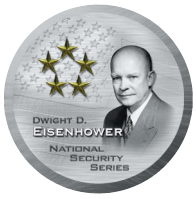
The Industrial College of the Armed Forces

# U.S. Defense Industrial Base: National Security Implications of a Globalized World




## The 2005 Dwight D. Eisenhower National Security Series Symposium

Edited by
Lynne C. Thompson and
Sheila R. Ronis

National Defense University

# U.S. Defense Industrial Base: National Security Implications of a Globalized World

Industrial College of the Armed Forces
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June 2, 2005

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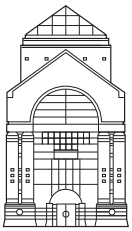

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# Contents

# Foreword

This book is based on the "U.S. Defense Industrial Base: National Security Implications of a Globalized World," The Dwight D. Eisenhower National Security Series Symposium conducted on June 2, 2005, by the Industrial College of the Armed Forces. The book's structure parallels that of the symposium itself and contains a mixture of verbatim and edited transcripts, thought pieces that analyze and synthesize discussion, and prepared papers. This foreword describes the book's macro structure and explains how the various elements contribute to a better understanding of the implications of the impact of globalization on the U.S. defense industrial base and military preparedness.

The book, like the symposium, is divided into six major sections (chapters). Chapter 1 presents a historical examination of the U.S. defense industrial base from the American Revolution to the end of the Cold War. With a firm understanding of the historical precedents, the focus shifts in the second chapter to an examination of what has transpired in the world and with the U.S. defense industrial base since the end of the Cold War. Chapter 3 is based on the luncheon speech presented by Lieutenant General Michael Dunn, USAF, President of National Defense University, and it serves as both a summary and transition from the morning's focus on past and present to the afternoon's focus on the future. The fourth chapter, then, takes the challenges and trends that were identified in previous sessions and extrapolates into the future. Chapter 5 includes two papers written by ICAF students. These papers were not presented in the symposium, but are included here because they are relevant to symposium themes and were judged as the best written examples of strategies for maintaining U.S. competitive advantage in the defense sector in a globalized world. The final chapter provides a synopsis and synthesis of key ideas that emerged from this symposium.

*Lynne C. Thompson, EdD, Colonel, USAF*
Editor and Symposium Coordinator
Industrial College of the Armed Forces

# Preface

This U.S. Army Eisenhower National Security Series event explored the issues surrounding the U.S. Defense Industrial Base: National Security Implications of a Globalized World. National security is the integration of all elements of national power: economic, diplomatic, and military. A global defense industrial base exists where all three elements intersect. The issues of globalization are many and varied, ranging from free trade to protectionism and "buy American" legislation to offsets; and from manufacturing competitiveness, basic research and development capabilities and science and technology policy to educating future generations of world-class minds.

The objective of this symposium was to support the outreach efforts of the Department of the Army through a forum to discuss issues surrounding the national security implications of the state of the U.S. defense industrial base. The program facilitated exchange beyond the Army to others at the Department of Defense and throughout the government, as well as industry, think tanks, and academia to better understand the realities of managing globalization and propose solutions for government policymakers.

These were the key recurring questions addressed throughout all of the sessions.

1. What is the role of the government during each era we are investigating?
2. What is the role of the private sector during each era?
3. What is the base environment?
4. Where were we going?
5. Where are we going now?
6. Where should we be going?
7. Who should decide?

The symposium consisted of three sessions. In Session One, Dr. B.F. Cooling and Dr. Alan Gropman provided a historical perspective on the U.S. defense industrial base from the American Revolution through the Cold War Era.

In Session Two, Dr. Shannon Brown led a distinguished panel discussion of the paper presented by the Honorable Jacques Gansler, former Under Secretary of Defense for Acquisition, Technology and Logistics. The paper examined the post-Cold War strategies and how these strategies have impacted today's industrial base in fighting the Global War on Terrorism.

Session Two Panel Members included:

- Lt. Gen. Lawrence P. Farrell, Jr. (USAF, Ret.), President and CEO, National Defense Industrial Association
- Dr. Kenneth Flamm, Dean Rusk Chair in International Affairs, Lyndon B. Johnson School of Public Affairs, University of Texas-Austin

- Hon. Suzanne Patrick, Deputy Under Secretary of Defense for Industrial Policy
- Mr. Alan Tonelson, Research Fellow, U.S. Business and Industry Council Educational Foundation.

The questions considered in Session Two included:

1. What trends have influenced the restructuring of the defense industrial base since the late 1980s?
2. What are the implications of the changes in the composition of the U.S. industrial base that have occurred since the end of the Cold War?
3. What strategies have defense companies embraced since the late 1980s in order to remain viable and competitive?
4. What policies should the federal government adopt in order to ensure that the industrial base can continue to support national security requirements?

In Session Three, Dr. Gerald Abbott led a second distinguished panel in a discussion of the paper presented by Mr. Pierre Chao, Senior Fellow, Center for Strategic and International Studies. They explored strategies needed to keep the country strong with a capable and competitive industrial base and accomplish the national security objectives.

Session Three Panel members include:

- Mr. Pierre Chao, CSIS
- Mr. Mark H. Ronald, President and CEO, BAE Systems North America
- Dr. Harvey Sapolsky, Professor of Public Policy and Organization, Massachusetts Institute of Technology
- Mr. Torkel L. Patterson, Vice President Business Development and President, Raytheon International, Inc.

The questions considered in Session Three included:

1. What is the character of globalization with the context of the U.S. defense industrial base?
2. What are the major national and international trends that are shaping or will shape the future U.S. defense industrial base?
3. What do you foresee as the major characteristics of the future U.S. defense industrial base in view of the shaping trends?
4. What do you believe will be the strategies followed by defense companies to ensure survival and preeminence in the future defense industrial base?
5. What will be the major challenges facing the U.S. Government as it attempts to "shape" the base and ensure base responsiveness to U.S. national security requirements?

The Symposium included a luncheon address by Lt. Gen. Michael Dunn, President of the National Defense University. General Dunn explored today's issues of globalization, the issues of offsets, the increasing presence of foreign defense companies in the United States, the role of trade policies, and the political pressure to create Fortress America and Fortress Europe and the potential dangers inherent in those policies.

As the capstone event of the Industrial College of the Armed Forces (ICAF) Class of 2005, this Symposium also recognized the two student papers judged by the leadership at ICAF as best exemplifying the Symposium's theme. The two industrial base papers, which are

included in this book, are: "An Aerospace Business Case for Transatlantic Cooperation," by Lt. Col. Michael T. Brewer, USAF and "Human Capital Strategy and the Future of Our Nation's Space Industry Workforce," by Susan W. Pollack .

Although there was no consensus that emerged from the discussion, the richness and complexity of the sets of issues explored reveal the challenges facing this country and its defense, industrial, and policymaking leaders.

*Sheila R. Ronis, PhD*
Symposium Chairperson
President
The University Group, Inc.

# Acknowledgments

This symposium would not have become a reality without the imagination and dedication of several individuals. We would like to thank all our speakers and panelists, the ICAF planning team that was led by Major General F.C. Wilson and Dr. Lynne Thompson, our Symposium Coordinator, and consisted of Dr. Shannon Brown, Dr. Gerald Abbott, Dr. Frank Cooling, and Dr. Alan Gropman.

We also want to thank our Service sponsors, Major Jim Craig of the Army's Eisenhower National Security Series, as well as Patti Benner and Kay Stephenson for their leadership at the Department of the Army.

Too, our corporate sponsors were essential in making this event successful. We want to thank Lieutenant General Larry Farrell, USAF (Ret.), President, National Defense Industrial Association; Major General Chuck Link, USAF (Ret.), President, National Defense University (NDU) Foundation; and the NDU Foundation staff for their administrative support.

*The Editors*

# Introduction

The Industrial College of the Armed Forces (ICAF) has continually adhered to its original mission of "keeping in touch with industry." During a lecture which was later read into the Congressional Record as part of a series of Hearings held on Mobilization in March 1924, Bernard Baruch, Chairman of the War Industries Board during World War II, stated, "The military minded man who has to devise the machines of destruction should keep in touch with the man of industry." The importance of this mandate has never been greater than it is today.

ICAF is uniquely positioned among the senior service colleges, not only due to its joint student body and diverse faculty, but also due to how its curriculum delivers joint professional military education. The Industrial College is the only military institution offering programs in industry studies to future senior leaders, both military and civilian. Civilian graduates of ICAF include Industry Fellows from a number of major U.S. and international companies. Along with these Industry Fellows, ICAF students from all branches of military service and many government departments study the economic and political ramifications of our national security strategy and, most importantly, how to resource that strategy.

A chief component of the curriculum is the Industry Studies Program, which focuses on industries critical to our national security strategy. Each year students analyze selected industries through domestic and international research, and brief their findings and recommendations to influential representatives of government and industry. In June of 2005, the "U.S. Defense Industrial Base: National Security Implications of a Globalized World" Symposium was a capstone event of this curriculum for the faculty, as well as the 312 students soon to graduate. This event was a highlight of the year's Industry Studies, as it brought together a wide variety of experts in their fields and served as a focal point for further examination of the defense industrial base. We are grateful for those who made possible this Symposium and this publication.

*Major General F. C. Wilson, U.S. Marine Corps*
Commandant
Industrial College of the Armed Forces

# U.S. Defense Industrial Base:
# National Security Implications of a Globalized World

# Chapter 1
# The History of the U.S. Defense Industrial Base from the American Revolution to the End of the Cold War

*B.F. Cooling and Alan Gropman*

Throughout history, there has existed a certain eternal paradigm about war and peace. The paradigm may be seen as a cycle of preparedness, surge and mobilization for conflict, conflict itself, followed by demobilization and reconstitution to begin that cycle all over again. This paradigm has defied the changing nature of war. It has been conditioned by the nature of the state and of government during each phase as well as the nature of business, industry, and the economy in each phase. Underpinning the cycle has been the type, nature, place, and numbers in the defense and business community whether public or private. The United States entered this paradigm as an independent player with the American Revolution.

