

**ACHIEVING THE DESIRED STRUCTURE
OF THE DEFENSE INDUSTRY
IN THE 21ST CENTURY**

by

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Table of Contents

Table of Contents	iii
Table of Figures	iv
Abstract	v
I. Introduction	1
Reorientation of the International Security Environment	1
A Revolution in Military Affairs	4
The Defense Industrial Base	6
Organization	8
II. Current Environmental Conditions	10
Holistic View of Security	10
Intelligence Changes	13
Unpredictability	14
Industrial Changes	15
Globalization	18
Recent “Scandals”	20
III. Assumptions about the Future Environment	22
Warfighting Changes—Irregular and Diverse Threats and Conflicts	22
China—Potential Peer Competitor	24
Domestic Budgetary Outlook	25
Defense Budget Shifts	28
Continuing Rapid Technology Change	29
IV. Desired, Mid-century, Defense Industrial Base Requirements	33
Broad Mid-century Requirements	33
Specific Mid-century Requirements	35
V. Barriers to Transforming the Defense Industry	43
Current Policies, Processes and Management of the Defense Enterprise Do Not Facilitate Transformation	43
The DoD Acquisition Workforce is Not Structured for Present Needs	48
Industry Trends and Government Policies Cater to a “Mature Industry” Model	53
VI. How Do We Get There?	59
Focus on Interoperable, Net-centric Systems-of-Systems	59
Achieve Lower Costs, Faster-to-Field, and Better Performance	60
The DoD Must Focus on Staying Ahead	61
The DoD Must Achieve Far Greater Use of “Best Value” Competitions	62
The DoD Must Understand and Realize Benefits of Globalization	62
Build a High-quality/High-skill Government Acquisition Workforce	63
Transform the DoD Logistics System to be a World-class Supply Chain	64
The DoD Must Envision, Incentivize, Achieve, and Monitor a Modern DIB	65
VII. Conclusion	67
Reference List	68
Acknowledgment	73
About the Authors	74

Table of Figures

Figure 1. Operational Challenges from <i>QDR</i> 2006.	4
Figure 2. National Security Interests and Political Objectives.	13
Figure 3. Defense Industry Consolidation	17
Figure 4. Jobs Created by Net Exports in Aerospace and Defense.	19
Figure 5. Defense and Selected Entitlement Spending as a Percent of the GDP.....	26
Figure 6. DoD Total Budget Authority (Constant 2008\$).	27
Figure 7. O&M and RDT&E as a Percent of the DoD Budget.....	29
Figure 8. U.S. Patent Activity 1790 to 2007.....	30
Figure 9. Export Market Shares in High-technology Goods	31
Figure 10. Trends in DoD S&T FY 1994-2009.....	44
Figure 11. Acquisition Workforce by Generation.	48
Figure 12. Acquisition Workforce Declined as Procurement Budgets Increased.	50
Figure 13. Graduate Enrollment in Science and Engineering.....	52

Abstract

A reorientation of the international security environment and a revolution in military affairs has occurred. As a result, the Defense Industrial Base (DIB)'s controlling policies, practices, laws and the Services' budgets and requirements priorities do not match present needs. Numerous environmental factors have contributed to this disparity, with the most influential being the rise of a holistic view of security, future unpredictability, the impact of globalization, and changes within the structure of the defense industry. In light of these factors, several important assumptions about the future environment must be made. Our research indicates that a continuation of irregular threats and conflicts will likely occur, and defense budgetary pressures will grow stronger. Concurrently, the rapid growth of technology will continue to complicate how defense issues are approached. All of these issues will be influential factors for twenty-first century defense planning. In order to meet the demands of the future, we recommend that the United States must be able to create an effective, agile, and affordable joint military force by forming a robust, responsive, efficient and innovative DIB. It must also update its policies and practices to permit the effective creation, acquisition management and support of large, complex systems, systems-of-systems and services.

To accomplish these goals, decision-makers must consider and overcome several barriers. On the whole, government policies, processes and management of the defense enterprise are not organized in a manner that would effectively facilitate the transition to a twenty-first century military force. Reductions in the DoD acquisition workforce also make transformation a difficult task, as the skills and people required are not available. Finally, industry trends and government policies have been long focused on a mature industry model that took roots during the Cold War and is a stark contrast from the dynamic requirements of the twenty-first century. Our vision for the accomplishment of our goals requires a focus on net-centric systems-of-systems; the determination to achieve lower costs, faster fielding and better performance for all emerging technologies; a DoD focus on staying ahead; the expansion of best-value competitions; a realization of the benefits of globalization; the recruitment and retention of a high-quality government acquisition

workforce; the creation of a world-class logistics supply chain; and a DoD-envisioned, monitored, and incentivized twenty-first century industrial base structure.

American military success in the twenty-first century is dependent upon a transformation of the Defense Industrial Base. Without the necessary changes in policies and practices within the Defense Department and the Defense Industry, the United States will be unable to accomplish future military success, placing American national security in jeopardy. Following our recommendations, we believe the required changes can be accomplished with careful planning and execution.

I. Introduction

It has been 18 years since the Berlin Wall collapsed. The monolithic threat posed by the Soviet Union has been replaced by fragmented and complex threats that have proven far more difficult to satisfactorily address. Failed and failing states have experienced civil wars, humanitarian catastrophes, and regional instability. The attacks on the World Trade Center and the Pentagon highlighted the growing global threat from terrorist organizations. This unstable international security environment makes it difficult to predict with any confidence the threats that the U.S. may face even five years from now. To address these concerns, the Department of Defense (DoD) has adopted a strategy of military transformation.

As a result, many facets of the U.S. Defense Industrial Base (DIB) are evolving to tackle these challenges. Change is evident in its controlling policies, practices, governing laws, the military Services' budgets and "requirements priorities." The various stakeholders, however, frequently have conflicting perspectives on how to proceed. The DIB and US military forces must be modified in order for the United States to successfully meet the broad spectrum of operational challenges it will face in the twenty-first century.

Reorientation of the International Security Environment

Over the last decade and a half, the face of international security has been altered by both internal and external forces. The United States has responded by making a consolidated effort to transform its military to meet the requirements of a newly dynamic environment. The end of the Cold War marked the starting point of an American security dilemma at the turn of the century. With no clear rival in sight, the United States expedited efforts to downsize its military forces in the 1990s. Some wrote of the end of history, inferring that mankind had reached the pinnacle of ideological evolution since the largest threat to the democratic principals of the United States had collapsed and left the U.S. as the world's lone super-power (Fukuyama 1989).

The relentless influence of the Soviet Union upon the nation, its defense posture and its national security strategy had vanished. The driving force behind decades of military

modernization and transformation no longer existed. At the beginning of the early 1990s, the U.S. was in the midst of fighting a very different war in Desert Storm. This war showcased what would be considered the new manner of warfare, involving precision strike capabilities used in conjunction with real-time information exchange, a crude version of net-centric warfare. However, there was still much to be learned and many additional advancements to be made. The Gulf War was but a glimpse of the technological capabilities that will continue to reshape warfare in the twenty-first century. The fact that this transformation occurred nearly in tandem with the end of the Cold War, the reduction in military forces, and a redistribution of power within the international environment made foresight particularly difficult (Kipp 1995).

Following Operation Desert Storm, powerful environmental forces began to influence policy makers as they anticipated an age of change. These included the accelerating information technology revolution, globalization, and the potential threat of terrorism. *The Bottom-up Review* of 1993 offered new guidance on the changing security environment, presenting the observation that an “Era of New Dangers” was upon the United States. The dangers of concern were listed as: 1) dangers posed by nuclear weapons and other weapons of mass destruction, 2) regional dangers, such as large-scale aggression by regional powers or conflicts based on ethnic or religious animosities, 3) dangers to democracy and reform, and 4) economic dangers to American National Security (Aspin).

The 1997 *Quadrennial Defense Review (QDR)* offered expanded analysis on the transformation of the security environment. This *QDR* characterized four areas of concern similar to those presented by the *Bottom-up Review* of 1993, including: 1) regional dangers such as coercion and large-scale, cross-border aggression in places such as Iraq, Iran and Southwest Asia; 2) the proliferation of advanced weapons technologies and dual-use technology in addition to nuclear, biological and chemical weapons threats; 3) transnational risks such as terrorists who will directly threaten the lives of Americans and undermine U.S. alliances and interests; 4) various risks to homeland security, such as weapons of mass destruction, terrorism and information based warfare (United States

Department of Defense 1997). This document provided specific insight on terrorism threats and declared the U.S. homeland a potential site of terrorism.

On September 11, 2001, previous analyses of the changing threat landscape for the U.S. had rung true. The events of that day created a new urgency for America's defense establishment and laid the foundation for the adjustment of the DoD to the new global security environment. This adjustment proved especially vital as the threats now addressed by the DoD were vastly different than the ones it faced during the previous five decades (Freier 2007). While previous reports had highlighted these differences in the security environment, the events of 9/11 provided a much-needed catalyst for reform.

The DoD's 2001 *QDR* reiterated concerns from previous DoD reviews. It also added insight to new challenges the United States would face in the post 9/11 era, including: increasing threats emanating from the terrorists based in weak and failing states, a diffusion of power and military capabilities to non-state actors, increasing unpredictability to the locations of conflict and increasing potential for miscalculation and surprise.

This new security environment continues to pose unique operational challenges, proving difficult for a Cold War-designed military to respond to. Recently, it has been the presence and strength of America's armed forces which has allowed for peace in some of the most important and dangerous places in the world. However, as the threats and enemies to be faced by the United States continue to change, so too must its forces. A military structured to deter Cold War-era armies must be altered to overcome many new operational challenges and be capable of responding to uncertain enemies and tactics (The President of the United States 2006).

Figure 1 illustrates two important points relating to the changing face of U.S. military operations in the twenty-first century. First, present security requirements demand the U.S. military be able to respond to disruptive, catastrophic, irregular and traditional challenges. Second, it demonstrates the current allocation of capabilities within the U.S. military's portfolio, illustrates the direction the Department is shifting its portfolio of capabilities to meet the new challenges, and highlights how far it is from adequately

responding to them. It is the combination of responding to the new operational challenges, while successfully bridging the gap between present capabilities and future requirements that must be addressed immediately.

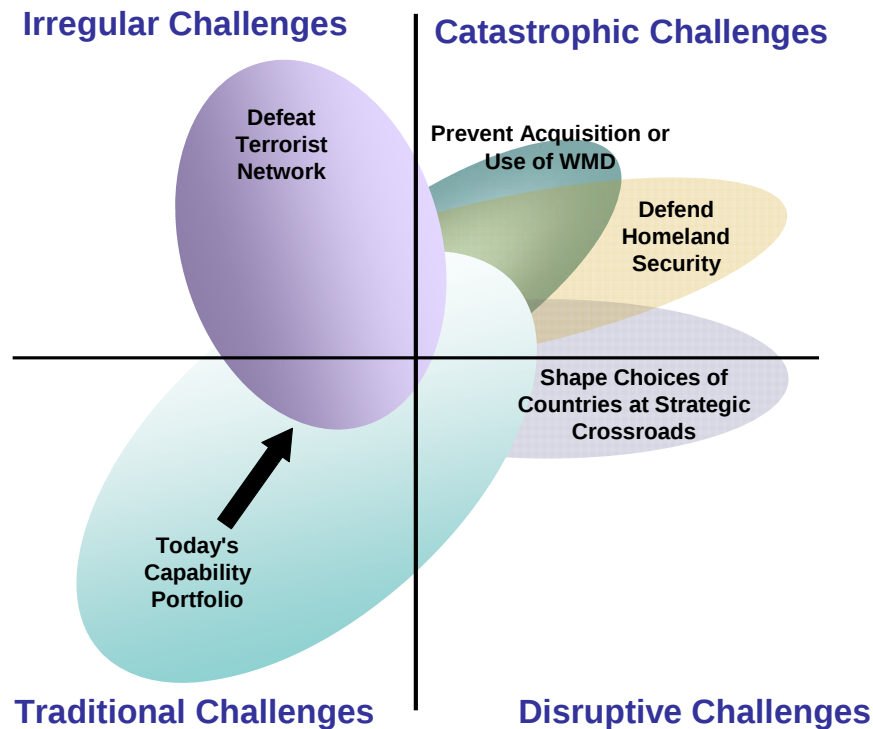


Figure 1. Operational Challenges from QDR 2006. (United States Department of Defense 2006b)

A Revolution in Military Affairs

A Revolution in Military Affairs (RMA) occurs when a nation's military seizes an opportunity to transform its strategy, military doctrine, training, education, organization, equipment, operations, and tactics to achieve decisive military results in fundamentally new ways.

William S. Cohen
Secretary of Defense (Cohen 1999)

While it is undeniable that changes in the security environment have occurred, the necessary responses to those changes are heavily debated. The DoD's previous military

strategy employed during the Cold War used a threat-based planning approach. This approach was hinged on the assumption that the United States would face either: a single adversary, the Soviet Union, and would need the totality of its forces to respond to that threat; or, one or two “major theatre conflicts” (i.e., in Korea and/or Iraq). In short, the United States believed it had identified its opponent(s), knew how it (or they) would fight, and what the appropriate response should be.

In contrast, the current capabilities-based approach provides the U.S. military with the flexibility to adapt and respond to various threats, independent of specific adversaries. The new strategy demands that the military maintain a high state of readiness, retain diverse capabilities, and be very responsive. These new requirements, in conjunction with advances in warfighting developed within the past two decades, are often referred to as a “revolution in military affairs” (RMA).

The current RMA is often defined as containing five components: 1) the ability to strike with great accuracy, independent of range; 2) the ability, through the use of stealth, to penetrate defenses with impunity; 3) the emergence of unmanned warfare; 4) the tactical and operational exploitation of space; 5) and the ability to move information rapidly and widely across a joint battle network, and to exploit the effects of increased joint force integration (Vickers 2004).

The creation of an effective national security infrastructure is vital for U.S. military success in the twenty-first century. This infrastructure must be able to respond quickly to changing operational challenges, while providing maximum flexibility to decision-makers. Numerous government and industry studies and reports have documented the need for change. In their 1999 report, the United States Commission on National Security in the Twenty-First Century forecast that the type of conflict the U.S. would be engaged in at the turn of the century would require sustainable military capabilities characterized by stealth, speed, range, unprecedented accuracy, lethality, strategic mobility, superior intelligence, and the overall will and ability to prevail. The report noted that in order to achieve these capabilities, the U.S would need to maintain technological superiority—in spite of the unavoidable tension between the acquisition of

advanced capabilities and the maintenance of current capabilities. In addition, it was recommended that considerable changes in non-military national capabilities would be needed, which would also likely lead to difficult organizational and budgetary choices (United States Commission on National Security and the 21st Century 1999).

It is this “unavoidable tension between acquisition of advanced capabilities and maintenance of current capabilities” described above that is at the heart of the current predicament. Events such as Desert Storm, Operation Iraqi Freedom (OIF), and Operation Enduring Freedom (OEF) are but a few examples of the external stressors that have influenced the present pace and direction of military transformation taking place within the DoD. These have placed external pressures on the ability of the Department to maintain current capabilities and to acquire new ones.

The combination of these internal and external pressures has created an interesting and critical policy challenge. What actions should the government take to help shape the DIB to meet the new military requirements essential to maintaining security in the twenty-first century? In short, the response requires a deep-rooted transformation of both the DoD and the DIB.

The Defense Industrial Base

The term “defense industrial base” is thrown around loosely to refer to infrastructure and resources required to produce or acquire assets related to national defense. Often, the terms defense industrial base, military industrial base, and defense industrial structure are used interchangeably. While there are no significant differences between these terms, it is important to note the varying language used to describe this concept and its impact on the assessment in the pages to follow.

