless, from the standpoint of trying to strengthen the industrial base, there are a few ideas that may merit consideration.

- > **REDUCE NON-VALUE-ADDED GOVERNMENT PRACTICES.** It appears to have been some years since the government has conducted a comprehensive "value added" review of all the steps, processes, practices, and assumptions involved in system acquisition. For example, how long do proposals for advanced weapon systems

²⁰⁴ The Navy's A-12 attack aircraft, which was to replace the aging A-6, is a good example of the complexity of defense reform issues. Many in industry have been inclined to blame Defense Secretary Cheney's decision to cancel the program in January 1991 on the fact that it was a fixed-price development. However, a 1995 statistical analysis of the program found that the cost overruns in this instance were "exceptional" compared to 58 other contracts, and that the A-12's demise could not be attributed to the fixed-price contract vehicle for engineering development (Eric M. McKsymick, "An Analysis of Cost Overruns in the Development of the Navy's A12 Avenger Aircraft," Naval Postgraduate School, December 1995, p. v.)

²⁰⁵ This count would obviously exclude the 2008 DSB report *Creating an Effective National Security Industrial Base for the 21st Century*.

²⁰⁶ Defense Science Board/Air Force Scientific Advisory Board Joint Task Force, *Acquisition of National Security Space Programs*, May 2003, p. 3. This task force reviewed three space programs: FIA, SBIRS High, and the Evolved Expendable Launch Vehicle.

really need to be—tens, hundreds or thousands of pages? Similarly, how much detailed cost data do government program officials require and how frequently need that data be reported? Processes that do not add value should be modified or eliminated.

- > REQUIRE COMPANIES TO CONDUCT NO-HOLDS-BARRED “LESSONS LEARNED” ON MAJOR PROGRAMS. Relentless pursuit of mistakes and their correction have been emblematic of very successful firms across many industries. Defense companies should be forced to join those ranks. The proprietary company knowledge that might be revealed in the process can be protected. A firm’s demonstrated ability to learn from its past failures, as well as successes, could even be used as criteria in selecting winners in future competitions.
- > MAKE THE LONG-TERM IMPACT ON THE INDUSTRIAL BASE AN EXPLICIT SOURCE-SELECTION CRITERION. There is little doubt that, informally at least, individual source-selection authorities have tried to consider the influence of the competition’s outcome on the industry as a whole as a factor in deciding the winner. Will the losers be inclined to exit the defense business or eliminate unique capabilities that the military may need later? Only by making the impact on the industrial base a formal selection criterion are such considerations likely to become the rule rather than the exception.

Finally, it should be stressed that the US defense industrial base is not presently in a state of imminent crisis. The industry remains fairly innovative, relatively strong, and is capable of supplying US soldiers, sailors, marines, and airmen with world-class weapons and systems, even if they tend to reach the fielded forces later than expected and at increasingly higher costs than initially anticipated. In July 2008, a DSB report on the industrial base argued that because the world “is at an inflection point” not unlike those that followed the launch of Sputnik and the fall of the Berlin wall, the “coming crisis” in the defense industry was plainly in sight.²⁰⁷ Whether “the coming crisis” is an accurate assessment remains to be seen. Nevertheless, this report certainly agrees that the extent to which the American defense industry will continue to be an enduring source of strategic advantage depends on whether the federal government as a whole, not just DoD, embraces a more consistent, thoughtful, longer-term, and active strategy for influencing the structure and capabilities of the American defense-industrial base. It remains to be seen whether future administrations will do so.

²⁰⁷ DSB, *Creating an Effective National Security Industrial Base for the 21st Century*, p. 5.

Acknowledgments

CSBA wishes to acknowledge the substantive contributions to this report, especially in terms of overall structure and focus, of Mr. George E. “Chip” Pickett. In 2007 Mr. Pickett, who had been vice president of marketing and business planning for Northrop Grumman’s Electronics and Systems Sector, retired after 21 years with the firm. Prior to his long career in the defense industry he had served in the US Army, on the staff of the Pentagon’s Director of Net Assessment, as a senior staff member and budget analyst for the Senate Select Committee on Intelligence, as a lead analyst on airborne collection systems at Booz Allen and Hamilton, and as a systems engineer at the Mitre Corporation. Mr. Pickett prepared a comprehensive report on the history and potential future of the US defense industry under contract to CSBA. His research identified many of the sources extensively footnoted in CSBA’s report, provided a balanced appraisal of the industry’s performance from which CSBA drew, and offered his insights into how the industry might become better prepared to meet the defense challenges of the early 21st century. Mr. Pickett is currently teaching business strategy at the University of Maryland.

The author would like to thank the CSBA staff for their assistance with this report. Special thanks go to Charlotte Brock and Eric Lindsey for their editorial and production support.

The analysis and findings presented here are solely the responsibility of the Center for Strategic and Budgetary Assessments and the author.

Center for Strategic and Budgetary Assessments

1667 K Street, NW, Suite 900

Washington, DC 20006

Tel. 202-331-7990 • Fax 202-331-8019

www.CSBAonline.org