Since that time, nations like the United States have progressed through the Pre-Industrial, Industrial, and Information Ages to today's globalized world. Factors shaping the production of arms for the state have evolved from the artisan through the armory system, to military "Fordism" of industrial mass production, to the agile manufacturing of today. In the view of some historians such as Paul A. C. Koistinen, the accompanying political economy of American warfare has embraced four factors. These include: the level of maturity of the economy; the size, strength, and scope of the national government; the character and structure of the military services with their relationship to civilian society and authority; and the state of military technology. Involved at every step of the way has been the influence of political, economic, and military elites.

In the Pre-Industrial era, these elites were merchants, large landowners, members of the propertied class, or professionals. The early Industrial Era supplanted the earlier elites with bankers, railroad magnates, and small manufacturers/suppliers. In turn, the Industrial Age included the vast corporate/industrial community. Today's Post-Industrial or Information epoch has introduced high-tech, service, as well as the now legacy "iron-triangle" grouping. In each case, vested interests in national security to ensure an economic system as well as the commonweal have inculcated ingredients such as fear of threat, monetary incentives (with accompanying scandals), as well as the persuasive elements of politics and patriotism to ensure a partnership for the common defense.

Throughout our history, key elements of the iron triangle (perhaps better known formerly as the "military-industrial complex") have included not only the military services, their parent executive departments, and private sector heavy defense industry, but also the Congress and all purveyors of military goods. Of course, the general public community (local as well as state) and the media (traditional and *nouveau*) have factored into play for good or ill. What may be striking is the dichotomy of interests in size and scope

between the limited dimensions of the Age of Washington, Jefferson, and Hamilton and the Cold War transformation of the capitalist democracy into a garrison or national security state. The national security state receded briefly in the 1990s before rising phoenix-like in the complicated early 21st century, where contradictions of extremism/terrorism as perceived threat exist side-by-side with globalized integration and threats to the continued existence of the nation-state with its apparatus of government and security. It is by no means clear at time of this writing where the trends of the defense industrial base will historically evolve in the future.

What remains clear, however, is the strategic importance of the phenomenon. The acquisition of national defense has strategic consequences. What could be developed and bought in any given period of our national history was dependent upon what the government was capable of developing and buying—either by itself (in government-owned facilities), procured from the private sector (under contract), or in some combination with its own establishment or through offshore acquisition. We often forget that before the period between World Wars I and II, the United States most often relied to a major degree for weapons upon European manufacturing and purchase. Self-sufficiency coupled with America's pride of developing the world's emerging preeminent industrial base since the 1890s sometimes ran afoul of an inability to translate potential capability into adequacy for timely provision of the sinews of war to the troops in the field in the American Revolution, the Civil War, and World War I. Fewer problems in doing so surfaced with smaller wars, expeditionary campaigns, and other crises, although scandals often developed when Native Americans and the Spanish in Cuba had superior weapons on battlefields with American soldiers.

Moreover, if we believe that the acquisition process determines how one fights, what strategies can be employed, and the type of national military, then the acquisition process and base are indispensable to developing grand or national security strategies. Major issues for the United States have always been budget, politics, and threat perception (real or imagined) and condition the expansion or consolidation of a defense industrial base. Consistency as well as change accompany the march of history in this sense and lead to the conclusion that this is strategically a continuing process of major importance. It has and does involve a system of complex relationships such as found in any mature partnership for survival. The unique economic environment is rooted in the Nation's political and economic system—perhaps most importantly in its *geographic* positioning, whereby sanctuary has been provided hitherto by distance and a two-ocean moat. Finally, the process of procurement for national defense has always operated within fiscal limits, although the billions spent today may not seem so and are, indeed, a far cry from those parsimonious dollars spent in the age of the Barbary Wars to avoid paying tribute to an enemy.

The history of this Nation, in fact, may be seen as a series of critical episodes in American state-building that encompass both war and socio-economic crisis (see table 1). Both public and private sectors have been affected accordingly.

Table 1: **Episodes in the Building of the American State**

| Episode | War and/or socio-economic crisis? |
|---|---|
| Founding (1776–1787) | Both |
| Civil War/Reconstruction (1861–1877) | Both |
| Progressive Era (1900–1914) | Socio-economic only |
| World War I (1915–1919) | War only |
| Depression/New Deal (1929–1940) | Socio-economic only |
| World War II (1940–1945) | War only |
| Early Cold War (1947–1963) | War only |
| Vietnam/Great Society (1964–1975) | Both |
| Post–Cold War (1991–2001) | Both |
| Global War on Extremism (2001–) | Possibly both |

Response in all cases required varying forms of "mobilization" of resources (human as well as material capital) involving government intervention in the economy and society for broad purposes of national security. Those purposes include national defense and survival as well as maintenance of stability benefiting enterprise and domestic tranquility. Each mobilization was unique to time and place and reflected the political ideology and system, the nature of the private sector, and its capabilities and needs as well as public-private partnering based on experiences of the past and expectations of the particular instance demanding mobilization. The resourcing base was always fundamental to successful response and demands of that response. In each case, the traditional American way of resourcing war was tested and led to restructuring organization and response that, in turn, conditioned the national security period thereafter.

For the 18th and 19th century peacetime continuum as well as wartime necessity, the traditional American way reflected limited central government, reliance on state and local manpower mobilization via a militia reserve system, with the sinews of war garnered by government order from bureaus overseeing national armories, arsenals, and navy yards, and the private contractor system. Fear of standing armies, business pacifism, and secure borders (physical as well as ideological isolationism) meant small standing militaries—supplemented in time of war via the Minuteman theory—governed defense policy even as the United States surpassed European competitors in terms of crude steel output and relative share of world manufacturing output by the early 20th century.

Frankly, national policies of neutrality and free trade were accompanied by development of a technologically modern "New Steel and Steam Navy" from about 1883 that required increased defense spending, transformational modernization of the military, and a budding (if sometimes tempestuous) partnership between government and private sector (the steel industry) in the name of defense, deterrence, patriotism, and imperialism. The underpinnings

of an industrial base supportive of the national effort in wartime were at least evident by the breakout of war in Europe in 1914.

The United States quickly became the "arsenal of democracy" for Great Britain, France, and other allies, in what was first styled "The Great War." That is to say, the industrial base of this country through the great financial house of J.P. Morgan and Company supplied the Allies with explosives, munitions, and raw materials to the amount of $1.3 billion even as President Woodrow Wilson promised to keep America out of the war. Financial loans as well as this resourcing of the war effort inextricably tied the Nation to the necessity of Allied victory, but it further developed the domestic industrial base through preparedness and experience with large-scale projects needed in modern war. Unfortunately, such resourcing for Europe often co-opted America's own rearmament needs once neutrality violations and other policy considerations prompted America's entry into the conflict. In many ways, the private sector was ready for war; the country's government and military were not.

World War (or World War I as it came to be called subsequently) truly transformed the relationship of government and the private sector through mobilization in the Industrial Age. The period of preparedness from 1916 to 1917 set the mark when the executive branch of government was authorized new power for economic and industrial mobilization in time of declared war. Such milestones as the National Defense Act of 1916 and Naval Appropriations Act of that same year, as well as creation of the office of Chief of Naval Operations, a Council of National Defense from War, Navy, Agriculture, Interior, Labor and Commerce cabinet departments to advise the President on national mobilization, suggested the seriousness of the country. Regrettably, what resulted (once war was declared in April 1917) was a subsequent period of typical American befuddlement, waste, and bureaucratic bungling that coincided with unforeseen events—blizzards that disrupted domestic logistics and the early collapse of Germany and the Western Front—just when America's vaunted industrial power was finally coming on line to resource both Allied and U.S. needs. From chaos, managerial metamorphosis, and expeditionary campaigning—that put over a million American "doughboys" in France using British and French weapons and equipment—sprang this first experience with big, centralized government (administered through the War Industries Board), mass production of the tools of war both military and civilian by an industrial sanctuary, as well as the full panoply of surge, mobilization, and offshore procurement that became hidden after the Armistice from all but those appreciative of that partnering effort between government and private sector.

Two sets of lessons emerged from World War I—the one *perceived,* the other *real.* Observers of the time perceived that the war "upset the previous opinion that adequate military preparedness is largely a question of trained manpower," as Assistant Secretary of War Benedict Crowell noted. Bernard Baruch, Chairman of the War Industries Board, decided that "when fighting ceased, war production in the United States was reaching its peak with every unit of the vast machinery keyed up to high speed." He had no doubt "that knowledge of this fact contributed materially to Germany's sudden realization of the hopelessness of her position." Perhaps these perceptions, however, came to counter the distinct slap at national

pride that seemed evident from America's inability to equip and outfit its own national army. The British Prime Minister underscored the latter fact when he declared:

> It is one of the inexplicable paradoxes of history, that the greatest machine-producing nation on earth failed to turn out the mechanism of war after 18 months of seating and toiling and hustling. … There were no braver or more fearless men in any army, but the organization at home and behind the lines was not worthy of the reputation which American businessmen have deservedly won for smartness, promptitude and efficiency.

The *real* lessons of the World War I included the following:

- The genuine problems of the war concerned planning and managing an economy under stress from a high level of demand —not converting a civilian economy to the massive production of specialized munitions.
- The most far-reaching impact was planning the wartime economy and its consequences for the future.
- Mobilization impressed corporate leaders with the importance of short- and long-term planning and exposed defects in their own operations.
- The war forcefully showed corporate executives the reality that their welfare depended on government actively involved in operations of the economic system, either formally or informally
- Mobilization set in motion two principal and related developments: creation of a government-business partnership for mobilizing the economy; and integration of the military services into the national mobilization system/effort.
- The government-business *planning* partnership of World War I was an extension of the government-business *regulatory* partnership that began emerging in the prewar Progressive Era, and it constituted the dominant trend in the 20th century political economy.