The Deputy Under Secretary of Defense for Industrial Policy defined (in 2007) the defense industrial base as “the Department of Defense, U.S. Government, and private sector worldwide industrial complex with capabilities to provide professional services, perform research and development, produce, deliver, and maintain Defense systems,

subsystems, or components to meet military requirements necessary to fulfill the National Military Strategy” (Krieg 2007).

Another definition states:

America’s [DIB] is comprised of the private-sector (both privately and publicly owned) and government-owned entities, located in the U.S. and globally, that provide the full array of goods and services required by the armed forces of the United States and select allies. The military industrial base is essential to national security. The means to forge, deploy, sustain, and maintain fighting forces have been and remain the lifeblood of war. A secure industrial base is a prerequisite for conducting prompt and sustained military operations. (Spencer 2005)

One author more generally defines the DIB as “those industrial assets which provide key elements of military power and national security: such assets demand special consideration by government” (Hartley 2007).

While each of these definitions provides a basic description of the concept, creating an all-encompassing definition of the DIB has become increasingly difficult because of the complex dependencies and relationships that exist within its structure. At the same time, globalization has yielded an industry that relies on its global supplier base to provide the raw materials and components it needs. The definition of DIB has broadened in scope as a result.

Changes have also taken place regarding the defense industry and its relationship with the government. Due to the drop in defense budgets of the early 1990s, a consolidation of the defense industry occurred, shrinking dozens of defense firms into the handful of large defense firms that exist today. These same changing requirements and budgetary pressures have forced the need for an examination of government monopoly provision of many defense services. Strategies such as “competitive sourcing” (i.e. public/private competitions) and privatization have been used, with a goal of introducing competition in order to improve performance and reduce costs.

An additional transformation consideration in the DIB is the ever-changing defense budget. Despite increases in spending for national defense and homeland security (for

the Iraq/Afghanistan conflicts), funding at these levels cannot continue indefinitely. It is almost certain that defense budgets of the future will be lower (Walker 2004). Due to this reality, a serious gap exists between future twenty-first century military operational requirements and the present abilities of the DIB.

Organization

Following the “need” discussion in Section One, the argument in this paper (for a transformed DIB) is divided into six sections—each addressing a different aspect related to transforming the present DIB. Section Two examines the question, “What are the factors that have influenced the gap in present capabilities and the demands of the current security environment?” This section will concentrate on the numerous changes that have taken place domestically and abroad that have led to the gap between the DIB and current needs. Some of the issues that will be examined include: the holistic view of security; industrial changes; and the effects of globalization. Section Three addresses assumptions about the state of the future security environment. These assumptions include: the continuation of irregular threats and conflicts, China as a potential peer competitor, domestic economic pressure and declining defense budgets, and continued rapid technology change. Section Four provides guidance for the future, with an examination of the likely future environment and the desired end-state. This section answers the question, “What should the future DIB look like?” Several recommendations are provided that should be implemented in order to ensure that the DIB is properly prepared to support twenty-first century operations. Section Five gives a summary of the barriers to successfully transforming the defense industry, which include: policies, processes and management of the defense enterprise; the DoD workforce; and the “mature industry” model. Section Six offers specific guidance on overcoming these challenges, as well as actions that should be taken to attain the broad and specific twenty-first-century DIB goals previously outlined. Finally, Section Seven concludes with a summary of the topics discussed and makes note of the most important considerations for implementation.

Numerous changes have occurred which influence the reorientation of the international security environment. These alterations range from psychological changes (such as how security is viewed in the world), to technological changes (such as the development of net-centric warfare), to strategic changes such as the introduction of new security missions. Some of these influences are a function of the modernization of society and the increased complexity within the global system, while others have occurred due to political shifts and changes in the worldwide economy. The adaptations that have occurred in response to the end of the Cold War are an enormous force of change around the world. It is under these conditions that the United States must modernize its military and its Defense Industrial Base to respond to the security needs in the twenty-first century.

II. Current Environmental Conditions

Holistic View of Security

America's political, economic and national security interests are highly complex, with challenges that are large in scope, not isolated to a specific region or opponent (global), and often inter-related. As a result, the United States is increasingly facing uncertain threats—from undetermined weapons and delivery systems, to undetermined targets, from often-undetermined entities, at undetermined times (Perl 2006). The pressure to become secure against all potential threats has arisen because of these new complexities, facilitating the rise of a holistic view of security. These new challenges include:

- **Global terrorism.** One change shaping how policy makers view national security today is the shift from relatively predictable and definable threats of the past to the more complex and indeterminable threats of today. Global terrorism can be nationally inspired or come from non-national actors, such as Al Qaeda, Hezbollah, and other extremists groups. Some of these transnational groups are very well funded and have access to advanced weapons on the international market. Their goals can be fairly narrow, such as the overthrow of legitimate regimes, or very broad, such as the establishment of a regional “caliphate.” Terrorist groups most often target innocent citizens, both at home and abroad. One of the greatest fears is that they will acquire and use weapons of mass destruction (biological, chemical, radiological, or nuclear). While statistics from both the Federal government and research organizations (such as RAND, and the University of Maryland's “START” Center on Terrorism) vary widely in their accounting of terrorist attacks, the consensus is that, since 9/11, the number of events have rapidly increased each year.
- **Regional conflicts.** There are several current examples, which include the U.S.'s Global war on Terror, with large-scale operations in Iraq and Afghanistan, as well as Israel's conflict with Hezbollah in Lebanon in 2006. These can be fought against national governments and/or groups of insurgents.

- **Potential, future peer competitors.** The most frequently identified is Mainland China, but others, such as India or even a resurgent Russia, should be considered. However, it is important to note that there is no current “peer” to the overwhelming strength of the U.S. military establishment.
- **Proliferation of weapons of mass destruction (WMD).** The proliferation of WMD (chemical, biological, radiological, and nuclear weapons)—as well as their delivery systems—increases the possibility of their use, with the resultant significant casualties. Many countries already possess WMD, or have the capacity to produce them. In addition, an increasing number of countries are in the process of acquiring and developing these capabilities. There is a growing interest among certain terrorist groups in acquiring such weapons.
- **“Rogue” nuclear states.** These states, such as North Korea and Iran, have or will soon have nuclear weapons and long-range missile delivery capability. Additionally, their leaders cannot be counted on as “rational actors,” in the opinion of most political and security officials. These individuals have demonstrated questionable moral positions—including a willingness to sacrifice large numbers of their own people. These “rogue” nations are often supported by larger states, requiring additional consideration about the complex integration of their politics, economies and militaries.
- **Non-traditional national security challenges.** There is a real possibility of devastating global pandemics (for example, outbreaks of infectious disease such as Avian flu) that can spread quickly and overwhelm national health care systems. Second, the increasing global demand for energy can cause a crisis, based on the limited supply of oil. Third, it is also foreseeable that there may be other crises over access to other critical natural resources, such as drinking water. Finally, global environmental degradations, particularly regarding the atmosphere, will negatively affect national security when viewed in this broader context.

As a result of the change in the perception of what it means to have security, the newly formed holistic view of security makes the crafting of a DIB policy very challenging.

One consideration to note is the view of the DIB from above. In other words, in what context is the DIB being examined? In this case, it is within the context of the national security strategy and the applicable economic and military components that one should focus on—i.e., a holistic, integrated national strategy for the United States. But what does this mean? A national strategy, in its truest sense, would include foreign, economic, diplomatic, military, education, and energy policies. These and other factors would be used to create a unified, holistic vision of who we are and what we need to become in the future.

The DIB had previously evolved and matured under the view of security that existed in the bi-polar world of the Cold War. This new, holistic view of national security, combined with twenty-first century threats, will require a more flexible and adaptive DIB. The DoD must work to ensure that an infrastructure exists which is capable of supporting American national security efforts within the context of the future fiscal and political atmosphere. Unfortunately, political and budgetary restrictions often keep the national leaders from thinking ahead in such a broad, long-term manner, making it difficult for them to develop a rational strategy for structuring the future DIB (Thompson 2006).

The holistic view of security has also resulted in demands for military involvement in new missions. Homeland defense, missile defense, stability and reconstruction, cybersecurity, and non-kinetic operations are just some examples of the new missions being taken on by the DoD. Historically, many of the new missions faced by the DoD were all considered to be outside the operational scope of a Cold-War-based military. Increasing requirements for humanitarian assistance, disaster relief, drug interdiction, border patrol, containment of regional hegemony, and nation building are now issues that have garnered the need for military involvement. These missions have raised many questions about the appropriate roles of military intervention. Because of the significant political, economic, humanitarian, cultural, and social dimensions of these problems, a twenty-first century military must be capable of responding to a wide range of crises when called upon.

New DoD missions have been aptly summarized in Figure 2. This figure outlines three interests the United States is concerned about for the future: Survival Interests, Vital Interests and Value Interests. These new mission requirements have added another burden upon the existing DoD infrastructure and will require a significant investment to ensure that resources are available to successfully carry out such missions.

Survival Interests	Vital Interests	Value Interests
Missions:	Missions:	Missions:
Survival of the Nation	Defense of Treaty Allies	Prevent Internal Conflict or Peacemaking
Territorial Integrity	Defense of Democratic and Pivot States	Peace Operations
Economic Security	Deter or Win Regional Conflicts	

Figure 2. National Security Interests and Political Objectives.
(Binnendijk 2002)

Determining the appropriate balance of resources and effort between these new missions will be difficult. The additional burden of internal problems, such as homeland defense, missile defense and cybersecurity, are likely to drain resources and shift attention from traditional external threats. The multidimensional nature of these problems further serves to cloud focus within the DIB. These new missions, in conjunction with the holistic view of security, have added an additional pressure to the already-stressed budgetary environment.

Intelligence Changes

The role of the intelligence community in the United States will be vastly different in the twenty-first century. Many advances in technology, in combination with changes in military missions and warfighting strategy, have put pressure on intelligence agencies to reform their operations. Operational requirements now include a push for fused data, an increased reliance on open-source intelligence, and the capability of real-time intelligence flow between soldiers, tactical and strategic sensors, and the command structure. At the

same time, there has been a renewed emphasis on the importance of language capabilities and cultural research and analysis—based on a newfound focus on the analytical examination of America’s opponents and allies.

Following the attacks of 9/11, the revised *National Security Strategy of 2002* called for improved intelligence warning and analysis to provide integrated threat assessments for national and homeland security (The President of the United States 2002). The primary role of intelligence in the United States has changed tremendously as a result. The first national intelligence strategy declares the number one mission objective of the intelligence community to be defeating terrorists at home and abroad (United States Office of the Director of National Intelligence 2005).

Unpredictability

The unpredictability of the future adds an additional dynamic of complexity to the reorientation of the international security environment. In the bi-polar Cold War, actions were perceived to be relatively predictable; the list of potential actions and responses were limited. In the new security environment, both actions and their actors are unpredictable.

Between 1961 and 1990, many within and outside the DoD believed the principal challenge of defense planning to be sizing the force: How many tanks? How many men? How many planes? How many ships? As a result, planning was based upon perception of the threat, which was formerly the Soviet Union. The logic of this thinking was that if the United States has enough firepower to respond to its greatest potential threat, it should be well suited to deal with any lesser opponents (Davis Winter 1996).

In the twenty-first century, the concerns of unpredictability have been multiplied by the changes in warfighting strategy and missions being required of the military. The capabilities-based planning approach was introduced as a result. This planning is based on the notion of preparing a military (with tailored characteristics) to carry out various missions—instead of building a force focused on responding to the threats of a specific opponent. Both the threats and the enemies the U.S. will confront in the twenty-first

century have changed; and, in response, American forces must change as well. The military structure of the Cold War, which sought to deter Cold War-era armies, emphasized preparation for fighting predictable opponents at specific locations. It must now be adept at transforming its tactics based upon how a potential adversary might fight (President of the United States 2006).

To meet the demands of creating a capabilities-based force, innovation in the armed forces will rest upon experimentation with new approaches to warfare—taking full advantage of science and technology (President of the United States 2006). But the transformation and adaptation envisioned will be difficult to achieve. DoD business practices and the congressional budgetary processes have not yet evolved to meet the changing demands on the American military. The evolution to capabilities-based planning within the DoD has neither been efficient nor effective.

Industrial Changes

In the aftermath of the large defense budget cuts in the first half of the 1990s, the DoD recognized that projected defense spending would not be able to sustain the existing industrial base. At a meeting that came to be known as the “last supper,” then-Deputy Secretary of Defense William Perry informed defense CEOs and industry executives that declining defense spending required consolidation. The position of the DoD was to strongly encourage mergers and acquisitions by agreeing to reimburse firms for the costs of such activities; with the condition clearly stated that the mergers and acquisitions must still allow for competition in all critical defense sectors and that the result of the activity would realize savings for the DoD. Today, following the widespread consolidation, only five of fifty major contractors from 1990 remain in business (see Figure 3; and note that BAE Systems was only a prime contractor in the U.K. in 1990); in addition, the defense industry has gotten significantly smaller relative to the size of the overall economy (Binnendijk 2002). As explained by former Lockheed Martin CEO Norman Augustine, the result of the consolidation effort has been advantageous for both the government and industry:

The bottom line is that consolidation also worked: Lockheed Martin alone has saved the government over \$3 billion per year by its consolidation actions, about equal to the savings from a single BRAC [Base Realignment and Closure]. Other firms in the industry have produced corresponding savings. Today, the industry is stronger than it would have been absent consolidation, albeit not without major challenges remaining.

Norman R. Augustine
Defense News, June 26, 2006 (Augustine 2006)

The consolidation increased the efficiency of the surviving firms through combined operations such as sales, purchasing, and overhead allocations, allowing for significant cost savings and removal of risk (Malburg 2000). Industry consolidation has successfully continued to this day through vertical integration, the process by which companies seek to buy upstream suppliers and downstream buyers for the purpose of satisfying a common need. Vertical integration has become prevalent as a new measure for cutting costs and increasing efficiency. In the defense industry, this generally occurs when the prime contractors acquire upstream suppliers to reduce transaction costs and maximize profits. However, these benefits generally require the continuation of competition, at both the prime and lower-tier levels.

In some cases, the consolidation has created a monopoly for those with the expertise and infrastructure to operate within the government procurement system and to provide the needed support (Davis 1996). Furthermore, industry's internal relationships are becoming increasingly important, as inter-departmental, inter-agency and international projects will be commonplace in future integrated-warfare environments. Finally, additional restrictions, specifically those aimed at controlling imports and exports for members of the DIB, have also hindered the ability of the DoD to experience the advantages promised by globalization in the twenty-first century.