Ironically, as Professor James F. Nagle notes in *A History of Government Contracting*, government and business memories of World War I colored the interwar period. The memory of the American army "begging for allied supplies haunted the military, creating a mania to be better prepared for the next war." Similarly, the memory of suffering soldiers "haunted others, who were sickened and infuriated by the idea that DuPont and Bethlehem and hundreds of other firms and individuals made millions." This latter group "vowed to prevent such profiteering in the next war." This distrust, political maneuvering, and antagonism between these two groups—"virtually a blood feud," noted Nagle—"marked the interwar period." Still, Baruch and others decided that proper planning in peacetime would overcome this traditional mobilization tangle that had, in fact, become handmaiden to the distinctive American way of war as seen in Civil War and World War I experiences.

Because of perceived industrial mobilization shortcomings in World War I, the Congress passed the National Defense Act in June 1920 to improve mobilization processes. The law created an Assistant Secretary of War who was "charged with the supervision of the procurement of all military supplies. . . and adequate provision for mobilization of materiel and industrial organizations essential to wartime needs." Based on the law, the Assistant Secretary formed

a Procurement Division (of about 20 officers) with two branches—supply and planning. The latter planned for wartime mobilization.

In 1924, about 3 years after the planning branch was first organized, the War Department developed the Army Industrial College to educate officers for mobilization responsibilities. In time, the college grew to have classes about the size and length of the Army War College (but never with the same prestige). The focus of the college was on resources for war, and within that concentration, industry. Students and faculty studied the activities of the World War I War Industries Board, surveyed American industry, and helped write several Industrial Mobilization Plans. During World War II, 90 percent of the contracts awarded by the Army went to companies previously surveyed by the Army Industrial College, and, significantly, during the war awards were made on a noncompetitive basis.

Readers should understand there was no defense industry base during the period between the World Wars. The United States, however, was indeed an industrial giant. In 1939 it had the most urbanized population, produced the most iron, steel, and automobiles, and consumed the most energy. It was the world's most productive state, accounting for 31.4 percent of the world's manufactures (Germany produced only 12.7 percent, but spent six times as much on defense and produced four times as many airplanes).

Because of the huge, if latent, American "defense" industrial capacity, President Franklin D. Roosevelt's grand strategy during World War II—the so-called Arsenal of Democracy strategy—was logistical in nature. This strategy led to the defeat of the Axis powers with the overpowering weight of munitions (especially airplanes, ships, and tanks) the enemy could not possibly match, let alone exceed. The strategy succeeded, the Allies won, and the United States suffered the fewest casualties of any major combatant.

Aware of the gravity of the political situation in Europe and Asia, Roosevelt created the first of many mobilization agencies in August 1939, the month before Adolf Hitler's Germany invaded Poland. This first organization, the War Resources Board, was terminated in November that year and left no significant record. Roosevelt probably believed the isolationist mood and temper of the country would not accept serious war planning during the so-called Phony War.

In May 1940, the month Germany invaded the Low Countries and France and the month after it conquered Denmark and Norway, Roosevelt established the Office of Emergency Management as an umbrella organization containing war-planning establishments like the War Food Administration and the War Manpower Commission. He also experimented with a series of industrial mobilization planning units, none of which succeeded for a variety of reasons, the main one being Roosevelt's unwillingness to extend full authority to these entities. In fact, it was not until May 1943 that he truly supported a mobilization organization! This was the Office of War Mobilization, under the stewardship of James Byrnes, former Director of the Office of Economic Stabilization, Supreme Court Justice, Senator, and Representative.

In July 1941, the President tried to solve a problem that had hindered all mobilization efforts to that point (and would, unfortunately, continue to hamper rational mobilization throughout most of the war); he ordered the War and Navy Departments to delineate the munitions needed for victory in a two-front war, factoring in Lend Lease aid to allies.

The services hurriedly put together a menu of needs. The Army Victory Plan called for establishing 215 total divisions of which 61 would be armored and 61 mechanized, compared to the 89 divisions produced by the Army during the entire war. Of these 89, merely 16 were armored and none mechanized (but United States Army infantry units were lavishly provided with trucks, armored personnel carriers and tanks by comparison to any enemy army). The Navy's plan called for 35 battleships, compared to only 10 built during the war; 20 aircraft carriers compared to 27 built; and 88 cruisers with only 44 built. From 1940 through the end of the war, mobilization agencies were plagued by inadequate and inaccurate information from the War and Navy Departments.

The first reasonably effective mobilization agency was the War Production Board, organized out of several bureaus created in 1940 and 1941 and officially stood up in January 1942 under the leadership of Donald Nelson, who had been part of several pre-war mobilization organizations. Its main responsibilities were to provide materials, machine tools, and workers for factories. Contracting for munitions, however, was left entirely to the armed services. From the start, unfortunately, Roosevelt did not fully trust Nelson. The chiefs of services and secretaries knew of Roosevelt's sentiment, resulting in countless end runs around the War Production Board Director and appeals to the Chief Executive to overrule him. This led to the creation of the Office of War Mobilization (May 1943) and appointment of James Byrnes as its Director. Byrnes' office was in the White House and, more importantly, his rulings were law. Byrnes was so powerful, he called himself Assistant President, and for mobilization matters he was appropriately titled (if self-designated) indeed.

The United States industrial output was prodigious, but not exceptional. The continental United States was never attacked, the American population was large and well-educated, and the state had abundant natural resources. Given the problems faced by the Soviet Union and United Kingdom, their industrial output was extraordinary—heroic in fact. The productivity of the United States, however, was sufficient to arm its own military forces, and very large segments of the Allies. In the European War, the Soviet Union killed more than three-quarters of all the Germans who died in uniform, and the Chinese killed about the same percentage of Japanese and both the Soviets and the Chinese (and the British) used numerous American weapons and logistical items.

To get the necessary workers into factories to produce this impressive output, the government saw to it that industry paid adequate wages and benefits, used draft deferments as a lure to male workers, enticed women into manual labor, and ensured that there were enough consumer goods to purchase to make war industry wages attractive.

To all intents and purposes, the American economy during World War II was a command economy, although not as regimented as the British, Soviet, German, and Japanese economies. Taxes were extremely high, war bonds were sold to absorb money from people of all economic classes, wages and prices were controlled through a number of devices, most goods worth owning were rationed, and contracts were negotiated to include profit margins. Roosevelt was determined to prevent morale-wasting inflation, and he succeeded in doing so despite large deficits. Ninety-five percent of the budget was spent on the war effort, and the bulk of that on armaments. What was the output of munitions?

The United States produced about four times the number of tanks the Axis built (more than 88,000). It also manufactured 1.6 times as many airplanes as its enemies (more than 300,000) and, if the weight of airplanes was considered, the ratio would be even higher because the most-produced airplane in the United States was the four-engine B–24. One might say, regarding airplanes, the United States produced offense and the Germans and Japanese produced defense.

The battle of the Atlantic against the German submarines was won partly through production—American shipyards could produce cargo vessels faster than Germany could sink them. The new capital ship in this war was the aircraft carrier, and the United States produced 27 (Germany and Italy produced none, and Japan very few). American shipyards built more than 82,000 landing craft, and Germany none. In only one major weapons system was the United States outproduced—submarines. Many weapons and logistic support items were sent to allies, as were useful materials such as armor plate and aluminum to be used in factories producing arms in the United Kingdom and the Soviet Union. Quantity has a quality all its own.

To produce such might, the United States adopted a controlled economy, with unique (for America) government intrusion into economics at all levels. During the Cold War, when mobilization issues were discussed, there was underlying tension between those who believed in great government domination and those who wanted to rely greatly on market forces. The debate simmered until the Korean War began when the Harry S Truman administration began to mobilize for a war on the Korean Peninsula and also a possible war with the Soviet Union. Before the end of 1950, Truman created the Office of Defense Mobilization, gave the director cabinet rank, and made him a member of the exclusive National Security Council. The Cold War/Korean War mobilization appeared to be moving in the direction of recapitulating World War II practices.

When Dwight D. Eisenhower became President in January 1953, however, the Mobilization Director was dropped from the National Security Council and was reduced from cabinet rank, and market practices became to a much greater extent the mobilization methodology. This, for lack of a better phrase, "market approach" did not change throughout the remainder of the Cold War.

When it began, the United States was more than the sole superpower uniquely armed with nuclear weapons and the means to deliver them—at no point in the future was the United States to be so uniquely powerful. In 1946, for example, the United States produced more manufactured goods than the rest of the world combined. This fact is remarkable, but not unanticipated given the smaller losses in combat than almost all major belligerents and the important fact that the continental United States was not attacked.

World War II was followed by a virtually planless demobilization with machine tools sold off for about 15 percent of value and government-built factories allowed to deteriorate. Although some preparedness mobilization actions were taken in 1946 and 1947, Truman kept defense spending low, frustrating many senior military officers. In the spring of 1950 strategists in the State and Defense Departments wrote an alarmist study, "NSC 68," which

called 1954 the year of maximum danger for America. Truman put it on the shelf and called for costing the ambitious program in the plan before making any decisions.

When the Korean War began in June 1950, "NSC 68" became the plan to deal with a nuclear-armed Soviet Union. The defense budget more than doubled in 1951 and increased by about 50 percent the next year. Eisenhower decreased the defense budget by 10 percent when he took office and tried to hold the line during his 8-year tenure.