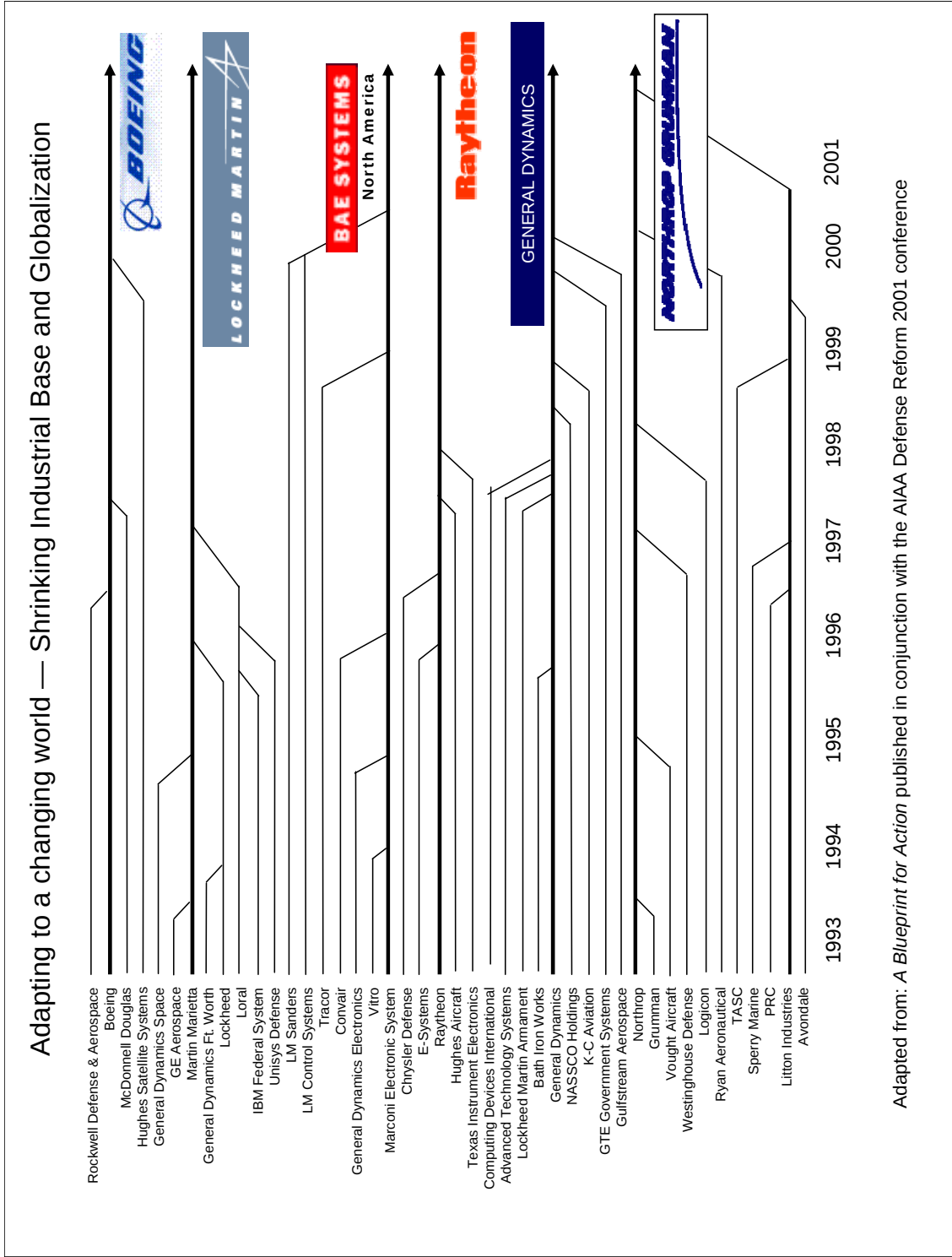


Figure 3. Defense Industry Consolidation

Globalization

The conclusion of the Cold War eased the great pressure against global trade that had been part of the protracted struggle between the Soviet Union and the West. Absent that pressure, trade is less constrained, thus providing the opportunity for economic advantages to be gained by all parties. The “age of globalization” has helped in developing countless diplomatic, economic and security-based relationships. There has been a steady increase in the influence of globalization as a part of the private, commercial and national security activities of the United States. “Globalization” is defined here as a movement toward a marketplace for products in a global context, served by a global industrial base for producing those products.

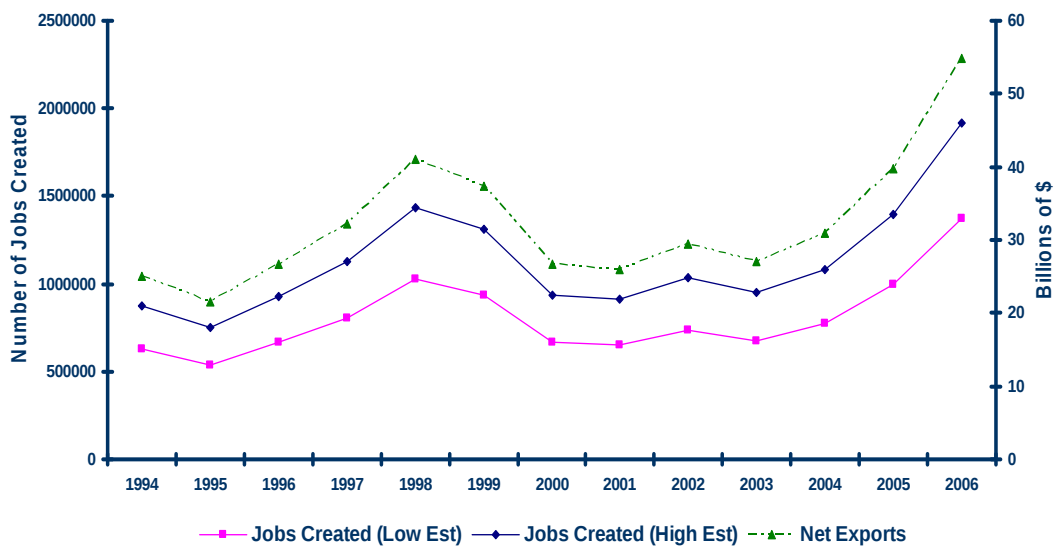
In parallel, advances in information technology and the proliferation of related products have given a large portion of the world’s population access to information. This phenomenon has stimulated innovation throughout the world by making knowledge available, allowing individuals to research, develop, construct and sell goods and services and to gain an understanding of the rewards available to those who engage in these practices. These circumstances have led to a monumental increase in economic activity across the developed world. From 1989 to 2005, the world gross domestic product (GDP) increased from \$17.4 trillion to \$40.9 trillion, and the U.S. GDP increased from \$5 trillion to \$11.7 trillion (World Bank 2005).

These globalization trends have enabled corporations to reap the benefits from the exchange of products, ideas, and information, along with the resultant increases in trade. This has given rise to many new markets, particularly for new IT products, services, and their producers in many countries. Corporate growth has vastly increased the number of consumer products while decreasing their cost, and has broadened the base for economic growth in most parts of the world (National Research Council of the National Academies 2003).

The effects of globalization can be seen as positively impacting the state of the defense industry. We believe that as a result of globalization, the defense industry is able to

achieve better performance through innovation, collaboration, and information sharing, while enabling the benefits of competitive pressure within the reduced set of prime and lower-tier contractors. In addition, globalization has allowed for lower costs via economies of scale, cheaper labor, access to new manufacturing methods, and even domestic job creation in defense-related industries (see Figure 4). Recent reports indicate that a substantial reliance solely on foreign sources does not exist for U.S. defense contractors (Office of the Deputy Under Secretary of Defense for Industrial Policy 2004). Numerous examples can be cited to emphasize the relationships now being forged in the name of advancing both military programs and allied relationships. For instance, the Army's Abrams tank uses a German cannon and British armor technology, and the Army's Striker armored vehicle is based on a Swiss design. The Army, however, is not the only service to utilize foreign resources to further a program. Lockheed Martin and

Jobs Created by Net Exports in Aerospace and Defense



Jobs Created at a rate of approx 25,000 per \$1B (Low Est.) and 35,000 per \$1B (High Est.)

Source: Aerospace Industry Association <http://www.aia-aerospace.org/stats/stats.cfm>

Figure 4. Jobs Created by Net Exports in Aerospace and Defense.

General Dynamics, the designers of the Navy's Littoral Combat Ship (LCS), turned to overseas partners in Europe and Australia to shorten development times by leveraging existing commercial designs.

However, it must be noted that the advantages afforded by globalization do come with risk. Globalization has provided potential adversaries with increased access to sophisticated technologies and sensitive information. As a result, insurgents in Iraq use cellular phone technology to trigger roadside bombs, and Al-Qaida cells in Afghanistan can use the Internet to provide secure communications and access to satellite imagery. These are but two examples of negative impacts caused by the diffusion of low-cost, advanced technology via globalization.

As a result of this trend toward globalization, it can be concluded that no state can support an efficient defense industry in isolation. The economic realities of the world have created an environment in which firms must take advantage of the market to get access to affordable materials and technology, as well as the potential market for their exports in reaction to lack of demand at home (Farkas 2006). From a DIB perspective, the impact of globalization can become significant if the line between foreign and domestic policy becomes distorted and can no longer be distinguished; but, an overprotective, autarkic policy can be equally, or even more, dangerous. It is a balance between the costs and benefits of globalization that must be realized.

Recent "Scandals"

Several recent "procurement scandals" have rocked the DoD and the world of Government contracting. While well-known examples, such as Darleen Druyun, Congressman Randy "Duke" Cunningham, and Jack Abramoff (see below) represent only three such occasions of impropriety in the business of defense, the impact they have had on both Congress and the Executive branch remains significant.

Although the vast majority of personnel involved with DoD acquisitions operate with the highest level of integrity, positions of power are always vulnerable to abuse. In recent years, there have been several high-profile scandals in which individuals took unethical

and illegal actions to profit at the expense of the taxpayers. Darleen Druyun, a senior Air Force civilian employee in charge of procurement, used her position to award contracts to Boeing Corporation in order to leverage job opportunities for herself and family members (CBS News 2005). Representative Randy “Duke” Cunningham (R-CA) was a member of Congress who took over \$2 million in bribes from contractors who wanted him to influence the DoD (Henry 2005). David Safavian, Administrator for Federal Procurement Policy at the Office of Management and Budget, was responsible for procurement policy for the entire federal government. In his previous assignment, as the General Services Administration’s Chief of Staff, Safavian used his connections to illegally aid Jack Abramoff, the D.C. lobbyist convicted of fraud, in purchasing property (Washington Post 2007).

Each of these scandals helped to create a political environment that is not conducive to bolstering public support for government officials to be working cooperatively with the private sector components of the DIB. While the scandals mentioned above are isolated extremes, they have painted a picture of lies and deception between the public and private sectors of the contracting community. A lack of political support makes addressing the needs of the DIB through Congress a difficult task, and perhaps politically unfeasible until the fallout from these incidents is over. It can be concluded that perhaps the government is not strict enough on poor performance by defense contractors who are misleading in their reports, fail to live up to appropriate ethical standards, or do not demonstrate business integrity and honesty (Gansler 1995). The recent scandals only exacerbate this feeling among the general public and government, and make it much more difficult to bolster public and congressional support for the needed defense industry transformation.

III. Assumptions about the Future Environment

Previous sections of this paper examined the environmental changes that have taken place, as well as the impact of these changes on the present organizational structure, policies and practices of the DIB. An understanding of the future environment is required to appropriately assess the desired character of the mid-twenty first century DIB, as well as effective implementation methods. Our assumptions for the coming decades include: a continued trend toward irregular threats and diverse conflicts; domestic economic constraints, and likely declining defense budgets; and rapid changes in technology. This section will explore these assumptions about the future security environment.

Warfighting Changes—Irregular and Diverse Threats and Conflicts

The Prussian philosopher of war, Carl von Clausewitz, posited that war has two natures: the “objective” and the “subjective”; i.e., war is both constant and changing. The objective nature includes those qualities that do not change, such as danger, exertion, uncertainty, chance, fluidity, and friction. Conversely, the subjective nature refers to those qualities that change over time and from war to war. This includes the kinds of forces used and the weapons and tactics employed (Clausewitz 1950). We believe that in the future, the subjective nature of war will continue to alter combat situations and to make their outcomes difficult to predict.

However, there is a possibility that a peer competitor may emerge, resulting in a Cold-War-like tension (many think that it will be China, but we do not believe that is inevitable). The Chinese question mark (covered in more detail below), the emergence of India as a counterweight in Asia, and the future of democracy in Russia, all create uncertainty for U.S. planning. As in the past, today’s friends may be tomorrow’s adversaries. Despite these factors, the risk of interstate war appears to be low for the foreseeable future.

The threats that are considered more likely have been described as “irregular.” The term irregular is used in a very broad sense; it refers to all types of unconventional methods of

violence and includes acts of a military, political, psychological, and economic nature. The objective of these acts is to influence either the local government or an external power (USMC 2006).

The emergence of irregular threats, along with the rapid diffusion of technology, will create an opportunity for the non-traditional adversaries of the U.S. to offset conventional American military dominance. Although the military has acknowledged the emergence of these asymmetric and irregular challenges, their diverse nature creates unpredictability. Offsetting this unpredictability requires a military and a supporting DIB—capable of rapidly adapting to change, while meeting an extreme range of operational demands.

While some believe that the current state of international affairs allow for an educated prediction of what is to come, the present environment demands that the United States continue to prepare itself to respond to a wide range of threats from enemies known and unknown (Betts 2005). However, as the U.S. transforms its forces and the DIB, it must be aware that the battles it fights today may be entirely different than those it will fight in a few decades or even a few years.

On one hand, the DoD must maintain its traditional military dominance; on the other, it must adjust to the rapidly changing security environment (Murdock 2004). It is the balance between the rapid change required by the recent shifts in warfighting, and the ability to rapidly develop and field technologically sophisticated systems, that will prove difficult for the DIB. Finite resources must be invested wisely to balance maintaining current capabilities and sustaining operations while modernizing for the future.

Instead, we contemplate the brewing threats of "Perfect Storms" of failed governments, ethnic stratification, religious violence, humanitarian disasters, stateless militants, apocalyptic terrorists, cataclysmic regional crises, and the proliferation of dangerous weapons. While we keep our eyes on possible peer or near-peer competitors, our security attentions are more frequently drawn to the dynamics of threats produced by lagging economies, unintegrated and disenfranchised populations, transnational crime, illicit sub-national power structures, poorly or ungoverned spaces, and destabilizing bulges of uneducated and unemployed youth.

History tells us, of course, that it is particularly hard to predict how this mix of conventional and unconventional challenges will manifest themselves at particular points in time...a blurring of the lines, as it were, between the categories of combat, the one representing a form of warfare for which we are supremely capable, and the other whose complexities we are still learning.

Dr. John Hillen, Assistant Secretary for Political-Military Affairs (Hillen 2005)

China—Potential Peer Competitor

Of all the United States' potential external threats which can be labeled more traditional in nature, China appears to be the most prominent. Currently, the trajectory of the U.S.'s future relationship with China is one of the largest question marks in the U.S. diplomatic community. The probable relationship between the United States and China is liable to be complex and multifaceted. The U.S. and China may find themselves to be economic competitors, global partners, or adversaries, at any time.

The future of the U.S./Chinese relationship is difficult to assess—partly because China has not overtly made any major declarations regarding its intentions, ambitions or grand strategy. It is likely that vagueness is a deliberate effort by the Chinese to conceal the true focus of its strategic planning, as well as any internal disagreements that may exist about its long-term strategy. One guiding principle of the Chinese strategy, referred to as the “Twenty Four Character Strategy,” translates as “observe calmly; secure our position; cope with affairs calmly; hide our capacities and bide our time; be good at maintaining a low profile; and never claim leadership” (Office of the United States Secretary of Defense 2007a). The ambiguity in this strategy is no coincidence; as a result, the true intentions behind this approach are not known. However, using Chinese defense expenditures as an indication of its future military plans may be insightful. From 1998 through 2007, Chinese defense expenditures, as published, will have quadrupled in size. While the Chinese budget of some \$45 billion still pales in comparison to that of the United States, the remarkable increase in expenditures over such a short period must be noted. Continued increases in spending, along with decreasing costs of high-technology, should give China the basis it needs to construct a modern military. Among chief concerns are when this effort will be completed and how the new capabilities will be used (Tellis 2005). The Pentagon must integrate the capability to respond to Chinese military modernization with its efforts to effectively respond to a diverse range of threats and missions. Of course, as China grows as an economic power, it is only natural that it would build its security infrastructure (including its defense capability). This infrastructure need not be used for expansionism, and that must be a major objective for

future U.S. foreign policy (for example, establishing partnerships with China in such as terrorism, energy, environment, etc.).

The question of China's future intentions has a tremendous effect on the DIB for two reasons. First, the ability of U.S. firms to take advantage of the benefits of globalization is severely limited by the fear that defense-related items outsourced to China may be produced by a future opponent of the United States. The private sector has shifted much of its industrial production offshore, along with some of its technical design capability, research, and development. For example, 65% of the labor content of the Boeing 787 will be foreign, with major airframe components—e.g., (the composite aircraft rudder)—being built in China. When considering China's growing position within the technology supply chain, the prospect emerges of future dependency on China for certain items critical to U.S. technological development (United States/China Economic Security Review Commission 2005).

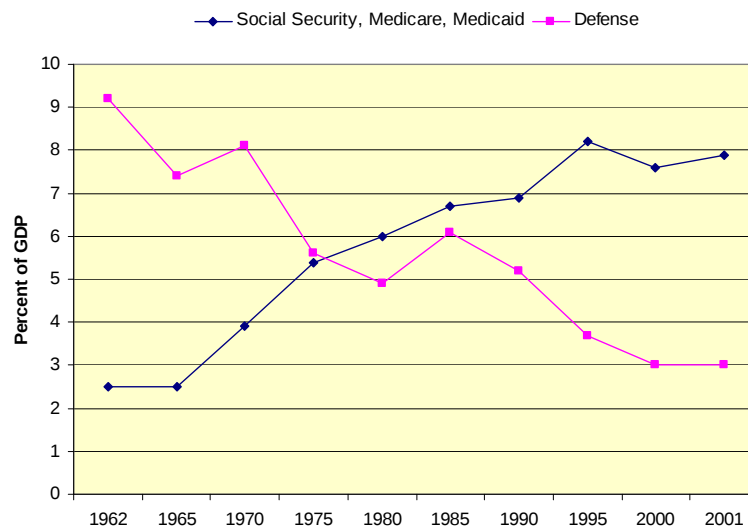
Secondly, a poorly managed relationship with prosperous and powerful China could allow for the reemergence of Cold War-type tensions. This would obviously weigh heavy on DIB planning. On one hand, the DIB must be modernized to respond to the rapid changes in technology and the diverse and irregular threats the United States will continue to face in the twenty-first century. On the other hand, the DIB may also need the necessary infrastructure to support the potential build-up of conventional forces needed to offset a rising China, much like the Cold War style build-up of the twentieth century.

China's economic and political potential only complicate the DIB transformation; however, this reinforces the need for reliable intelligence, which would provide the necessary lead-time to make the required changes.

Domestic Budgetary Outlook

The United States faces several long-term budgetary challenges. These challenges, and the impact they will have on the domestic economy, will directly contribute to the ability of the DoD to transform for the twenty-first century. The U.S. will have a rapidly increasing financial burden as baby boomers age (by 2020, the number of people in the

U.S. population between the ages of 65-84 is expected to rise by nearly 50% (United States Census Bureau 2004)), and mandatory spending on programs such as Social Security and Medicare will undoubtedly increase. By 2017, the annual growth rate of Social Security spending is expected to rise from 4.5% to 6.5%—while Medicare and Medicaid are projected to grow in the range of 7 to 8% annually (United States Congress: Congressional Budget Office 2007). Spending on these programs is directly tied to rising cost-of-living and healthcare costs in the United States; and, as depicted in Figure 5, it has outpaced defense spending as a percent of the GDP. Although defense spending has been increased since the Cold War drawdown, it is nowhere near historic record levels as a percent of the GDP.

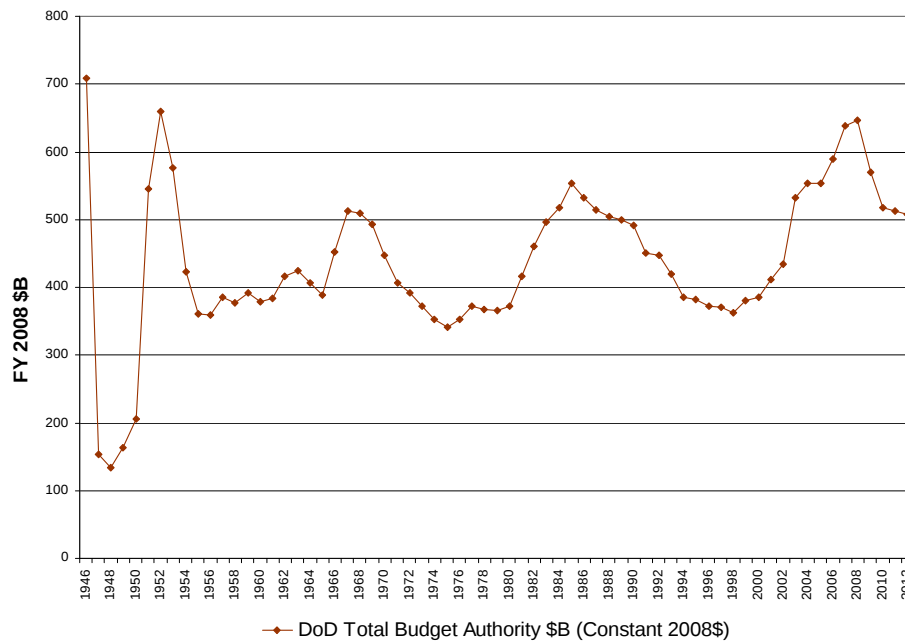


Source: CBO's Long Range Fiscal Policy Brief July 3, 2002

Figure 5. Defense and Selected Entitlement Spending as a Percent of the GDP.

Additionally, the DoD has come to rely on “supplemental” funding, which will likely be ceased or significantly reduced as early as FY 2009. This is due to the weary attitudes of Congress and the general public toward the war in Iraq. Finally, given the rising costs of military personnel compensation, annual health care, and facilities programs, it is clear that a sizable portion of “defense discretionary” spending is not available to be spent

freely, as it is already earmarked for future requirements (Defense Science Board Task Force 2005). And even though defense budgets are currently well above the Cold War average (as shown in Figure 6), they will likely decline significantly based on past historic trends.



2007 includes \$93.4 billion supplemental appropriations request.
 2008 includes \$141.7 billion request for GWOT operations.
 2009 includes \$50 billion projected for GWOT operations.

Source: Historical And Projected Funding For Defense: Presentation Of The FY 2008 Request In Tables and Charts By Steven M. Kosiak, CSBA, June 7, 2007

Figure 6. DoD Total Budget Authority (Constant 2008\$). (Kosiak 2007)

The rising costs on mandatory entitlement programs, coupled with the enduring, projected budget deficits, will create an inevitable downward pressure on future DoD budgets. This will serve to constrain the funds available for recapitalization, modernization, and transformation of the military. Future DoD budgets will require hard decisions and will be dependent on a reengineering of processes and the efficient use of resources (as a source of funds for these requirements).

Defense Budget Shifts

"The biggest issue facing the Defense Department will be the mismatch between requirements and funds available."

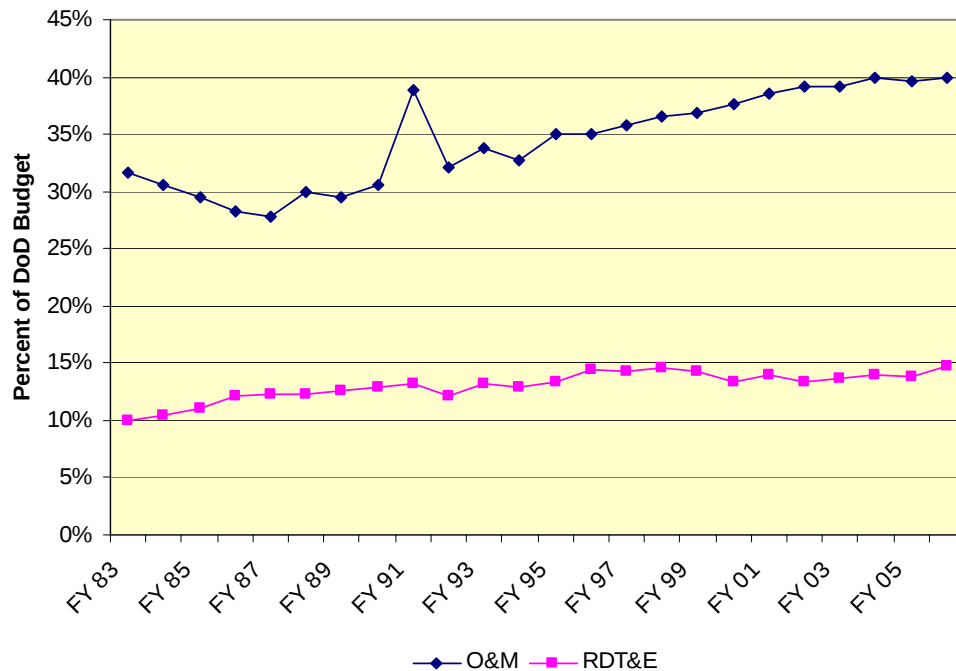
General Charles Krulak
Former Marine Corps Commandant
Grossman, Elaine M. *National Journal*, May 30, 2008
(Grossman 2008)

As new military missions and requirements emerge in response to the evolving security environment, funding for equipment, personnel, operations & maintenance (O&M) and homeland security will be dependent on the crisis of the moment; this fluid environment will make long-term planning difficult.

Currently, operations and support funding represent nearly two-thirds of the DoD budget, while funds dedicated to modernization represent only one third. During the 1980s, operations funding and modernization funding were receiving equal budgetary consideration. In the 1990s, the rapid cost growth seen today in operations and support was kept in balance by a 24% reduction in military manpower (Spring 2007). However, the most recent projections from the Congressional Budget Office show major increases in spending in areas such as personnel and O&M, which are projected to rise 30% and 20% respectively by 2024. At the same time, funds invested in research, development, testing & evaluation (RDT&E) are expected to decline by roughly one-third during the same period—stifling future investment in modernization and stagnating military transformation (Congressional Budget Office 2006).

Historically, funding for research and development (R&D) in the defense industry has come at the expense of production. Defense firms tend to minimize their risk by choosing not to pursue new ideas or applications independent of government support (Gansler 1980). In the present environment, it is likely that the increasing O&M costs for legacy systems—along with the projected rising personnel expenses—will be financed at the expense of future R&D. Defense firms will be required to invest more in their own efforts to discover the next technological breakthrough, without the same level of government assistance that had been previously given. As Figure 7 indicates, spending

for O&M as a percentage of the DoD's budget has been consistently increasing over the past decade, while spending for RDT&E has remained relatively flat.



Source: National Defense Budget Estimates For FY 2007
Office Of The Under Secretary Of Defense (Comptroller) March 2006

Figure 7. O&M and RDT&E as a Percent of the DoD Budget.

Continuing Rapid Technology Change

The consequences of rapid technology change could not be better exemplified than by the findings of Gordon Moore, electronic engineer and co-founder of Intel. In 1965, Moore observed that the complexity of minimum-cost semiconductor components had doubled per year since the first prototype microchip was produced in 1959. He also predicted that the number of transistors per integrated circuit chip would continue to double in each technology generation. This became known as “Moore’s Law.” When he developed this formulation, there were just 30 transistors on an integrated chip (Office of the United States Secretary of Defense 2007b). Over forty years later, the transistor counts exceed a few hundred million for logic chips and even more for memory chips, despite skepticism

that this trend would continue. Some have used Moore’s Law to describe the exponential growth of technology in general (Defense Science Board Task Force 2004).

This trend of accelerating technological change is illustrated in Figure 8, which shows the increasing growth in the number of U.S. patents granted (USPO 2008). This rapid change has had, and will continue to have, crucial impact on the defense industry as the military develops applications based on these new developments in advanced information technologies, quantum computing, nano-technologies, bio-technologies, and robotics.

With the continued influence of globalization on the development of advanced technology, and with the global expansion of industry, many future advancements will take place outside the United States. An understanding of this reality influenced the President, in the *National Security Strategy (NSS)* of 2006, to openly declare that the United States will seek to foster increased cooperation and to build international markets through trade and diffusion of technology. This strategy seeks to provide developing countries with a “leg up” in acquiring low-cost technological advancements key to their development (The President of the United States 2006).

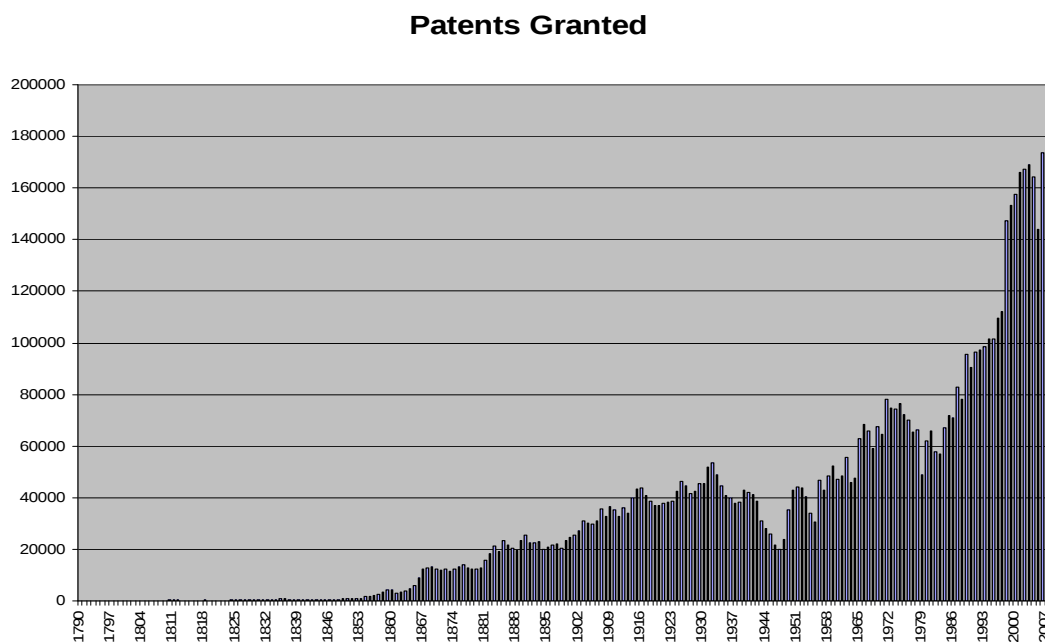
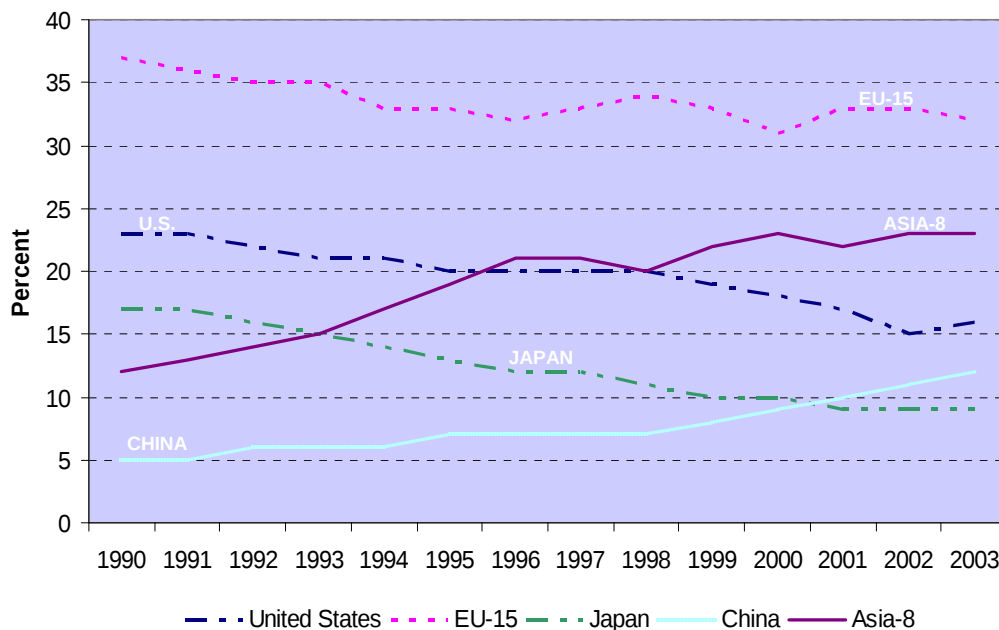


Figure 8. U.S. Patent Activity 1790 to 2007.