The industrial world that emerged during the Cold War was the one the United States Government wished to emerge. Through the encouragement of American foreign direct investment, foreign aid as symbolized by Truman's Point Four and the Marshall Plan, the creation of such organizations as the World Bank, the International Monetary Fund, the General Agreement on Tariffs and Trade (today's World Trade Organization), and the United Nations, and continuous advocacy for free trade, Washington was ensuring that over time, it did not want to—nor probably could it—maintain utter domination of the industrial world, and it did not.

In 1946 the United States produced, for example, 75 percent of the world's motor vehicles and by 2002, 20 percent. In 2002 the American share of world manufactures had fallen to about 25 percent. America in 2005 is certainly much more prosperous than it was in 1946, but so is the rest of the developed world and that was certainly what the United States planned for. One example might stand for all: in 1960, Japan produced 1 percent of the cars in the world and in 1984, 23 percent. The question for many pundits in the United States is this: in an era of globalization does the United States retain a robust enough defense industrial base to produce munitions to defend itself and its allies?

The answer in mid-2005 is uncertain. The United States with 4 percent of the world population produces more manufactured goods than any other country, including those with much greater populations. Its share of world automobile production has slipped dramatically in the past 20 years, but it manufactures millions more motor vehicles than it did a generation ago. Similarly, the percentage of world aircraft production has shrunk from 90 percent in 1970 to 66 percent 15 years later; and military aircraft production has fallen by about 66 percent since the end of the Cold War. The United States is today first in the world in military aircraft production, but its margin of superiority has indeed shrunk.

Similarly, this trend holds with finished materials like steel. In 1947, the United States manufactured 63 percent of the world's steel. A decade later, while increasing steel output by 25 percent, its percentage of world output had slipped to 35 percent, and at the end of the century, while producing about the same amount as in 1957, America's global share was about 12 percent.

The decline in American shipbuilding has also been quite dramatic. During World War II, the United States far outproduced the world combined in every type of warship (except submarines) and also cargo ships. In 1970, Japan produced 250 percent more cargo ships than America. In 1977, the United States possessed 10 public shipyards, 27 major builders, and 41 major ship repairers. In 2003, there were 4 American public shipyards, 24 major builders, and 28 ship repairers. Also in that year, the United States had 3 shipyards capable

of building Very Large Ships (tankers, container ships, etc.), while Japan had 12, and Korea and China 5 each.

Thus, in June 2005 the United States still produces sufficient quality munitions to arm its active and reserve forces and remain the world's biggest arms seller. Its ranking in the world of manufacturing has declined in every category, but this is a globe it created. One last metric might symbolically stand for both past and present. In 2000, America produced more than 35 percent of the world's computer chips, and four years later, that figure had fallen to 29.5 percent. What then should the United States Government do regarding the defense industrial base to ensure its security in a globalized world?

The United States in June 2005 remains the sole superpower (at least for dealing with major conventional force threats to its interests), and would seem likely to remain so for some years in the future. It is certainly the only state with a global force projection capability. It must, however, be ceaselessly attentive to asymmetric attacks and, in line with the topic at hand, totally cognizant of emerging military, economic, political, social, and financial threats. Intelligence agencies must pay heed to harbingers of change that could erode essential defense capabilities and industries such as those that produce warships, combat aircraft, precision weapons, computers, avionics, advanced land combat vehicles, and other critical systems.

The economic philosophy that has guided United States defense manufacturing since the Eisenhower administration has been market-oriented (or at least more market-oriented than it was during World War II). It would seem that the guiding belief was this: if you want a robust defense industry, make it compete. The executive branch shunned protectionism as an economic tool (although protectionism was certainly advocated often by members of the legislative branch and manufacturers).

Doubtless, the proper government role is to confirm that the global economic playing field is level, to ensure (as best it can) United States industry is not disadvantaged by states that break the World Trade Organization or bilateral or multilateral trade treaty rules.

The government, moreover, must protect American industry against piracy. During the 20th century, U.S. business had been enormously productive, increasing the standard of living significantly. A major factor in this increase in output was superior technology, mainly because of American investment in research and development. The government must pursue those who would bootleg American intellectual property to ensure the rewards of technological growth go to those who created it.

The most important responsibility in this defense industrial base arena is to promote United States education at every echelon. At one point in world history, America led the world in education, and partly because of the quality of schooling at all levels, the United States became a magnet for immigrants who wanted to better themselves and their children. In some areas, America still leads the world; but its lead is dwindling and, in public elementary and secondary school education, it has fallen behind many less-affluent countries. If America wants to maintain and improve its defense industrial base, it must upgrade the most important of all the elements of national power—people.

# Chapter 2
# The U.S. Defense Industrial Base from the End of the Cold War to the Present

## Overview

*Lynne C. Thompson*

This session examined factors impacting the U.S. defense industrial base beginning around the time the Berlin Wall fell and the Soviet Union collapsed. Additionally, the session identified changes in the nature of the industrial base that resulted and challenges that emerged. The panel was moderated by Dr. Shannon A. Brown, a professor in the Department of Grand Strategy and Mobilization at the Industrial College of the Armed Forces.

In this chapter you will find two articles. First, Dr. Jacques Gansler, in a paper that parallels his presentation to the symposium, identifies the factors that initially shaped our defense industrial base following the end of the Cold War: declining defense budgets that shrunk defense business leading to consolidation through mergers and acquisitions; the introduction of netcentric warfare that changed the operational perspective of warfare; and globalization and increase in outsourcing. The overall result as the United States entered the second millennium was a smaller defense industrial base, fewer competitors, and increased reliance on parts being made overseas. September 11, 2001 brought a change in one of the trends as defense budgets increased significantly. But, adverse challenges have also arisen, such as the increasing national debt, increased potential of excessive acquisition oversight, and public support for the war in Iraq decreasing.

The panel discussion that followed is succinctly summarized by Dr. Brown in the second part of this chapter. In addition to providing insights into the factors introduced by Dr. Gansler, the panel introduced some alternative perspectives, such as Dr. Flamm's "revisionist perspectives," and identified current challenges that we are facing today. Some of those challenges include the need to grow multiple sources of innovative technology, the need for increased emphasis on basic research, and the need to rethink oversight procedures for acquisition. In sum, the main challenges facing the military community and U.S. defense industrial base are how to grow the U.S. industrial base and increase U.S. competitive advantage. Thus, the paper presentation and panel discussion set the stage for the afternoon panel's investigation of strategies and possible government responses in meeting the challenges.

## The U.S. Defense Industrial Base: From the End of the Cold War to the Present

*Jacques S. Gansler*

First the Berlin Wall fell. Then the Soviet Union collapsed. In response, Americans demanded a "peace dividend." And the Nation's defense budget was cut by $100 billion, with the biggest impact on procurement of weapon systems (a 60 percent reduction, which some referred to as "unilateral disarmament").

**Consolidation**

As a result of the large "Reagan Defense Build-Up," and then the sudden end of the Cold War, there existed a huge excess of defense industrial capacity by the mid 1990s. The Nation had too many aircraft plants, shipyards, missile plants, etc. to support the greatly reduced demand. Thus, with encouragement from senior leaders in the Pentagon (especially when in 1993, then-Deputy Secretary William Perry announced, at the famous "last supper" with industry executives, the absolute need for consolidation) rapid defense industry consolidation began—with a vengeance, according to some. The government actually incentivized this behavior by allowing consolidation costs to be reimbursed as overhead costs, as long as savings to the government could be projected. And, of course, this consolidation was welcomed and was being stimulated by the denizens of Wall Street who made millions on each major merger or acquisition.

These mergers and acquisitions were occurring both horizontally (such as the McDonnell-Douglas and Boeing combination in the aircraft industry, or Hughes and Raytheon in missiles), and vertically (such as Loral by Lockheed, and Westinghouse by Northrop). In less than a decade, what had been well over 50 major defense suppliers (prime contractors and large subcontractors) had been consolidated into only a half-dozen, dominant defense firms.

The Justice Department and the Federal Trade Commission were increasingly concerned about the declining number of firms available for competition; but they allowed the consolidations due to the obvious shrinkage in the available business, and the acknowledged uniqueness of the defense market structure (normally, a monopoly buyer and only a very small number of oligopoly suppliers, fighting fiercely for the few, infrequent, major procurements). The regulators reasoned that if the only customer (the DOD) was satisfied with the limited competition, and if the cost of maintaining additional potential suppliers was prohibitive, they would not object to the consolidations on antitrust grounds. And the DOD assured them (as Secretary Perry had explicitly stated) that "we will only allow consolidations if it reduces costs to the DOD, and if adequate competition will still exist after the merger or acquisition."

Importantly, it was noted, there had always been fierce competition for DOD's aircraft engines, even when only two suppliers dominated the U.S. defense business (General Electric and Pratt & Whitney)—and with Rolls Royce available should they be needed. Thus, it was agreed that two or three competitors would be adequate for competition in each critical sector and that the shrunken defense market could not support more than that.

And this move, toward the DOD feeling "satisfied" with only 2 or 3 suppliers in each critical sector of the defense industrial base, continues today. In fact, the Pentagon's February 2005 Report to Congress on the adequacy of the defense industries' capabilities, stated that

of the "255 priority, critical technologies and components for warfighting capabilities" there were "over 800 companies with relevant [sic] industrial base capabilities." Of course, it must be recognized that these firms with "relevant capabilities" are not all capable of maximum, state-of-the-art performance. And the report went on to say that, currently, of these "priority critical, technologies," nine have been put on the protection or watch lists for concerns about a loss of U.S. technological leadership or of U.S. suppliers' insufficiency.

Clearly, the shrinkage of the defense industrial base now requires that DOD no longer simply assume (as was often the case in the past) that it will always have an adequate number of competitive suppliers available. Instead, it will have to closely monitor all of its critical technology areas to assure that an adequate number (at least two) high-performance suppliers continue to exist in each area; and, if necessary, take steps (such as an award of a next-generation research and development contract) to maintain the second U.S. source.