As the rate of technological change continues to accelerate, we believe advances in relatively new technologies—such as information technology, biological technology, and nano-technology—will continue to have a profound impact on military operations and on warfighting systems in the future. Additionally, as these technologies improve and become more affordable, countries previously priced-out will be able to acquire “high-tech” advancements. The technological advantage currently enjoyed by the U.S. will likely shrink as a result. The pace of this technological diffusion can be viewed in Figure 9, which indicates respective export market shares of global high-technology, owing to significant growth in China as well as within the Asia-8 since 1990.



Notes:

EU = European Union

Asia-8 includes South Korea, India, Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand.

Source: National Science Board, Science and Engineering Indicators 2006

Figure 9. Export Market Shares in High-technology Goods.

Domestic defense firms are often prohibited from using the best sources of materials (if they are coming from overseas) and restricted from cutting-edge R&D located abroad by

protectionist rules and regulations. Unless drastic changes are made in policies related to foreign sourcing for military technology, U.S. firms will continue to seek cost-cutting advantages via vertical and horizontal integration, which will hinder both competition and innovation—thus harming both U.S. economic competitiveness and U.S. security.

Operation Desert Storm is perhaps the best example of the influence of advanced technology on warfare following the end of the Cold War. This conflict demonstrated the effectiveness of joint forces and the employment of integrated systems that made total battle-space awareness a reality. In the future, the DIB will be called upon to provide an even wider range of technological solutions for application on a twenty-first century battlefield. While it is clear that advanced technologies can be used to aid the United States and its military forces, the global diffusion of such technology can also provide current and future adversaries the same advantages.

The increased reliance of the DoD on advanced technologies, coupled with adversaries increasing access to them, has significant implications for the U.S. military and the defense industry. The DoD is now, more than ever, reliant upon the defense industry to quickly provide the most advanced weaponry possible, which in turn creates several challenges for the DIB. First, U.S. forces will need to be able to respond quickly, with little time for industrial mobilization. A traditional mobilization approach is clearly inappropriate given both the crisis response times available, as well as the short technological lifecycles experienced today (National Defense Panel 1997). Clearly, the defense industry will need to be much more responsive. Typical acquisition cycles of fifteen to twenty years will not be able keep up with the rapidly changing technology cycle, now measured in months. Also, many of the new requirements, such as advanced information processing systems and integrated “network-centric” systems, are different from the traditional types of weapon platforms (tanks, planes, and ships) that have been acquired by the DoD in the past. They must be integrated to operate effectively, creating a whole host of new challenges. Finally, technical innovations in many critical areas are coming from a global industrial base. This creates a tension between ease of access to the latest technologies and national self-sufficiency, with all of its accompanying political baggage.

IV. Desired, Mid-century, Defense Industrial Base Requirements

Based on our general assumptions for the mid-twenty-first century environment, we can assess the desired characteristics for the DIB. The U.S. needs an effective, agile, and affordable joint military force, and it must nurture a robust, responsive, efficient and innovative DIB to support that force. Thus, the objective of DIB modernization must be to enable a successful, responsive, and affordable joint military force.

First and foremost, the DoD must position itself to facilitate the development and maintenance of a highly agile and affordable joint military force without compromising effectiveness. Transformation of the DoD enterprise should entail a three-part approach. An effective force must allow for continuously transforming processes, capabilities and culture—thus permitting a long-term evolution of how the DoD conducts business, combat operations, and its affairs with other agencies and nations. In summary, all components of the DIB must work together to quickly, efficiently and effectively acquire and support technically complex-systems, systems-of-systems and services. All of this must be accomplished in an environment of severely constrained defense budgets.

The following are both broad and specific mid-century requirements for the envisioned DIB if it is to accomplish the required transformation.

Broad Mid-century Requirements

Construct a Robust, Responsive, Efficient, and Innovative DIB

The DIB must be restructured to allow for greater responsiveness, improved efficiency and increased innovation. The DIB must be able to adapt and respond rapidly as the needs of the DoD change. Just as free markets respond to the changing demands of the consumer, so too should the DIB respond to the changing requirements of the DoD. In order to accomplish its goals, the DoD must develop and implement policies and procedures that encourage its own needed changes, along with the enhanced responsiveness of the DIB. This will require a significant change in the way the

government does business, as well as a change in the underlying culture of its acquisition workforce. Making such significant changes will prove extremely challenging, and will require strong leadership with a clear vision—in addition to an extended leadership team that makes this transformation a high priority.

Since the Department's acquisition policies and decisions shape the technological and programmatic focus of industry, the evolution of the DoD will allow the industry to follow its lead. Therefore, the DoD must be more aggressive in pushing industrial-base-related policies into its acquisition regulations and in utilizing strategies to promote competition and innovation. It must also, in specific cases, work to preserve critical defense industrial capabilities and technologies. Increased specialized regulation by the DoD, along with growing isolation from the commercial industry, will only cause significant cost increase in the acquisition of defense goods and services, and will slow down the acquisition process (with a resultant delay in getting state-of-the-art equipment to the fighting forces). Additionally, regulation also increases the barriers-to-entry for world-class commercial suppliers and limits the future potential of integrated civil/military production lines (through the use of “flexible” manufacturing). These integrated production lines normally offer great cost savings and crisis-surge potential by rapidly shifting the work from civil to military. The growing limitations placed on these possibilities is clearly contrary to the DoD's future need for low-cost, high-performance technology, as well as to rapid and flexible industrial responsiveness.

Finally, in order for the U.S. to sustain its military dominance, it must maintain an advantage over its potential opponents—widening the gaps between our technology and theirs; innovation is the key to staying ahead. This can only be accomplished by an active research program in the private sector, working both independently and in concert with the DoD. The Department must continue to directly fund innovative research through successful programs such as the Small Business Innovative research (SBIR) program, incentivize continued private sector investment, and leverage fast-paced commercial research.

Effectively Acquire Large, Complex Systems, Systems-of-Systems, and Services

The focus of twenty-first century acquisition will lie in several areas, including intelligence, unmanned systems, professional services, and advanced information systems. Emphasis on enhancing these “mission-oriented” areas is a movement away from the “platform-centric” thinking of the past to a more “network-centric” thinking, in terms of integrated systems-of-systems (with large numbers of inexpensive, distributed sensors and shooters, all interlinked with complex and secure command, control and communication systems).

The DoD and DIB must focus on better ways of acquiring these systems and services. The acquisition process must be streamlined and updated to reflect new demands; increased oversight must occur in problem areas, and regulation must be decreased at choke-points; new leadership must have a vision of the future, and highly trained government personnel must be hired to support them.

The DoD should continue to integrate its acquisition organizations with the ultimate goal of creating a digitally integrated DoD enterprise. Defense business transformation should focus its efforts on creating an acquisition lifecycle management environment that enables efficiency, flexibility, and innovation while eliminating waste.

Specific Mid-century Requirements

The previous section outlined some general ideas for DIB composition in the twenty-first century. This section, however, will focus on specific measures that we believe should be implemented to achieve the desired broad characteristics.

Competitive Design Teams in All Critical Areas with the Means for Extensive Prototyping

In the uncertain environments that military planners face, it is necessary for them to attempt to be prepared for as wide a range of potential contingencies as budgets and manpower can allow. An effort to mitigate the effects of uncertainty has been undertaken through the capabilities-based planning approach. However, it is an imperative that areas

which may not be of particular focus in the short-term continue to receive long-term consideration.

In this light, it will be necessary for the DoD to support competitive design teams in all critical areas of defense development. While it is probably not necessary to wholly produce the end-items each of these teams is designing, it is extremely valuable to maintain research, development, and prototyping capabilities. It will also prove vital to continue production planning for assets that may be of particular value to the U.S. armed forces in the future. The DIB must also maintain a capability to rapidly implement the most sophisticated and evolving emergent technologies—such as bio, info, and nano-technologies that are likely to be game-changers of the twenty-first century. Synergistic combinations of these could produce truly revolutionary capabilities.

Retaining design teams in critical areas fosters innovation and competition (which reduces costs) and allows for spiral development during prototyping. Spiral development permits the evolution of emerging systems. In this case, the maintenance of a vast prototyping capability allows for the refinement of advanced concepts over time, without the financial commitment to production. This allows developers time for innovation while contributing to U.S. military transformation.

For example, the use of a five-year cycle for each block (from the time of commitment to the block's system development to its initial operational capability) would require that each block utilize only fully proven technologies, allowing for R&D to be funded in parallel for subsequent blocks. Thus, once the new technology is found to be functional and sustainable in use, it can be phased in to that subsequent block. It is important to note that, when properly implemented, such spiral development will not only more rapidly distribute high-performance equipment into the field, but will garner an average savings of approximately 30% and with much lower risk.

As a result of the ever-changing defense climate, failure to transition advanced technology into operational capabilities will have severe consequences. If U.S. forces do not have the capabilities to anticipate and respond to adaptive adversaries, they will be at a severe disadvantage. At the present, several major systems are fielded with obsolete

technology at unnecessarily high costs. These systems only hinder the ability of the military to modernize. As a result, the DoD experiences a “requirements creep,” which is primarily a result of delays in creation of new, cutting-edge technology in a timely fashion. An existing technological development capability, with competitive prototyping in all areas, will provide the American military with opportunities to exploit “disruptive,” and other, technologies that are required for success. However, the DoD’s current processes and practices of transitioning technology, primarily based upon Cold War planning models, are not adequate for today and must be changed.

Introduction of Innovative Systems Architecture/Systems Engineering and Software Firms

DoD system engineering capabilities have severely declined over the past twenty years as an unintended consequence of downsizing in the military at the end of the Cold War. The DoD’s civilian acquisition workforce has suffered similar limitations from this downsizing effort. As a result, the DoD’s systems engineering capabilities were seriously degraded. With the requirement to develop increasingly complex, net-centric systems, it is clear that the DoD will have to depend heavily on the private sector to provide many of the Department’s systems engineering and integration functions.

It was in light of these difficulties and the consolidation of the defense industry over a decade ago that the DoD moved to a Lead Systems Integrator (LSI) model. LSIs were meant to perform functions that include development of requirements and technologies and the construction, modification, administration, management, testing and validation of systems (Lipowicz 2007). The LSI model, however, has not fulfilled its promises of better management, oversight and cost savings. Unquestionably, the LSI model has left programs like the Coast Guard’s “Deepwater” or the Army’s “Future Combat System” (FCS) as examples of the ineffectiveness that has come from contracting out to an LSI. By no coincidence, the growth in the LSI approach coincided with the 50% reduction in the Pentagon’s acquisition workforce from 1995 to 2005. One primary complaint was that the DoD lacked the technical sophistication and managerial expertise to perform such functions independently. Now that the LSI role is being challenged, questions are arising

once again about the government's ability to carry out such functions by itself; thus, it has become an additional hurdle to DIB transformation (Lipowicz 2007).

Although the major defense contractors have the skilled workforce necessary for these tasks, they frequently have real or perceived conflicts of interests as a result of the industry consolidation. Consequently, a real need exists for high-quality, independent private sector firms who focus on systems engineering and software development only. These firms could provide benefits for DoD transformation by taking hardware exclusion contracts that would prohibit them from designing systems or software in which they could later profit by producing the applicable deliverables. This approach supports "open systems" design and would create a new market for firms with engineering capabilities that lack manufacturing facilities.

For example, within the Coast Guard's \$17 billion modernization program, called "Deepwater," it has been widely noted that management and oversight of the program was difficult because of the relationship between the prime contractor, Integrated Coast Guard Systems (ICGS) (a joint venture between Lockheed Martin and Northrop Grumman), and the two first-tier sub-contractors, Lockheed Martin and Northrop Grumman (United States Government Accountability Office 2004). A program as large as Deepwater highlights the disadvantages that exist in the lack of independent systems engineering firms who can provide technical assistance. In this instance, it is the integrator, ICGS, that has advised the Coast Guard on systems engineering issues and trade-offs, but it benefits from both sides of the contract, development and production; so, try as ICGS may, it is difficult for it to be objective. Independent firms take this conflict out of the equation. As firms with hardware exclusion contracts are only concerned about ensuring proper selection and integration of systems, development and design, they have no vested interest in one particular system or another when it comes to constructing the system. In this example, the success of an independent firm is dependent only on the ability of the total package to function optimally and at the lowest cost.

A Risk-based, “Globalized Defense Market”

No matter what laws are passed, the U.S. cannot prevent the globalization of technology and industry. Rather, it must learn to embrace the benefits of globalization for both the nation’s security and its economy. Within the globalized defense market, there will be a greater sharing of information, technology, and personnel—within obvious security concerns. In order for the DIB of the twenty-first century to remain abreast of all emerging technologies and the general advancement of knowledge, the Defense firms must have the ability to openly interact with U.S. allies and trading partners. A globalized defense market not only aids the U.S. in development of advanced military capabilities, but also contributes to the expansion of domestic commercial technologies, strengthens political ties, and provides significant economic benefits.

The growth in global research and development has fostered both international cooperation and competition. Many of America’s allies are now becoming more engaged in advanced scientific and industrial R&D activities, allowing for more potential cooperation. A prime example occurs at the parts level: essentially all U.S. weapon systems include components and parts from off-shore (such as semiconductors from Japan, precision glass from Germany, etc.). This is primarily because these off-shore vendors provide the best value—both higher performance and lower costs. Despite a growing dependency on foreign parts, we do not believe there is a corresponding U.S. vulnerability. There is no need to be concerned about a violation of the *Buy American Act* when considering the components, as the act only applies to the end-items and not to subcontracts or parts.

In response to this trend, the U.S. should foster a risk-based, globalized defense market for two reasons. First, the modern battlefield will be made up of interconnected and dependent sensors and shooters from multiple countries. Thus, it would be in the U.S.’s best interest to ensure that each country involved in the coalition would have the best possible technology and that it is designed and tested to be interoperable among the coalition partners in order to be effective. Second, as defense budgets are likely heading towards a major downturn, the globalized defense market can be used to gain efficiencies by sharing development costs and production lines (for economies-of-scale).

Allowing for a globalized DIB could also enable domestic firms with less wealth or access to capital to more effectively compete with established firms. This approach may even create enough momentum to break into the current oligopolies in the defense industry. If international firms are welcomed to enter the U.S. defense market, to produce and compete on an equal basis with defense firms, they will stimulate both innovation and competition.