Another option, of course, is to consider a foreign source as the alternative supplier—especially in any area in which the U.S. market size is simply too small to support two domestic sources. The United States recognized and accepted this option when it made the decision to allow its two remaining, domestic aircraft landing gear suppliers to merge, while allowing a French-owned, Canadian-located firm to compete equally on all defense programs, including the obviously critical Joint Strike Fighter. However, such competitions between a U.S. source and a foreign source must be real, i.e., the foreign source must be allowed to win if their offer is more attractive. Otherwise, they will simply stop bidding, leaving the United States with a monopoly supplier in a critical area. Naturally, politics will attempt to play a role here, and steps must be taken to address this. For example some systems of a foreign design could be built in the United States (as will be done in the award of the "Presidential Helicopter" to a partnership of a U.S. and foreign firm, based on a proven foreign design; and, as will be done with an Army transport aircraft, where the only two competing teams are partnerships of U.S. and foreign firms: and where both bids are based on foreign designs).

It must be emphasized, at this point, that since U.S. defense strategy is based upon technological superiority, the primary purpose of assuring competition (whether all-domestic, or with foreign firms included) is to stimulate innovation. (Price reductions usually come along also, but they are a secondary consideration.) And, since small businesses are often the most innovative, the government can stimulate their entry into the DOD market through direct funding of their research and development (R&D). For example, through the Small Business Innovative Research (SBIR) program, DOD funds around $1 billion per year. Such funding of small business R&D is an excellent way to introduce competition at a relatively low cost.

Another consequence of the rapid decline of the defense budget in the post–Cold War period, was that many large commercial firms—those that had the choice—simply sold off their defense divisions to the defense giants who were committed to stay in the business; for example, IBM sold their Federal Systems Division to Lockheed (by then, Lockheed-Martin), and Westinghouse sold their Defense operations to Northrop (which was, by then, Northrop-Grumman). Many observers (this author included) were disappointed by the DOD's loss of these commercially oriented, parent firms to the defense industrial base because of the loss of both their often-more-advanced technology, and their lower-cost-design orientation.

But these firms simply saw defense business as unattractive due to the low profit, excessive regulation, and shrinking market. In fact, by the mid-1990s, defense firms were themselves gathering data, and making the case that, even for them, defense business was becoming more and more unattractive (due to the lower profits being realized from the intense competition for the few procurements taking place; the heavy debt they were carrying from the acquisitions; and, of course, the shrinking defense business). And these industry claims were later substantiated by an independent Defense Science Board report on the ill-health of the defense industry in the post-Cold War period.

Some defense firms attempted to diversify into the commercial market; but their "culture" (particularly in terms of marketing, finance, and maximum-performance-at-any-cost engineering, which are all significantly different from the commercial world) made it very difficult to diversify. So, further defense consolidation appeared to be the only attractive path whereby, through consolidation, they believed they could capture a larger share of a shrinking market, and, simultaneously reduce the amount of competition in the defense market.

They also began to aggressively pursue the large and growing foreign military sales market (especially to the oil-rich Gulf states). And, by 1998 U.S. foreign arms sales reached $25 billion (certainly dominating the military-foreign-sales market). But, in general, defense firms simply hunkered-down and waited for the next, crisis-based cyclical build-up in the defense budget that history indicated was sure to come along. The only questions, they believed, were whether could they survive until then and when the build-up would come.

Eventually, of course, the horizontal integration of defense firms would have to come to an end, since the government would not allow consolidation from two firms to one (i.e., from a duopoly to a monopoly) in any critical defense sector. Both the DOD and the Justice Department demonstrated this policy by not allowing General Dynamics (who had previously bought Electric Boat) to buy Newport News, and thereby combine the only two nuclear submarine builders. So, the remaining choice for the big defense firms often was to move aggressively to buy-up lower-tier defense suppliers (the major subsystem and critical-component firms). However, when this reached the point of threatening to go from two to one suppliers in any critical sub-tier sector, again, the government had to step in—as it did in stopping the proposed Lockheed-Martin and Northrop-Grumman merger (not so much because of anticompetitive considerations at the prime contractor level, but because of the threat of creating monopoly suppliers at the critical lower tiers, and because of vertical-integration considerations). This proposed merger helped to make visible a growing concern regarding vertical-integration: namely, if one prime contractor owned or acquired the only (or even the acknowledged best) supplier of a critical subsystem, that would put them at a very significant competitive advantage against other primes who would not (as a result of the merger or acquisition) have access to that subsystem supplier on future, large weapon-system bids. Of course, the primes proposing the merger or acquisition of the lower-tier supplier usually argued that their acquired subsystem division would be a "merchant supplier" to anyone bidding against their parent firm, but this argument was not believed to be very credible.

Incidentally, this problem of "vertical integration" still exists today. It exists not in terms of a lack of multiple, subsystem suppliers, but in terms of the question "how does the government

assure that its selected prime contractor has picked the best of the possible subcontract suppliers, rather than the subcontractor that is now part of its own company (as a result of all of the prior acquisitions)?" In fact, this concern has forced the government to get much more involved with the prime contractor's "make-or-buy" decisions (on all major subsystems and critical-components) than it had been in the past. And, this issue has become an even greater concern as the government moves to the use of a "Lead Systems Integrator" on complex systems of systems. For example, on the Army's Future Combat System, the vertical-integration issue is now elevated by one level (to what had previously been the government's selection of a "platform" supplier) since this choice is now the responsibility of the Lead Systems Integrator.

**Warfare Changes**

While the massive consolidation of the defense industry, in the post-Cold War period, was largely being driven by the declining defense budget, a second major structural change in the industry was being driven by the changing nature of projected future warfare. Facilitated by the commercially led information era, there was a "revolution in military affairs" taking place —one in which the traditional weapons platforms (ships, planes, tanks, etc.) were no longer the central elements of the battlefield. Rather, future military strategy would be based on "information dominance"; and the implementation would be achieved by many, distributed, highly intelligent sensors, combined with many, distributed, precision "shooters," all linked together ("fused") through advanced, secure, global, command, control, and communications systems. Thus, the critical skills needed from industry were systems integration and information technology. Prime contractors, to win major system awards—or, more recently, systems-of-systems awards—would have to change from being suppliers of ships, planes, tanks or missiles to being "systems integrators," simulating, optimizing, and selecting the best mix of sensors and shooters, and effectively integrating them all, for various warfighting scenarios. This shift (from platform supplier to system integrator) is truly a major structural change (some might say a cultural change) for the few remaining prime contractors of the defense industry. Yet, to satisfy their stockholders and large production workforce, they still have to answer the question, "How do I keep my factories full?"—especially when, in many cases, the firm's consolidations did not result in their integrating the various factories that they acquired through their acquisitions. (For example, Lockheed Martin still builds the F–22 fighter aircraft in Georgia and F–35 fighter aircraft in Texas; Boeing still builds aircraft in Missouri, Washington, and California; Northrop Grumman still builds ships in Mississippi and Virginia; while General Dynamics still builds them in Maine and Connecticut.) Clearly, with the reduced defense budgets, to achieve the economies-of-scale that mergers and acquisitions promised, many of these duplicative plants needed to be closed down (rather than run at low volume). But, of course, that is politically very difficult, so it usually wasn't done.

Complicating this desire to achieve efficiency in defense plants, is the redundancy that exists between facilities in the private sector and those maintained by the government (from laboratories, through arsenals, to maintenance depots) for work similar to that done in the private sector. And, of course, these large (sole-source) public-sector facilities are strongly protected by their representatives on Capitol Hill. For example, one law says that at least

"50 percent of all maintenance work on defense equipment must be done in government facilities" regardless of their cost or performance.

**Globalization**

Another major structural impact of the post–Cold War era on the defense industry, was that of globalization. Even before the Cold War ended, but with increasing intensity since then, the commercial world has been thinking and acting in view of the global market, both in terms of production and consumption. And even in defense, at the parts-supplier level, essentially all U.S. weapon systems were becoming increasingly dependent upon parts from offshore (for example, semiconductors from Japan or precision glass from Germany). This was being driven, primarily, by the higher performance of these foreign sources, but also by their lower costs. However, studies were being done to show that even though there was a growing dependency on these foreign parts, there was not a corresponding U.S. vulnerability—depending upon the number of potential suppliers, the number of countries in which they were located, and particularly, whether there was a potential U.S. supplier as a fall-back alternative. And there was no need to be concerned about a violation of the Buy American Act, since that only applied to the end items and not to subcontracts or parts.

There were two other significant multinational considerations in this post-Cold War time period, one military, the other economic. On the military side, from a geopolitical perspective (far more than from a military one), it became increasingly clear that the United States would not be entering any future military operation without a coalition of allies. So, with the battlefield made up of mutually interdependent, interconnected, distributed sensors and shooters from multiple countries, it was clear that it would be in the U.S. interest to ensure that each country involved in the coalition would have the best possible technology (which was usually U.S. technology); and that all equipment had to be designed and tested to be interoperable among the coalition partners, in order to be militarily effective. (For example, in Kosovo, full interoperability was not the case; U.S. and Dutch planes flew next to each other, yet they could not communicate in a secure mode, thereby greatly reducing their effectiveness and increasing their mutual vulnerability.) Thus, critical U.S. military technology needed to be shared with our allies, and by the end of the 1990s this was increasingly recognized by both the U.S. State and Defense Departments; leading to a new, White House-announced policy in early 2001 on increased technology-sharing with our allies (known as the "Defense Trade and Security Initiative"). Of course, a clearly-stated condition for this U.S. technology-sharing with our allies was that they needed to effectively implement strict controls over further third-party transfers of the technology.

The other, perhaps more traditional, argument for greater multinational consideration of the defense industry structure was economic. Namely, if the U.S. defense budget was down and each of the European countries were cutting its defense budget (in many cases even more), then, to gain efficiencies, countries should share development costs and have common production lines (for economies-of-scale). As a result of this thinking, numerous transatlantic programs were initiated, from radios (MIDS), to missile defense systems (MEADS), to aircraft (Joint Strike Fighter). And, consistent with the commercial industry globalization trend, as well as the rapid global spread of technology in the information age, the major defense industrial

firms (on both sides of the Atlantic) began to aggressively enter each other's markets, often in transatlantic partnerships and frequently through acquisitions. The most notable of these was the aggressive U.S. acquisition program of BAE Systems (the dominant UK defense firm), first by buying Tracor, then Sanders, and, most recently, United Defense. These "crown jewels" of the U.S. defense industrial base now make BAE Systems (a "UK firm") one of only six remaining U.S.-based, major defense contractors (along with Boeing, Lockheed Martin, Raytheon, General Dynamics, and Northrop Grumman). And, who is to say what nationality BAE Systems really is. While its headquarters is in London, it has as many American employees as British employees, and it currently is between 51 and 54 percent owned by U.S. investors.

**Competitive Sourcing**

A last significant defense industry structural change for this period was the result of the fact that the world-class commercial firms (in both the pre- and post-Cold War periods, and with increasing intensity) were outsourcing a significant share of their non-core work, both to domestic and offshore sources. Companies found that not only were costs significantly reduced when work was competitively outsourced to other firms (whose core-competence was in the business area being outsourced), but that their own firm's overall corporate performance was also significantly improved. Thus, in the highly competitive, post-Cold War defense environment, U.S. defense industry also began to take advantage of this trend (with, of course, security requiring domestic sources) and began to outsource non-core business functions (particularly "back-office" operations). However, the government itself was initially reluctant to move in this direction for a variety of reasons, mostly, fear of losing jobs and/or fear of losing control over the activity. Nonetheless, as the government work force was reduced along with budgets (with the civilian workforce having been cut by 40 percent), within the Pentagon this alternative became more and more attractive to senior department managers. Naturally, recognizing an opportunity for a bigger potential market, the defense industry began to push for increased outsourcing of all government work that was "not inherently governmental." However, in the interests of fairness to the government workforce, and because they (in fact) may be able to do the work both better and cheaper if pressed by competition, there was a strong move to run public/private competitions (known as "competitive sourcing"). In literally thousands of examples of DOD public/private competitions, the results showed that no matter who won (and the public sector actually has been winning a majority of these competitions), the average price of performing these non-inherently governmental functions (that had previously been done by government employees on a sole-source basis) were reduced 30 to 40 percent as a result of the introduction of competition. And, importantly, the performance was improved significantly! So, with results like that, and with dollars short, it is no wonder that both Democrat and Republican administrations supported the concept of competitive sourcing of non-inherently-governmental work. In fact, when George W. Bush came to office he made it one of his top five Presidential Management Initiatives. And, with well over 800,000 federal jobs classified as "not-inherently-governmental" (about half of the civilian workforce in 2001), it obviously got the attention of defense industry. As a result, many of the major firms either set up or acquired outsourcing and/or services divisions. Then, with military downsizing and increased outsourcing, and with increased DOD

operations—first, for the war in Bosnia, and then Afghanistan and Iraq—demands for industry support increased significantly, not only at home, but with an increasing number of defense contractors actually working in the war zones. And this introduced a whole variety of interesting industry issues, such as: are these contractors covered by the Geneva Conventions? Are they allowed to be armed? Whose control are they under? These and other problems have yet to be fully resolved.

**Post 9-11-01**

What has been described above were the major U.S. defense industry trends in the so-called post-Cold War era; but on September 11, 2001, a new era began. The United States was at war. It was a very different kind of war (against "terrorists"), but, nonetheless, one for which the Nation's voters would clearly support greatly increased defense expenditures. And grow they did! While defense research, development and procurement had started to rise at the turn of the century (in recognition of the "procurement holiday" and the resultant equipment aging of the 1990s), the defense budget literally exploded after 2001. And then the enormous supplemental defense budgets to cover the wars in Afghanistan and Iraq just compounded the growth. So, from 2001 to 2005, even in the presence of large administration-ordered tax cuts, there was a huge increase in the defense budget; and, correspondingly, there was far less concern (by the administration, the congress, the DOD, defense industry, and even the public) about economic considerations. At the macroeconomic level, this is seen today in the poor financial condition of the country, namely the enormous and still growing deficit and a correspondingly poor trade balance. At the weapon-system level we see it in the high and growing costs of individual weapon systems. And, on the international level, we see it in the extreme protectionist measures being pushed in Congress. For example, in 2004 the House of Representatives passed a new version of the Buy American Act that would have required every part, in every U.S. weapon system, to be made in America and on U.S.-made machine tools. This action, I estimate, would have not only lowered the performance of U.S. weapons, but at least doubled the cost of each weapon! Fortunately, the Senate didn't pass it.

Another, very troubling recent trend , undoubtedly being driven by the high operating and support costs of the war in Iraq, is the significant shift away from early-stage research to near-term developments and procurements. A quick look at the fiscal year 2006 President's research budget is all that is required to see that we have made the choice to "eat our seed corn" and give up our historic, long-term defense strategy of technological superiority. Here, it must be emphasized that the issue of importance is not the total R&D budget, but the "R" (the research) part. The unfortunate shift has been to fund more short-term development at the expense of long-term research (for example, the Army research budget submitted for FY 2006 is 21 percent below the 2005 level).

This shift away from research funding is particularly troubling when combined with the growing shortage of scientists and engineers in America and the attraction of the commercial world for them. This is especially troubling considering that over half of the graduate students in these fields, at U.S. universities today, are foreign students (many of whom have historically stayed, and become our leading innovators, as U.S. citizens). Yet, we are making it increasingly difficult for them to come here; and then difficult for them to do research

here (especially if the research is "dual use"), since we are increasingly classifying such work and putting other restrictions on foreign student involvement (such as calling it "deemed export" if they use equipment in performing their university research that is restricted from foreign export).

**Increased Regulation**

The last of the recent impacts on the defense industry's future is the likely effects brought on by the "Darlene Druyun procurement scandal." I worry that this incident will have a potentially significant, adverse reaction, that—through a movement toward far greater regulation of the defense industry—will dramatically set back (under the heading of "acquisition reform") all of the positive steps to improve defense weapons and services acquisition that have occurred over the last two decades. This increase in regulation will create further, large cost increases in weapon systems, as well as build high barriers-to-entry for commercial firms (especially those in the lower-tier supplier base) to do defense business (as a result, for example , of requiring government-unique and highly specialized cost accounting requirements, as well as government-unique procurement regulations). Numerous studies have shown that such increased regulation, and isolation from the commercial industry (and even from best commercial practices), cause a significant increase in the acquisition costs of defense goods and services, as well as a slowing down of the acquisition process (with the resultant delay in getting state-of-the-art equipment to the fighting forces). And, of course, increased regulation greatly discourages world-class commercial suppliers from entering the defense market, and removes the future potential (through the use of "flexible" manufacturing) of integrated civil/military production lines that would offer great cost savings, as well as crisis-surge potential (through rapidly shifting the work from civil to military). All of this is clearly contrary to the DOD's future need for low-cost, high-performance technology, as well as for rapid and flexible industrial responsiveness.

**Conclusion**

In summary, the period since September 11, 2001, has been in many ways a reversal of the prior decade of the post-Cold War era. Defense budgets have skyrocketed, and defense industry profits are way up (the average return-on-investment for the top four defense firms in 2004 was 9.6 percent, versus comparable large commercial firms in the range of 6.69 percent to 7.3 percent). But, with the Nation's debt build-up, and the public tiring of supporting the war in Iraq, as well as the growing moves toward protectionism and a potential return to excessive regulation, the future trends for the U.S. defense industrial base are very much uncertain. For the Nation's future security, I believe these potentially adverse trends warrant very close scrutiny, and—if necessary—preventive actions.

## Synopsis of Panel Discussion

*Shannon A. Brown*

The morning discussion panel focused on the recent past and present state of the U.S. industrial base; the participants spoke on changes to the structure and composition of the industrial base since the late 1970s, and commented on the influence of globalization before and after the end of the Cold War. Members of the discussion panel included Dr. Jacques Gansler, former Deputy Under Secretary of Defense for Acquisition, Technology, and Logistics and Roger C. Lipitz Chair in Public Policy and Private Enterprise at the University of Maryland School of Public Affairs; Hon. Suzanne Patrick, Deputy Under Secretary of Defense for Industrial Policy; Dr. Kenneth Flamm, former Principal Deputy Assistant Secretary of Defense for Economic Security and Special Assistant to the Deputy Secretary of Defense for Dual Use Technology Policy, currently holding the Dean Rusk Chair in International Affairs at the University of Texas; Lt. Gen. Lawrence Farrell (USAF, Ret.), President, National Defense Industrial Association; and Mr. Alan Tonelson, Research Fellow at the U.S. Business & Industrial Council Educational Foundation.

The questions considered included:

1. What trends have influenced the restructuring of the defense industrial base since the late 1980s?
2. What are the implications of the changes in the composition of the U.S. industrial base that have occurred since the end of the Cold War?
3. What strategies have defense companies embraced since the late 1980s in order to remain viable and competitive?
4. What policies should the federal government adopt in order to ensure that the industrial base can continue to support national security requirements?

The panel discussion was preceded by an outstanding paper presentation on the recent history of the defense industrial base by Dr. Jacques Gansler (the paper has been included in this volume). The excerpted comments that follow were based in part on the questions above, informed by Dr. Gansler's opening paper, and represent the diversity of opinions expressed by the panel members.