Vertical Decentralization of the Defense Industry

Horizontal and vertical integration of the defense industry, along with restrictions upon foreign sourcing and competition, have created a small set of oligopolies within the defense market (often with only two firms in a critical sector). To increase competitiveness—along with the essential byproduct of innovation—incentives should be introduced to entice small and medium-sized firms to enter the defense industry. These firms, if adequately funded and focused, could be the key to opening up the defense industry and could aid in vertical decentralization. One method for encouraging these firms would be the utilization of targeted investments, restricted to areas of needed emerging technologies. In addition, decision-makers must maintain open dialogues with the companies that produce such technologies in order to provide them with streamlined interaction with the DoD. A point of central importance to this strategy is the regulation of actual dollars competitively awarded to small businesses (as primes, sub-contractors, or vendors). Increased participation from small businesses would foster increased competition within the industry and contribute to innovation and growth.

The Small Business Innovation Research (SBIR) program is an example of a successful program that has provided incentives for the growth of new firms and the development of innovative technologies within the defense sector. This program, focused on fostering innovation within small businesses, budgeted \$1.13B in 2007 for DoD programs alone. Because the program has been successful in providing a vehicle for small business growth in vitally important areas of R&D, it should be noted that expansion of this program could enhance U.S. technological capabilities and provide more diversity within the DIB.

The need for increased competition within the defense industry cannot be denied. The benefits of competition include encouraging innovation, improving performance, accelerating development schedules and lowering costs. Methods for accomplishing these goals, via vertical decentralization, should be explored in greater detail and must include competition throughout the lifecycle.

Independent “Red-Teams,” Representative of Potential Asymmetric Options from Adversaries

It is essential that U.S. armed forces remain prepared for the evolving threats of the twenty-first century war environment. Using independent "red-teams" to simulate the potential asymmetric options—from adversaries utilizing modern, global technologies in reaction to our systems and solutions—is one method of providing realistic training and learning environments that will aid in combating these threats.

Red-teams can be employed to challenge current assumptions, measure risks, and increase opportunities by capitalizing on an approach that can create new knowledge of how opponents may exploit our military. To be effective, successful red-teaming requires careful application of all known situational and organizational elements. In a simulated training environment, the value of the simulation is only as good as it has been planned and executed. The independent nature of these teams should represent some of the best the military has to offer and should have full inter-Service participation to get experience from all different perspectives. Aggressive red-teaming would enhance the DoD’s development and fielding of weapon system prototypes, networked capabilities, and related systems-of-systems.

Network-centric Industrial Operations throughout the Lifecycle; Interconnected to Government and Supplier Bases

Network-centric industrial operations throughout the lifecycle will enable the DoD to fully plan, implement, monitor and control all aspects of R&D, production, and support. Network-centric industrial operations are found in robust, networked organizations that facilitate and improve information sharing during the acquisition lifecycle. Information sharing and subsequent collaboration enhance the quality of the information and enable

improved situational awareness during the R&D, production and support phases of the weapon system lifecycle. As applied to the defense industry, just as to the battlefield, a net-centric environment would permit total visibility across all inputs. It is this improved visibility that would make improvements possible in program management—i.e., improved cost and inventory control, schedule compliance, and ultimately system performance.

V. Barriers to Transforming the Defense Industry

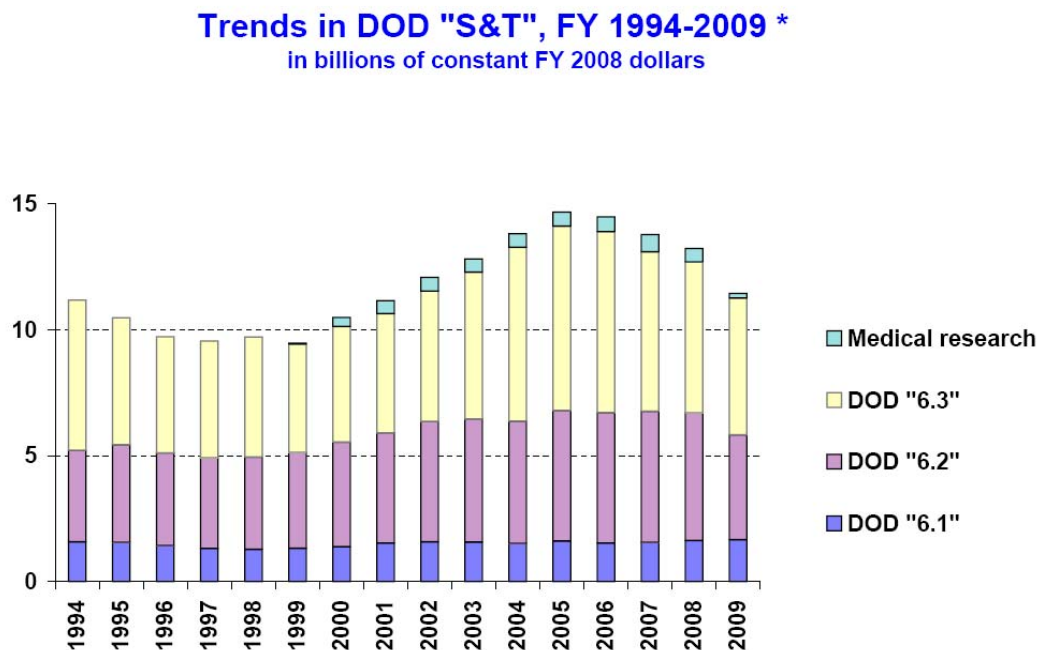
Current Policies, Processes and Management of the Defense Enterprise Do Not Facilitate Transformation

The DoD faces a critical period—in which fundamental change is needed in the way it develops new capabilities—as a result of the confluence of several significant factors. While well prepared for conventional, high-intensity warfare, the DoD is less prepared or equipped for the “likely conflicts” of the next decade—and slow to shift its focus. The most likely wars or conflicts of the future will be markedly different from those of the past; the enemies faced by the U.S. military will not only be those of nation-states, but often dispersed, non-state networks. In many cases, U.S. operations will occur on many continents and in countries with which the U.S. is not at war. It must also be understood that military power alone will not suffice to win this type of war, but the military establishment must have the necessary capabilities to meet the demands of the likely threats posed by these challenges (United States Department of Defense 2006a). At the same time, the DoD acquisition process still does not deliver systems on schedule or budget; they remain generally inflexible and averse to risk. These factors coupled together create a tremendous barrier that must be overcome in order for the DIB to achieve an effective twenty-first century transformation.

At the forefront of the problems with the acquisition cycle is the slow-changing “requirements process,” which has yet to focus itself on the new and different security needs of the country. A tug-of-war exists within the Department between the transition to a net-centric-based force structure and the maintenance of a platform-based one. As a result, the general pace of transforming the force is slow, disorganized, and not agile enough to respond to quickly changing threats and tactics. This effect has been referred to as a “death spiral.” This occurs when the maintenance and upgrade of existing platforms and systems is required to maintain readiness. However, the costs of this effort are a drain on resources which are required elsewhere for force modernization. As a result, modernization budgets are reduced; and, as a consequence, schedules are stretched out, reducing the procurement quantities. The final outcome is a delay in modernization

because of the inherent tension between maintaining what the DoD has and buying what the DoD really needs for the future (Goure 1999).

The resource shift to nearer-term demands has caused a lack of attention to long-term, potentially disruptive technologies. Funding for science and technology, after reaching a peak in FY 2005, is declining—as demonstrated in Figure 10.



Source: AAAS analyses of R&D in annual AAAS R&D reports.
 * - FY 2009 figures are latest AAAS estimates of FY 2009 request.
 Medical research appropriated outside RDT&E; appropriated in "6.2" accounts before 1999.
 FEBRUARY '08 © 2008 AAAS



Figure 10. Trends in DoD S&T FY 1994-2009.
 (American Association for the Advancement of Science 2008)

In addition, funding for much-needed innovation efforts is not readily available, despite the obvious need for them during DIB transformation. These innovations include competitive prototyping (which has the potential to reap tremendous cost savings over the

long term), logistics and supply-chain modernization. The problem is compounded by the difficulty of adopting new technologies developed in the commercial sector, or implementing technology developed outside the U.S. For example, the biotech industry plays a critical role in national defense by producing countermeasures to biological weapons. However, the domestic capacity to develop and manufacture these countermeasures is threatened by several developments. Federal funding for all R&D in life science is less than half of funding for traditional defense R&D, even though there is wide-spread recognition that future threats are likely to be non-traditional in nature. Additionally, the U.S. holds an increasing trade deficit in all life science products, despite the fact that it has developed an increasing dependence on foreign pharmaceutical R&D (Matheny 2007).

In addition, the revolution in global business is transforming the nature of the present acquisition environment; there are elements at home that continue to push for isolation, citing that the benefits of globalization do not outweigh the costs. Those who oppose defense industry cooperation and trade partnerships overseas argue that the United States cannot afford to let sensitive technologies proliferate around the world and potentially fall into the wrong hands.

However, the concerns about proliferation of technology are legitimate, and they must be taken into account in international industrial arrangements. This belief has become the motivating force behind recent initiatives to protect information and guarantee the security of data. But overall resistance to globalization remains, and the belief endures that U.S. interests are best served by focusing inward (Farrell Jr. 2004). Efforts such as the *Buy American Act*, the *Berry Amendment*, *International Traffic in Arms Regulations (ITAR)*, export controls, and the numerous restrictions on foreign scholars, students and science and technology workers serve as checks against the development promised by globalization. They further represent policies that hinder DIB transformation, as well as general industrial innovation and development.

The push for isolation is driven by a fear of over-commitment abroad, and rests squarely on the belief that American security is an investment best made domestically. As it

becomes necessary to engage new allies and create new relationships for the sharing of intelligence (in a world of uncertainty) and technology (in a world of globalization), isolationist policy severely undermines the strength of international relationships and the benefits which can be reaped by sowing the American seed abroad. While the U.S. has not yet reached a crisis point, careful examination of the barriers should begin. U.S. military forces could find themselves short of critical equipment, due to out-of-date rules and regulations that create modernization roadblocks (Farrell Jr. 2004).

Isolationism also runs contrary to the principles of the defense industry, as nearly all U.S. equipment has been reliant on sales and shipments of critical components from foreign countries (Gansler 1989). The idea that businesses can suddenly stop the interconnectedness created by globalization and begin relationships solely with American providers for defense needs is unrealistic at best; it would result in higher costs and lower product quality. Additionally, navigating the intricacies of export restrictions and domestic-sourcing requirements are difficult. It is crucial for companies to have a comprehensive understanding of their supplier base in order to avoid costly violations (Corrigan 2007). If these restrictions were loosened, lower costs and higher performance could be achieved. As the defense budgets decline in the future, the ability to get the best value will become vital for the DoD to complete the process of modernization. This makes the benefits of globalization ever more important for DIB transformation.

To correct these shortcomings, fundamental changes are needed at structural and organizational levels to ensure that new capabilities are effectively developed and deployed. While there are continuing transformation initiatives in a number of areas within the Department, they are discrete; on the whole, reform efforts have not transformed the acquisition process sufficiently. Thus, it can be concluded that the acquisition system should be considered the weak link in the transformation chain (Defense Science Board 2006b). As it stands, DoD acquisition cycles are too long, expensive, and inflexible to respond to the changing and unpredictable needs of the twenty-first century. Laws, policies, and practices frustrate both DoD and Industry efforts to provide troops the most effective systems, in sufficient numbers, and at affordable prices. Internal bureaucracy, business processes, and operational procedures

cost additional time and money, and these complications must be avoided while DoD leadership is in pursuit of solving modern battlefield problems. As we have moved to a military based on complex systems-of-systems, overall management of the acquisition of these systems and components (from requirements through realization) has grown more difficult. The tremendous amount of oversight that is needed to manage these programs, coupled with the technical knowledge requirements, makes it difficult for the government workforce to maintain the pace of the private sector.

Of additional importance is the reality that the DoD no longer has a virtual monopoly on all military-relevant technology. Aerospace and defense companies are now commonly being referred to as IT or systems companies, and in many cases these companies work hard to get that moniker. The line between the defense industry and the IT industry will continue to blur as DoD systems become more net-centric (i.e., more dependent upon IT and networks, and more complex). Using space as an example, the initial use of satellite technology had been virtually a military monopoly. However, with the advent of microwave communication in the 1960s, satellite technology has been heavily adopted by private communications firms. Satellite technology is now driven to a large extent by the commercial market.

The DoD uses commercial satellites to meet much of its communication and information transmission needs. The importance of commercial satellites to the DoD is especially evident during a communications requirements surge. For example, commercial communications satellites were used for 45% of all communications between the United States and the Persian Gulf region during Desert Shield/Desert Storm (this was despite the fact that these satellites remained vulnerable to security breaches, as a result of little or no pre-determined satellite protection standards) (Government Accountability Office 2002).

This example highlights the DoD's reliance on commercial technology and its loss of monopoly influence over critical technology sectors. In this type of environment, it is more difficult for the DoD to effectively drive the direction of technological

development. Market forces may push or pull technology development with little regard for the needs of the DoD.

The DoD Acquisition Workforce is Not Structured for Present Needs

Generation	National (2005)		DoD (2006)		DoD AT&L Civilian Workforce (2006)	
	Workforce (millions)	% Workforce	Workforce	% Workforce	Workforce	% Workforce
Silent Generation (born before 1946)	11.5	7.50%	45,625	6.70%	8,322	7.40%
Baby Boomers (1946 to 1964)	61.5	42.00%	438,971	64.50%	77,779	68.70%
Generation X (1965 to 1976)	43.5	29.50%	132,948	19.50%	17,581	15.50%
Generation Y (1977 to 1989)	31.5	21.00%	62,676	9.20%	9,394	8.30%
Millennium (1990 to Present)	51	0%	153	0%	0	0%
		100%		100%		100%

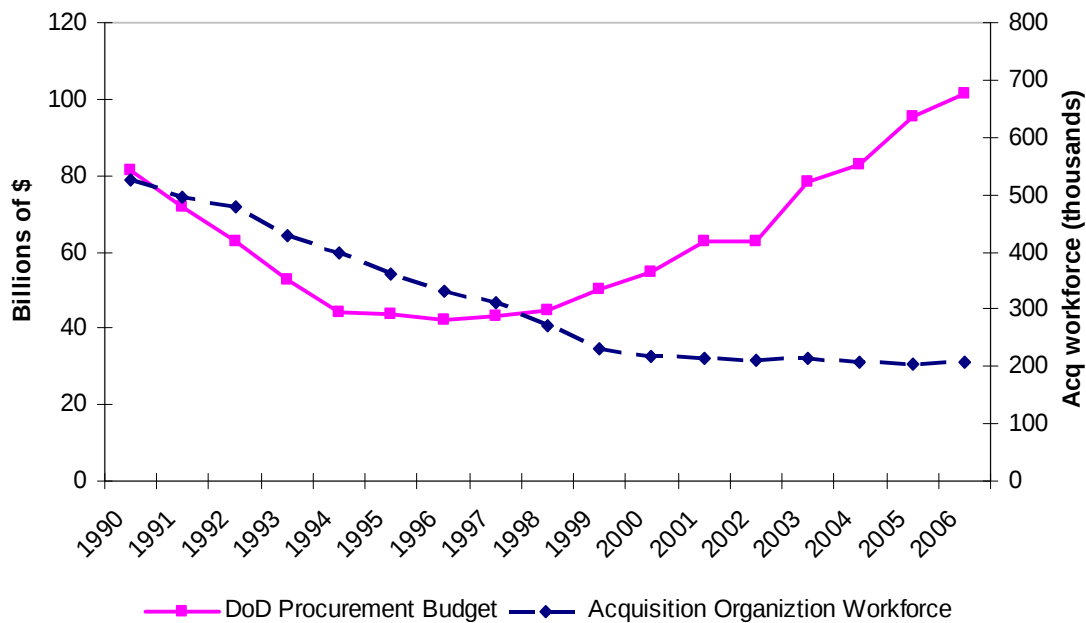
Source: AT&L Human Capital Strategic Plan V3.0 2007

Figure 11. Acquisition Workforce by Generation. (Undersecretary of Defense for Acquisition 2007)

The DoD acquisition workforce (civilian plus military), in its present state, is not well suited to support DoD transformation. The current demographic structure of the workforce is composed in such a manner that a majority of the personnel is approaching or has already reached retirement age. In addition, new entrants to the DoD acquisition workforce are only trickling in and are not adequate in number to replenish the flow of outgoing workers. As of 2006, Baby Boomers represented over 64% of DoD's

workforce, while Generation X and Y civilian personnel represented a combined total of just 28% (Undersecretary of Defense for Acquisition 2007). This uneven distribution of personnel, as exemplified in Figure 11, creates an interesting problem due to the loss of institutional and cultural knowledge shared by outgoing employees. It also highlights the gap that exists between the experience of existing personnel and current acquisition demands, which are focused on modern transformational technologies. It is the lack of experience and/or skills held by these Baby Boomers that reinforces the DoD's Cold War business practices and discourages innovation. In addition, legal and regulatory changes, budgetary pressures, scandals in the acquisition community and perverse incentives have discouraged creative and innovative acquisition practices; they have, instead, created a risk-adverse acquisition workforce.