## Major Themes and Discussion Points

*1. The Department of Defense needs to take a closer look at how and where new and emerging technologies (with military application) are being developed, and foster partnerships with firms that are often excluded from government contracting opportunities on account of the federal regulatory system that governs the defense acquisition process.*

Ms. Patrick: "It is in the small companies, companies even that have fewer than a hundred employees, that some of the most priority-critical technology resides. … the entry barriers for small companies had to be reduced significantly if our warfighters were to enjoy the benefits of this leading edge innovation. It told us, also, that the regulatory framework for mergers and acquisitions may be inadequate to give us sufficient visibility into transactions involving

these very small companies." [These remarks were based in part on findings that appear in the Defense Industrial Base Capabilities Study series.]

*2. The government must strive to be a "good customer" in order for vital relationships between the private and public to thrive; this may require making changes to the regulatory system that governs defense acquisition and procurement, or creating new technical approaches to acquisition:*

Ms. Patrick: "We must also be good customers to large or small commercial companies who don't necessarily have to do business with us because they can easily monetize their inventions in the commercial world, but who are critically important to us, particularly in the areas of commercial IT, in the functional capabilities for protection, where we share a lot of technology sources with the medical community, with law enforcement, once again with commercial IT, and in the functional concept of focused logistics, where a lot of our logistic systems are largely commercial-type systems as we go forward, and we must be good customers to commercial companies as well, which is something that we haven't done as good a job of in the past. …"

Gen. Farrell: "We've experimented with a number of ways to manage this changing animal we call 'the industrial base,' and we've done things like 'commercial acquisition,' 'lead systems integrator,' etc., and we've found that there are [problems with] all of these things and a lot of them simply haven't worked very well."

Ms. Patrick: "Our focus really now is on looking to see ways that we can expand the defense industrial base, not necessarily because we think it's become overly consolidated, but because we recognize that there are numerous small and commercial companies that need to find us to be good customers in order to be able to access and find their place in the defense industrial base… the entry barriers for small companies [have] to be reduced significantly if our warfighters [are] to enjoy the benefits of this leading edge innovation… the regulatory framework for mergers and acquisitions may be inadequate to give us sufficient visibility into transactions involving these very small companies."

*3. Several assumptions are often made about the defense industrial base, and these assumptions demand closer scrutiny if we are to understand recent history:*

Dr. Flamm: "*Revisionist point number 1*: There was *not* a huge shrinkage in defense industrial output in the 1990s… procurement budgets, authorizations, obligations, etc., were declining by something on the order of 70 percent, 60–70 percent range, in the mid 1990s… but if you look at outlays—not the spending on paperclips, PCs, that sort of thing—you find that the decline was much smaller, maybe around 35–40 percent. Also, keep in mind that in the late 1980s, defense exports were something like 20 percent of the defense procurement budget. By the late 1990s, they were up to about 70 percent—a huge change. So, you factor those two things together (decreased outlays and increased U.S. defense exports) and look at the overall size of the defense industry, it's true that it declined, but it was not the dramatic decline that is often cited when we talk about this period.

*"Revisionist point number 2:* You often hear talk about a decline in the number of defense materiel suppliers as a result of consolidation, but the fact is that, during the big defense build-up

of the 1980s, there was not a huge expansion in the number of suppliers. In fact, the long-term trend throughout the Cold War was a consolidation—a process that was ongoing even as the defense budget was increasing in the 1980s.

*"Revisionist point number 3*: How many suppliers does it take to have a competitive industry? Can we say that there is true competition within our defense industrial base? There is a methodology for asking that question: the Herfendall-Hershman Index, which is a measure of the concentration in an industrial sector… [some federal agencies use this index to establish] guidelines for when you have to start worrying about the absence of competition. Competition is supposed to be a hallmark of the acquisition system that we've had since the end of World War II…but with only two big firms (which is the case for some categories of military equipment provided by our industrial base), there is little competition in the traditional sense. In fact, this situation—two firms that divide market share—has a name: *duopoly*. Not monopoly, but duopoly—and it's pretty tough to brand duopoly circumstances "fierce competition."

Dr. Gansler: "There's a trade-off between regulation [of the industrial base] and market forces [that shape our industries], and we walk a narrow line between the two. I'm worried that perhaps we're going too far now in the direction of regulation as a result of the reactions [to scandals, concerns about the integrity of the system]. The pendulum swings between these two positions on a cycle, if you consider the history of the industrial base."

Ms. Patrick: "We look at numbers of sources in two different ways, and I think it's very important to note that we look at both of them as very important. First of all, we look at *numbers of sources* to create price competition. That's one category by which we judge the sufficiency of numbers of sources… [the government also looks at whether sources] lead in innovation. [In various studies], we've found that there are examples where there are multiple sources [and competition], but in the aggregate we have an insufficient industrial base for certain priority-critical technologies."

Gen. Farrell: "It's easy to say that supplier declines are overstated—it's a fact that 95 percent of the suppliers we had 10 years ago are still around—but that's not the impact on the military and that's not the way the military looks at it… "eaches" are the problem. What I mean by each is the single component—part of an integrated system, like the crystals used in the JDAM—that are sole source. This is a problem when the sole source—often based overseas—decides to pull the plug on the supply. Even though we still have 95 percent of our industrial base, there are other problems out there—unrelated to source numbers—that many people just don't recognize."

*4. Since the end of the Cold War, the shrinking of the defense industrial base—and a shrinking military—has created new challenges for readiness.*

Gen. Farrell: "So, everything is smaller. Fewer numbers, and so here's the challenge for industry: how do you keep your teams together? …[another challenge] is the ability to keep a full range of industrial capabilities at hand."

Gen. Farrell: "We're talking about an industry which has really radically changed from the days of World War I and World War II, and let's keep in mind that we've gone from analog technology to digital technology since the 1950s. Today, everything is digital and it's made a huge improvement in the quality and the reliability of our defense systems. … [Acquisition in the digital age] is very challenging, and I don't think we really have the tools to be able to manage many of these incredibly complex development programs—yet."

*5. The effects of globalization on the U.S. Defense Industrial Base—and the larger U.S. economy—are far-reaching with consequences that are yet to be determined:*

Mr. Tonelson: "According to research that I've done, nearly every major American industry…is losing market share in the home market. [This] tells me the United States as a site for doing manufacturing is becoming significantly less competitive. Given that the defense industry is inextricably intertwined with that manufacturing sector, that tells me that the defense industry is likely in more trouble than perhaps a lot of us realize.

"The linkages between warfighting capabilities and critical technologies seem to be very well thought out, but I often see products or things defined as components which aren't really components at all in any meaningful supply chain sense—things like kinetic kill vehicles, antenna systems, sensor systems. I mean, there may be some military system that does classify these things as 'components,' but from a supply chain standpoint, they're not components because they are, in turn, made up themselves of often hundreds or thousands of smaller parts, and many of these parts come from [outside] the United States. …offshoring is an issue that demands our attention."

Dr. Gansler: "I would argue that [offshoring] is very important, and I agree that if the DOD starts to buy [parts or equipment from overseas] just because it's the cheapest, we're making a catastrophic mistake. [If] we're buying it offshore is because it's better, that's another matter. And if we start buying the stuff *only* from domestic suppliers, we're either going to dramatically increase our costs for the parts we buy (high-quality semiconductors, for example, or precision glass) [if we must] set up a whole factory and require that work be done with only U.S. machine tools. … what we should do instead is emphasize the importance of best value purchasing rather than buying the cheapest."

Gen. Farrell: "We've never been totally self-sufficient in our defense market, and it would be kind of shortsighted to think that we could ever become self-sufficient. We need to be careful about how we do it, but globalization—and the ability to reach out to other technologies where the R&D has already been done by somebody else—can be a good thing."

## Audience Question-and-Response Summary

*What contribution do small businesses make to the U.S. defense industrial base, and what does DOD do to encourage or foster the growth of small companies that can enhance the capabilities of the industrial base?*

Discussion on this topic covered a wide spectrum of subjects, including various federal programs that are designed to foster entrepreneurial projects, and the problems associated with the over-bureaucratization of the government-business relationship.

*What human capital issues will the defense industrial base—especially the elements dedicated to research and development—face in the coming years, given projections about shortages of talent in engineering and scientific fields?*

Reponses from the panel members ranged from optimistic (about the state of education in the United States, and the ability of U.S. firms to attract quality talent) to pessimistic (concerns were raised about the ability of the U.S. to create and protect intellectual property if large numbers of engineers and scientists are foreign-born).

## Summary

The end of the Cold War accelerated changes to the composition and size of the U.S. defense industrial base—changes that were underway before the collapse of the Soviet Union. Since the early 1990s, U.S. firms have continued to concentrate their efforts on high-technology solutions to military problems, and the relentless pursuit of "the leading edge" has taken place against a backdrop of corporate consolidations and evolving government regulation. Globalization—a process that, in fact, pre-dates the end of the Cold War—is an important factor when considering the future of the defense industrial base. Politicians, military leaders, and businesspersons alike are coming to terms with the fact that defense industries are global, and that they will become more interconnected in the years to come.

Ms. Patrick: "It really is the thing that distinguishes the United States defense industrial base from all other defense industrial bases that I've become familiar with during my tenure [as Under Secretary of Defense for Industrial Policy] is that we do not adopt a cost-constrained or an imagination-constrained attitude when we think about warfighting capabilities. We strive to understand what it is the warfighter 20 years from now will need and we strive to produce that and we strive to do the hardest things, the most innovative things well, and that will always be our claim to fame."

# Chapter 3
# The U.S. Defense Industrial Base: Past, Present, and Future Challenges

*Lt. Gen. Michael M. Dunn, USAF*

*Editor's note: This chapter is based on the speech presented by Lt. Gen. Dunn at the Fort McNair Officers' Club on June 2, 2005.*

Good afternoon ladies and gentlemen, I am pleased to address this symposium on "The United States Defense Industrial Base: Implications of a Globalized World."