Despite the DoD having almost 700,000 civilian employees on its payroll, current operational demands are expanding the role of the DoD's civilian workforce, and every effort is being made to allow military personnel to focus solely on warfighting duties. However, since the end of the Cold War, the DoD's civilian workforce has also been significantly reduced (approximately 38% between fiscal years 1989 and 2002). These reductions were made without a strategic vision of what would be needed in the future and relied on voluntary turnover, retirements, and freezes on hiring authority. In its present state, the DoD civilian workforce is inadequate to meet the needs of the DIB in the twenty-first century. This poorly planned downsizing has resulted in a workforce not balanced by age or experience, with close to 60% of personnel now eligible for early or regular retirement (Inspector General 2000). This is especially true with the DoD's civilian acquisition workforce. Even as the DoD procurement budgets grew significantly, after 9-11, there was no commensurate increase in the numbers of qualified acquisition personnel—as indicated by Figure 12.



Source of workforce data: DoD IG Report D-2000-088 Feb 29, 2000 & DoD IG Report D-2006-073 April 17, 2006

Source of budget data: Annual Defense Reports, available at http://www.dod.mil/execsec/adr_intro.html. Procurement supplementals for FY2005 and FY2006 not yet reflected in Annual Defense Reports were obtained from Congressional Research Service Reports.

Figure 12. Acquisition Workforce Declined as Procurement Budgets Increased.

A recent RAND analysis indicates that DoD AT&L civilian workforce members retire at a slower rate than do those in the DoD overall. Findings reveal that only 20% of the DoD AT&L workforce retires within 1 year of becoming eligible. Eventually, those who are currently retirement-eligible will leave the DoD AT&L workforce (likely, many over the next decade), which will result in a further decrease in DoD AT&L workforce size. As those from the Baby Boomer generation are retiring, they are not being replaced at a comparable rate by new hires—resulting in an acquisition workforce replacement gap. The projected shortfall in personnel due to this gap is estimated to be more than 20% by 2015 (Undersecretary of Defense for Acquisition 2007).

The new Federal Employee Retirement System (FERS) is also a factor to be considered when decision-makers are planning human capital strategies. Vested FERS employees may become more mobile and very attractive to both the private sector and other federal agencies. Unlike its predecessor plan, the Civil Service Retirement System (CSRS),

FERS has a portability feature that may increase the likelihood of employees leaving government service early if there are better employment opportunities outside. The DoD needs to capture more and better workforce data in order to conduct trend analyses. This will help leadership understand if new migration patterns are evolving relative to FERS employees.

There has also been a fundamental shift in the roles and responsibilities of the DoD workforce. Market-based sourcing strategies such as competitive sourcing, outsourcing, and privatization, along with the requirement for more service contracts, has altered the role of many government acquisition employees from “doers” to “managers of doers.” One cause of this is because government does not possess the necessary expertise to do the work on many, modern, highly technical acquisitions. Acquisition personnel with the requisite systems engineering experience are required to successfully oversee these new complex developments, in addition to overseeing lifecycle management (in a continuous-improvement environment)—making for quite a big challenge. Besides having a strong technical background to accomplish these tasks, personnel must have management and supervisory training, and experience if they are to be successful. This combination of education and experience is a rarity in the existing workforce and is difficult to find in future hires—especially given the financial incentives in the private sector versus those in public service. For example, in the contracting field, less than one percent of college graduates employed by the government have a degree in an engineering-related discipline. As a result, many of today’s government employees do not have the education and skills to perform a significant number of today’s acquisition functions (such as on the complex system-of-systems or on performance-based service contracts). These tasks are very different from the procurement of piece-parts or single weapons systems (the predominant skill-set of the older acquisition employees).

Additionally, as the acquisition of information technology and IT-based systems becomes more prevalent in the federal government, the demand for skilled IT workers has risen. Based on the Clinger-Cohen assessment survey of 2003, the typical IT worker in the federal government is between 45-50 years of age and has no private-sector experience (where much of the innovation and implementation of the latest technologies

has taken place). Less than 10% have extensive experience in knowledge management, records management, privacy, solutions architecture, enterprise architecture, capital planning and investment, and E-Gov (Federal Chief Information Officer's Council 2004). Modern DoD systems will only get more complex, and it is vital that the next generation of government employees has experience in areas related to future DoD missions.

As technical capabilities and the support structure of the DoD have become more complex, the need to have highly skilled personnel in place to deliver goods and services to the DoD becomes vital. Modernization of the DoD requires a workforce with new skills and abilities beyond those traditionally sought for acquisition professionals, such as analytical, business and management experience, and education (Government Accountability Office 2002). The relatively slow growth of U.S. education in advanced fields, such as science and engineering, has also contributed to a diminished pool of qualified potential employees—as exemplified in Figure 13. This figure demonstrates the increase in temporary visa holders that are pursuing graduate degrees in science and engineering as a proportion of all students. With an increase of more than 50% over the last 16 years, it is likely that this trend will continue.

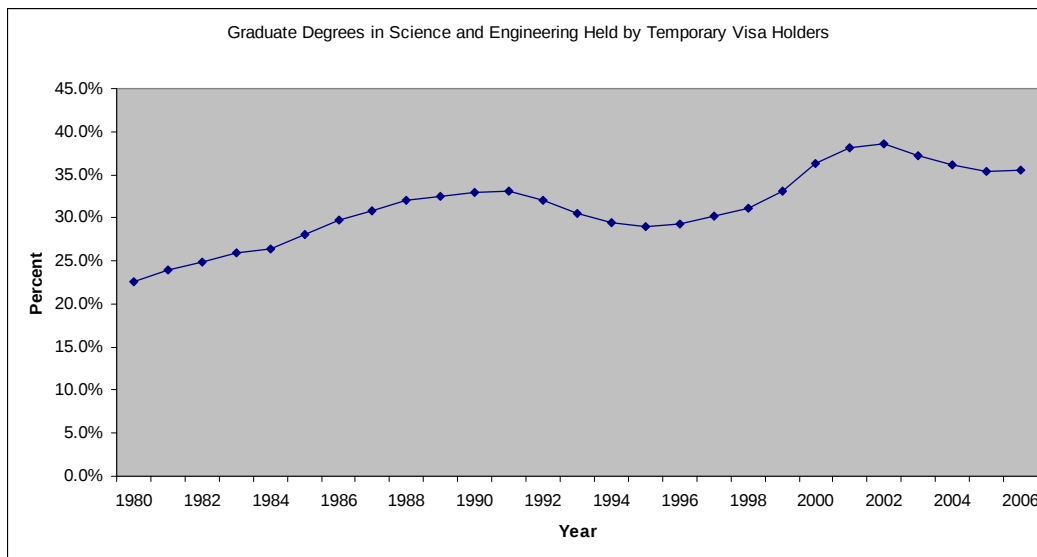


Figure 13. Graduate Enrollment in Science and Engineering.
(National Science Foundation 2006)

The final challenge in developing and maintaining a competitive, cutting-edge acquisition workforce is overcoming the lack of flexibility in government hiring practices. Private industry often allows for recruitment and retention of employees to be addressed by human resources offices. These offices are given hiring flexibility through employment negotiations to get the people that are essential to effectively run their business. In contrast, the DoD is disadvantaged by federal employee hiring rules and regulations, as well as by a lengthy hiring process that makes it difficult to provide support in a timely manner. The DoD's failure to recruit personnel with new skills or different perspectives does not facilitate the creative environment needed to foster innovation and effective management of the acquisitions of systems and services. Additionally, the DoD is also unable to retain top employees, as many are now seeking employment by the government only to gain some experience on their way to a better, higher-paying, private-sector job.

The current acquisition workforce can be considered one of several weak links in the transformation chain; however, it is the people who will ultimately allow the DoD to be successful in its modernization efforts. Therefore, the Department must be given the ability to recruit and retain the best and brightest for the job.

Industry Trends and Government Policies Cater to a “Mature Industry” Model

Industry trends and government policies are more applicable to a “mature industry” model as they:

- Focus little on positively influencing the state of the DIB
- Weaken independent R&D
- Encumber the flexibility/responsiveness needed for the twenty-first century

Present demands are pushing the DoD in several different directions: such as fighting the War on Terror, deterring future conflicts, and force transformation. During recent years, the DoD has encountered a period of the high industry concentration, advanced capabilities development, and a great amount of change within the competitive environment. The Department's leadership and resources have focused little on industrial

capabilities and the structure, conduct, and performance of the DIB. This point is significant because historically it has been the American technological advantage that is the cornerstone of U.S. military supremacy. However, with such demanding and diverse operational requirements, along with the trends in globalization of industry and technology, that advantage is now being tested. Efforts to transform the military into the highly flexible, mobile fighting force needed to encounter a wide range of threats is dependent upon the acquisition of highly technical, game-changing systems; examples include manned and unmanned aircraft systems, net-centric communications systems, and advanced air and ground weapons systems. All of these systems rely upon technological superiority to maintain their dominance; however, if they are not constantly being adapted to remain ahead of potential threats, they could be rendered useless. At present, industry trends and government policies are tailored to work within a “mature industry” model that is not designed to address dynamic requirements.

The defense industry has changed significantly as a result of a decade of consolidations, mergers, and acquisitions previously discussed. This consolidation has created a geographic concentration of defense industry jobs and contractors. Currently, more than 75% of defense contracting dollars is going to ten states—resulting in consolidated political power and a localized commitment to maintaining current programs (Rundquist 2002).

While many defense firms have suffered severe financial setbacks due to the budgetary cuts of the 1990s, it has not been until the post-9/11 period that those firms remaining have been able to recuperate. The road to recovery has caused defense firms to migrate into diverse markets and businesses, sometimes away from providing defense products and services (Deutch 2001). As defense budgets are likely to decline in the future, an attempt at continued consolidation of the industry will likely occur, and many firms will choose to exit the defense industry altogether. When this divergence is coupled with the decline in future defense budgets, it seems likely that the industry will adopt several company-based coping strategies (including exit, further consolidation, and minimal investment). These may be counterproductive to the DoD’s interest, although potentially

positive for shareholders. A balance between national security interests and business interests must be struck.

The consolidation of defense firms and the tight budget of the 1990s has also led to a weakness in independent R&D. Current domestic budget resources have shifted to addressing short-term needs at the expense of long-term programs, thus threatening the maintenance of U.S. military technological superiority. Unfortunately, industry lacks the needed agility and flexibility to respond to changes in missions and requirements—in part because they hesitate to spend their own money on R&D investment. In most cases, defense firms cannot hope to earn very high profits from production after successful private R&D investment. This is due to both profit caps imposed by the government and to the military customers' interest in controlling the characteristics of the weapons that they buy. The need for control often leads customers to reject systems proffered by contractors, when government-determined requirements did not define the original product specifications (Dombrowski 2006).

On the flip side, government funding for short-term requirements comes at the expense of declining investments in long-term science and technology. Every investment that is shifted from long-term development to a short-term project is costing the U.S. its competitive advantage in two ways. First, the decrease in investment is taking funding directly away from long-term R&D projects, which are potentially game-changing discoveries at the basic and applied research levels. Second, the decrease in investment is also taking place at a time when others, such as China, are increasing their R&D outlays, thus shrinking any potential U.S. advantage (Gordon 2007). Over the past two decades, U.S. investment in science and technology has decreased by nearly two-thirds as a percentage of the GDP (Pielke Jr. 2004). Defense firms have, thus, pursued less "disruptive" innovation in light of short-term demands for the GWOT. In addition, the DoD is providing fewer incentives (and less encouragement) for innovation (e.g., less funding for unsolicited proposals, competitive prototypes and demonstrations)—especially from smaller, non-traditional suppliers, further contributing to a lack of innovation and R&D.

Small businesses have a culture of innovation and offer a hotbed for new ideas and technology. However, due to vertical and horizontal integration, smaller-sized firms are brought under the wings of larger firms. This is demonstrated in an examination of DoD expenditures, over half of which goes to only ten large firms. As a result, it is difficult for small and medium-sized businesses to remain independent and to pursue defense-related research. In addition, “start-ups,” as well as small and mid-sized innovative firms, are not being sufficiently encouraged by the government to grow and thrive within the DIB. Many chaff at the burdensome bureaucratic requirements and would prefer to focus on the potentially more profitable commercial sector. Consequently, the pool of small and medium-sized innovative firms is diminishing. This is also true in defense services; many independent systems engineering firms are now being acquired by large prime contractors and are losing their innovative culture, as well.

Consolidation of the defense industry is only one of the roadblocks to DIB transformation. Regulatory processes (including DoD processes) and internal corporate practices have also been tailored to a mature industrial model. This operational environment runs contrary to the much-needed dynamic, agile, innovative and information-based processes and practices that should be utilized for DIB transformation. Due to institutional constraints, the DoD has frequently failed and/or is unable to get access to the best available technology from commercial and foreign sources in order to respond to its needs. As discussed previously, protectionist policies that restrict access to the best sources and commercial competitive forces hinder the DoD's ability to modernize economically and efficiently. In addition, many of the DoD's regulator processes and policies can be traced to portfolio management—which is based upon platform-centric product lines as opposed to network-centric ones. These processes have forced the Services to compete with each other for roles and responsibilities as well as for funding for platforms. The culture of competition between the Services still exists, and a net-centric approach to acquisition is not easily implemented. Ironically, current policy still does not take into account the fact that a significant part of the industrial base (such as government depots, shipyards and arsenals) still remains in control of the public sector; yet, it could be managed from a unified, joint, net-centric perspective—allowing for more joint research and collaborative efforts.

While the DIB has undergone fundamental changes, the DoD has failed to adapt and respond to many issues. As a side effect of consolidation, firms are vertically integrated, with systems, products and technical services holdings that directly relate to the platform-centric mindset previously described. Organizational conflicts-of-interest (OCIs) are becoming a critical issue for the DoD (far more than at the time of a 1997 Defense Science Board study on vertical-integration) (Defense Science Board 1997). As only a few firms provide the backbone for development, production and support for the majority of DoD platforms, profit motives have urged firms to further horizontally and vertically integrate as a way to control the market. This fact is further aggravated by DoD awards of large “Total System Performance Responsibility” and “Large Scale Integration” contracts, as well as large services contracts to prime system firms. For example, as a result of consolidation, prime contracts going to the mid-sized, independent firms (e.g., \$200M to \$2B) have been greatly reduced (in both products and services); in addition, service contracts to mid-sized companies are down 40% over the past five years (Chao 2007). This reduction of mid-sized company awards deprives the DoD of some of its best sources of competitive, innovative, and cutting-edge technical support.

The acquisition of services is especially important for the DoD, both now and in the future, as it currently buys more services (60% of all dollars (Chao 2007)) than hardware. However, the DoD's acquisition organization is primarily focused on buying hardware; therefore, most of the resources and time are spent on this endeavor. Acquisition strategies are very broad and usually include a combination of hardware and services. Special attention should be paid to service acquisition, specifically because of its uniqueness. Finally, at the most basic level, acquisition personnel within the DoD lack the necessary training on acquisition of advanced technical services—which is consistent with the “mature industry” hardware model and is not conducive to an agile, twenty-first century military (requiring lots of services support).

Industry trends have made it difficult for the DIB to effectively meet its transformational needs. Because U.S. government laws and regulations and DoD policies have not changed in sync with its needs, the DIB faces a difficult road to transformation. The demand for new, modern, and different kinds of systems and services has created a high

hurdle for the acquisition workforce to overcome in its present state. In addition, the DIB's mature industry model makes it increasingly difficult for it to operate efficiently, as well as inhibits its ability to pursue and acquire cutting-edge technology. Overcoming these issues would allow the DoD to attain higher performance at a lower cost. The failure of the LSI model and the disappearance of the DoD's monopoly influence is at the heart of the disconnect between the present state of the DoD and its desired goals for transformation. The DoD and U.S. government have seen the need for many structural and organizational changes but have been unable to implement policies that are capable of meeting the demands of the new security environment. Under these conditions, current U.S. Government policies, processes and management of the Defense Enterprise do not facilitate the transition to an effective, agile, and affordable joint military force.

VI. How Do We Get There?

The DIB has experienced difficulty meeting program management and system engineering challenges. It is increasingly isolated from the broader domestic and global economy, and it is less agile and innovative than before. The key to achieving a twenty-first century DIB that meets the goals of transformation is the pursuit of the following implementation objectives primarily focused on changing the DoD. We believe that in order to achieve the desired DIB, it will be necessary to first transform the way the DoD does its business; transforming the “demand side” will force a change in the structure of the “supply side.”

Focus on Interoperable, Net-centric Systems-of-Systems

In order to drive the changes in the DIB, the DoD must accelerate its move away from its legacy focus on weapon systems and platforms to the envisioned and required interoperable, net-centric systems-of-systems. This will be one of the most important steps in maintaining U.S. military dominance in the twenty-first century. The ability of the military to integrate across dimensions such as time, echelons, functions, geography, agencies and coalitions will determine how successful these forces will be in the future. However, at present, a mechanism to define the needs and capabilities and an acquisition strategy for these systems, within the Services, is lacking.

The management and integration of technology to leverage the benefits of net-centric systems-of-systems requires the Department to establish authorities over the entire infrastructure and to have a single accountable figure for achieving net-centricity within the DoD. Since in most cases these systems-of-systems will operate in a joint environment, the management and oversight structures must also be joint in order for leadership to properly manage their development. For this management to be effective, the structure must have a mechanism to influence and control the funding for the associated programs. The DoD should consider appointing a Combatant Command, such as Joint Forces Command (JFCOM), as the institutional systems integrator; and education and training programs should emphasize net-centric systems-of-systems engineering and management processes.

Achieve Lower Costs, Faster-to-Field, and Better Performance

The government's current acquisition policies, practices, processes and political considerations must be changed according to the needs of the twenty-first Century armed forces. They currently do not facilitate the innovative development, rapid deployment, and affordable support of the weapons, systems, and services that are crucial to military success. To date, reform efforts have not transformed defense acquisition by any significant measure, as demonstrated by continuing cost overruns, performance issues, long development cycles, and schedule slips. The acquisition process remains inflexible and risk averse—precisely the opposite of what is necessary when transitioning to a highly agile and adaptable military force structure.

One critical change that will help to ameliorate these problems is the revision of the requirements process. The new requirements would be created with cost and schedule in mind, and will function as part of a systems-analysis effort that precedes the issuance of a firm set of requirements from the Service or the Joint Requirements Oversight Council (JROC). In this case, risk should be managed by the use of a spiral development process, allowing for the fielding of improved capabilities over time. Program managers should be empowered to make cost, schedule or performance trades for each spiral with the approval of the appropriate acquisition executive (USD (AT&L) or SAE) and the lead Service Vice-Chief. This approach would allow for flexibility in a program's requirements and, through spiral development, would get relevant capabilities into the hands of the warfighter faster. User feedback would be obtained with each and every spiral, helping to improve performance and gauge success.

Finally, in order to provide a timely response to the asymmetrical threats of the globalized environment and the evolving needs of the warfighter, the DoD should consider creating and funding a permanent organization that is dedicated to the rapid fielding of necessary protective and reactive systems. One such organization, called the Joint Rapid Acquisition Cell (JRAC), was established in 2004 to assist, determine, monitor and track the fulfillment of what they have termed Immediate Warfighter Needs. While this endeavor has demonstrated the ability to significantly shorten acquisition

cycle times when needed, it is not a permanent fix and has been funded only out of wartime supplemental budgets. In the event that an organization like JRAC is created for permanent inclusion in the DoD, it is imperative that it remains independent enough to forego the traditional bureaucracy and red-tape of the Department—such as cumbersome procedures or intrusion by other parts of the Department (Middleton 2006).

The DoD Must Focus on Staying Ahead

Continued American military dominance in the twenty-first century will be based, to a large degree, on the ability of U.S. forces to maintain their technological advantage over potential adversaries. Although the U.S. does not currently have a peer competitor, other states and non-state actors are working diligently to bridge the technological advantage held by the American military. Additionally, technology continues to change and improve at an ever-increasing pace. In order to achieve its future objectives, the DoD must continually focus on maintaining its technological superiority. This will require the DoD to resist the demonstrated tendency to reduce funding for Science and Technology (S&T) research and other “engines of innovation.”

This may require that an increased share of the R&D budget go to research. The Services must pay particular attention to “disruptive”¹ architectures and technologies and give emphasis to developing prototypes and technology demonstrations to test innovative concepts. In order to leverage investment and research in the private sector, the DoD must continue to encourage the use of dual-use technology. Finally, the successful Small Business Innovation Research (SBIR) program must be fully supported and modifications such as higher limits on firm size and award amounts should be considered.

¹ A disruptive technology or disruptive innovation is a term introduced by Clayton M. Christensen describing a technological innovation that uses a “disruptive” strategy, rather than a “revolutionary” or “sustaining” strategy. According to Christensen, disruptive technologies are less expensive, simpler, smaller, but may result in poorer performance in the near-term (Christensen 2000).

The DoD Must Achieve Far Greater Use of “Best Value” Competitions

Best value competitions allow the DoD to include performance parameters in addition to price when making acquisition decisions. The greater use of “best value” competitions will enable the DoD to leverage competitive pressure while trading off performance requirements with cost. This will allow for the highest capability at the most economical price.

Increased early funding for a second-source prototype may be required; however, this competition will not only reduce production costs, but will also ease lifecycle operations and support costs as well. Contracts need to be written to provide profit incentives that encourage cost savings, improved productivity and smart make/buy decisions. The latter can be accomplished by awarding extra points to proposals for the methodology the prime contractor uses to evaluate its make/buy decisions. Finally, “best value” competitions should also be more widely used for service contracts, in which they can greatly increase efficiencies and performance.

The DoD Must Understand and Realize Benefits of Globalization

Globalization offers the DoD many benefits. The foremost of these is the increased use of commercial products, technologies and services—none of which can be separated from the globalization phenomenon. The DoD can no longer deny its increased dependence on the commercial sector without major setbacks in capability. Moreover, commercial acquisition has substantially lowered the cost of selected new systems, system upgrades and operational support (Defense Science Board/ 1999). The competition provided by foreign sourcing can additionally improve innovation in domestic firms.

The benefits of globalization must be fully realized and embraced by the DoD so that it can field a modern, mobile, adaptable military under the time and fiscal constraints of the future. The need to encourage new industrial combinations—via mergers and acquisitions, outsourcing or open foreign sourcing—is especially important to meet the challenges posed by military transformation. The technologies necessary for transformation may reside only in a very few or even sole-source U.S. companies, so

competition and innovation may come from overseas. As a result, globalization will be a vital component of the twenty-first century DIB. In addition to obtaining access to required technologies, the value of globalization in helping to promote inter-operable coalition forces should also be recognized. However, international cooperation should not be undertaken at the expense of security; therefore, appropriate security measures must always be enacted and enforced.

To fully realize the advantages of globalization, the DoD will need to advocate and promote changes in the many restrictive and protectionist laws and regulations, such as the *ITAR*, Export Controls, *Berry Amendment*, and specialty metals restrictions. As the DoD increases its use of global technologies, it will also need to develop sets of effective tools and techniques to ensure the security of Commercial Off the Shelf (COTS) hardware and software, as well as foreign supplies.

Build a High-quality/High-skill Government Acquisition Workforce

Transformation of the defense enterprise will require a more adaptive, experienced and broadly educated total workforce—capable of responding to the spectrum of demands in joint, multi-agency, and international environments. Since requirements will continue to change, the workforce must be trained in a variety of areas to allow for effective response. Development of initiatives to promote early entry into the acquisition field is also important, since the next generation of acquisition workers will have grown up during the information technology revolution.

The DoD must take full advantage of the new flexibilities offered by the National Security Personnel System in order to compete with industry in recruiting the nation's "best and brightest." Although retention of new acquisition employees must be a central consideration, the DoD should also encourage industry-to-government and government-to-industry rotations to help maintain technical and systems engineering skills. In addition, the Department must develop and put in place incentives to encourage creative and innovative behavior and continuous process improvement, with a focus on achieving

greater performance at a lower cost. Special attention must be paid to the development of effective and adaptive training regimens in order to integrate and balance Service personnel who work in acquisition-related positions (Defense Science Board 2006a).

Transform the DoD Logistics System to be a World-class Supply Chain

Development and procurement of systems is only a small piece of the puzzle in equipping and sustaining a modern military. The ability to provide the required logistics support through a global supply chain is what will enable the nation's twenty-first century military to continue to be effective. It is this supply chain that makes possible mobility and an agile-response capability. Currently, the American military suffers from an outdated legacy supply chain that artificially separates logistics from operations, creating inefficiency and uncertainty. In order to overcome this disconnect, the DoD logistics system must be transformed into a world-class, information-based supply chain, and must strive to meet the standards of efficiency and organization that have been set by the private sector.

To achieve this logistics transformation, the DoD will need to develop a “demand pull” supply chain, based on secure, integrated, end-to-end IT systems. The DoD's current logistics system is based on a “supply push” concept, in which it depends on large inventories that must be bought and maintained and often become obsolete before they are used. This system has remained virtually unchanged for the last three decades. On the other hand, global corporations such as FedEx and UPS have leveraged the capabilities made available by the IT revolution, and have shifted away from these traditional logistics strategies to market-driven, “demand pull” supply chain management—reducing inventory levels while increasing efficiency. Other automating technologies, such as “sense and respond” prognostics and automated identification technologies (AIT) must also be accelerated and incorporated.

In addition to technological improvements, the DoD must revise its business strategies. First, it will need to streamline contracting and financing mechanisms to enable aggressive competition and, thus, buy availability and readiness (as measured by

performance criteria, not by parts-on-the-shelf—as is currently often done). This should provide improved performance and significantly lower costs. Second, it should expand performance-based logistics (PBL) for both new and legacy systems, as PBL have demonstrated impressive results. This should be accomplished using “gain sharing” (with industry) and other incentives to drive up availability and promote continuous improvement. Since much of the DoD’s support is still provided by organic or monopoly resources, the Department should strive to increase public vs. private competitions for all “non-inherently governmental” logistics work.

The DoD Must Envision, Incentivize, Achieve, and Monitor a Modern DIB

To encourage the DIB to respond and position itself to support the demands of the DoD in the twenty-first century, the Department must envision, monitor and incentivize DIB transformation along with that of the military.

The defense industry continues to provide the DoD with robust technological development, manufacturing and management capabilities. However, the industry is not well suited for the twenty-first century national security environment. Senior DoD leadership must take a proactive role in identifying and clearly articulating the desired structure for the DIB in the twenty-first century.

The new structure should be responsive to rapidly changing requirements, have a strong focus on technology and innovation, offer the DoD lower cost alternatives, and provide responsible management. This vision should also address future industry consolidations and mergers. The DoD must continue to review and evaluate the impacts of potential mergers and acquisitions, with a goal of maintaining at least two viable suppliers in mature markets. A greater number of suppliers should be maintained in areas that require innovation, or where demand is exceptionally high. The objective must be to create a DIB that is vibrant enough to preserve a competitive environment while discouraging anti-competitive consolidation (horizontally or vertically) and anti-competitive teaming. The DoD should develop an appropriate mix of incentives for the industry to embrace its DIB vision and should take the actions necessary to make it a reality.

The DoD should use financial incentives and cost-savings sharing to incentivize a reduction in excess industrial capacity. This will act as a means for accomplishing long-run DoD cost savings. In addition, the DoD must take a leadership role to remove barriers that prevent non-traditional companies from entering the DIB. The Department should develop a new initiative to break through the rules, regulations and practices that could allow it to reach beyond the traditional defense companies as well as to seek transformational technologies and services.

DoD policy must define and use various tools to maintain competition at both the prime and sub-tier levels. Industry should be provided with a mechanism to voice its concerns at a level above the program manager, such as the program executive officer. The DoD should also develop the review process for mergers and acquisitions focused on maintaining a competitive environment and publicize it widely. Program offices should consult with OSD on any prospective industry teaming.

By the mid twenty-first century, the DoD should reach a point in its transformation at which it is responsive to the changing security environment. It should be able to utilize modern technology to adapt and respond to threats and should be fully staffed with an acquisition workforce that is seasoned in acquiring new systems and services; it should remain engaged in international commercial partnerships to take advantage of globalization; it should operate a logistics system that rivals those of the best commercial firms; and it should cooperate with a DIB that has evolved to meet the demands of the military. It is when these goals are accomplished that the DoD can best meet its goals of creating an agile military force and can be capable of supporting the acquisition of affordable, modern programs and services.

DIB transformation in the twenty-first century is imperative for U.S. military success. Given the anticipated environmental factors—such as rapid changes in technologies, decreasing DoD budgets and the changing nature of conflicts—the road ahead for the DoD will not be easy, but it is a journey the nation must take.

VII. Conclusion

There are many factors that are driving changes in the twenty-first century security environment. These have negatively contributed to the already difficult task of military transformation, making it even more challenging. However, it is because of these factors that modernization of the Defense Industrial Base is so critical. The rudiments of change that are required to meet the demands of the American military and the transformed DIB do exist; but the long-term vision and strategy for this transformation must be realized.

In light of our assumptions about the future environment, the overarching goal for DIB transformation should be a Government/Industry partnership in a continuously competitive market. The DIB must strive to foster an industry that satisfies twenty-first century security needs by being flexible, adaptable, agile, affordable and innovative. In order to achieve this transformation, we believe the DoD must first transform itself to allow for the effective acquisition, management and support of the complex systems, systems-of-systems and services required of a capabilities-based military.

While the U.S. holds a considerable global military advantage in the world at present, it may not last forever. Careful planning and implementation of a DIB transformation strategy—initiated by strong leadership with a vision to anticipate the changing nature of the international security environment—will allow for a U.S. military that can ensure American security throughout the century. The time for change is now.

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