We have had a challenging morning with stimulating discussion, which raised the strategic questions we hope this symposium will begin to answer. Frank Cooling and Alan Gropman showed that there has been no single approach for dealing with the defense industrial base over our 230-year history. Arsenals and government shipyards were once key, then private industry was central; but during World War II, the United States operated a command economy producing the "Arsenal of Democracy" that helped win World War II. A command economy, however, as an organizing principle was rejected during the Cold War, especially after January 1953, when Dwight Eisenhower became President.

We also saw declines in America's *relative* industrial might between 1945 and 2005, mainly because the United States sponsored investment in industries on every populated continent, and helped create global free trade.

Jack Gansler took the story forward for another 15 years and gave us his knowledgeable views on the workings of the base since the end of the Cold War and also his practical thoughts on improving it. We look forward to Pierre Chao's paper after lunch that will deal with his approach to advancing the base. Let me tell you how I see the situation.

The American way of war has been to equip the warrior with high technology munitions which has led to the United States losing fewer men and women in combat than its adversaries—even in losing ventures like Vietnam. In World War II, the United States lost about one-tenth as many killed in action as Germany, and the latter had a smaller population base to suffer losses. The story is the same in the Great Pacific War. Japan's number of those killed in action was nine times ours.

We accomplished this largely through the "Arsenal of Democracy" strategy of supplying allies—the United Kingdom, Soviet Union and China—with munitions and providing logistics, with a capital L, for our troops.

During World War II, the United States also supplied munitions material to its allies—armor plate to make tanks and aluminum to make airplanes. The Soviet Union manufactured more than twice the number of tanks as Nazi Germany manufactured—many built with American armor plate. We also manufactured more than four times the number of Germany's tanks and gave 10,000 tanks to the Soviet Union, which was half the total that Germany manufactured. At Sevastopol in 1944, the Soviets outnumbered the Germans in tanks 12.5:1—

quantity has a quality all its own. We gave the British more than 20,000 tanks, more than Germany's total tank production.

We know the United States is still a great manufacturing country today, but many of the industries that produced the Arsenal of Democracy from 1941 to 1945 are not as robust as they were in the later 1940s, 1950s and 1960s. In 1939, General Motors was America's biggest employer, today it is Wal-Mart! But does that matter?

We learned today the country that produced 80 times as many motor vehicles as Japan in 1941, was passed in automobile production by Japan in 1980. We saw Japan has more than three times as many shipyards capable of producing sea-going giants than the United States. The United States share of world manufactures has shrunk dramatically since the late 1940s, but we still produce a lot of cars, airplanes, computers, rifles, artillery pieces, tanks, etc. We do indeed have a defense industrial base that makes our military units the best equipped in the world, and we also manufacture quality arms sufficient for the United States usually to be the world's biggest munitions exporter.

Sure, the United States' economy is today more oriented to services—banking, insurance, software—but it is still a prodigious manufacturer, its output with 4 percent of the world population is a quarter of the world's output of manufactures.

General Cody asked about the health of the current defense industrial base, and I would answer that it is reasonably healthy, but there are reasons for concern. There have been many defense industry mergers. There are, therefore, many companies competing for contracts which means less competition and less internal research and development; this, in turn, could mean less innovation, less capability, and less surge capacity in a crisis.

Also, the entire industrial base of the United States has shrunk as a portion of the American economy and with it the defense industrial base. There are, therefore, fewer factories that could be converted to make munitions. During World War II, Oneida Silver Plate stopped making spoons and forks and made more than 600 items needed by our military!

Between 1998 and 2003, the percentage of gross domestic product produced by U.S. manufacturing fell from 15.36 percent to 12.68 percent and that percentage is expected to decline further. This relative decline, however, is partly balanced by two significant changes.

First, manufacturing, like much of industry since the 1980s, has focused on "core competencies" and largely divested itself of functions that could be easily outsourced. When these functions migrated outside the factory gate, the Census Bureau reported a significant drop in manufacturing jobs and a similar increase in service jobs.

The second change was a major manufacturing productivity revolution going on simultaneously. This revolution had its foundations in massive investments made during the 1980s in information technology and new plants and equipment. This investment, you may recall, took place when most pundits predicted the Japanese would "eat our lunch."

Between 1972 and 2003 total manufacturing production increased by more than 270 percent while the workforce fell from 17.2 million to 14.5 million. Manufacturing productivity remains the major driver of U.S. GDP growth. Manufacturing of computers and electronics today fetches 20 percent more dollars in our economy than does motor vehicle production. That trend illuminates all manner of developments.

How is the defense industrial base changing? First of all, it is becoming more global. Look at the way the Joint Strike Fighter is being built and where it is being built. Look at how well Airbus Industries competes with Boeing. In terms of trade in goods and services, the world has returned to a level of globalization surpassing every index in the past. Commercial firms are increasingly engaging in international trade that takes many forms. Whether the defense industrial base is following this trend with the same level of enthusiasm is a matter of debate as is the power of countries to check this trend or to alter it to suit their self-interest.

I would suggest that despite rhetoric to the contrary, sovereign governments retain great power over their defense industry, both native born and foreign owned on their shores. Yet there are trends that need exploration that I am sure we will undertake in the conference. Among these are:

1. The benefits and costs of further liberalizing U.S. trade in armaments.
2. The real impact of offsets especially on our defense subcontractor base.
3. The increasing presence of foreign defense companies setting up shop here: for example BAE, EADS and others.
4. The continuing trend to establish special relationships for trade, development and technology transfer.
5. The potential for creation of Fortress Europe and Fortress America.

Like all industry, the defense industry is global. Weapon systems we use have components made in many countries, some allied with the United States, some not allied. I don't believe this is necessarily bad or dangerous, but it is a fact that schools like the National Defense University and the Industrial College of the Armed Forces within the University are acutely aware of.

Twenty-five years ago when the Industrial College students traveled to study industry, they traveled entirely in the United States. That is no longer true. Industry is global, the defense industry is global, and the students, therefore, travel globally.

What characteristics make the modern industrial base different from that of the past? The global nature which I have mentioned is one, and foreign ownership (or heavy investment) in defense manufactures is another. This phenomenon is driven by the fact that the United States spends four times as much for armaments procurement as the European Union.

Let me finish with two notions I believe this symposium might consider. We have a defense industrial base, and it is a good one, but it has non-prime contractor problems that can be critical when war heats up. Specifically, we have significant difficulty surging small arms ammunition, batteries for guided systems and combat rations. There is, furthermore, more to preparing for combat than industry.

What we do not have, and have not had since the end of the George H.W. Bush administration, is a civilian organization to consider mobilization-planning issues across the spectrum: not just industry, but also people, transportation, finance, etc.

Up through 1991, we had in the Federal Emergency Management Agency (FEMA) an Emergency Preparedness/Mobilization Division that was eliminated by James Lee Witt, and not resurrected by Joe Albaugh.

During the first Gulf War this small (30-person) organization was tripled in size and it became the mobilization adviser to the National Security Council and the analysis behind the

Emergency Preparedness/Mobilization Policy Coordinating Committee made up of people across government departments that met in the Pentagon and saw to it the Defense Department got what it needed for Operation *Desert Storm*. That Policy Coordinating Committee no longer exists.

The Mobilization Division in FEMA, which is now in the Department of Homeland Security, exercised mobilization simulations across the government regularly, and there have been no such interagency exercises since 1991.

There is an existing Executive Order—12656—that calls on FEMA to advise the National Security Council on mobilization issues, but there is no organization to do that. I can assure you as a veteran military officer, that we have joint military problems, though we are doing much better than in the past, but the interagency process is broken and that is the major reason we need a mobilization planning entity to pull together the American economy and all government departments.

My last point: I believe we must avoid using national security as an excuse to keep alive through protectionism, of one form or another, an industry that is lagging technologically or managerially. Politicians and manufacturers have often used defense as a shield for poorly operating companies. We can no longer afford this because such action detracts from our ability to support the warfighter.

# Chapter 4
# The Future of the U.S. Defense Industrial Base

## Overview

*Sheila R. Ronis*

The purpose of the afternoon session was to discuss the trends affecting the future U.S. defense industrial base and to examine the options for the way forward including "appropriate" government responses to form the future base to be most responsive to national security needs, both current and emerging. The diverse membership of the panel ensured that many points of view were considered

Overall, the issues of increasing globalization and change are taken as irrevocable and impacting the U.S. defense industrial base. The associated issues of the changing threats to U.S. security, a global marketplace, increasing technological changes and the accelerating pace of offshoring and foreign participation in the defense process were enumerated.

Shaping the world to support U.S. national interests through defense acquisitions appears poorly coordinated and not effective. There is no consensus regarding how the United States is preparing to support defense industrial cooperation between nations in any systematic way. There certainly did not appear to be a clear plan to support the needs of the warfighter while maintaining strength in the domestic base.

The defense industrial base will remain ultimately tied to national politics, jobs and changes in the defense research and development (R&D) and procurement accounts. Despite the continuation of many platforms, the numbers of people employed in the defense sector has declined and the cost of maintaining the military has soared, forcing the Department of Defense to outsource many functions that had been considered the purview of the uniformed military.

The competition between national interests (e.g., control of technology) and the need to build international relationships necessary for global action will continue to increase with fewer competitors and an increasing rationalizing of companies across borders.

The need for the United States to maintain some industrial leadership with world-leading technology development is considered an imperative, but very difficult to achieve in a global economy, especially when the need for innovation is getting tougher with consolidation and a reduction in the numbers of competitors.

The need to define allies and countries that can be trusted is increasingly essential since the U.S. industrial base must work globally to support the needs of the warfighter in the 21st century. Is there any remaining strategic case for keeping any portion of defense manufacturing in this country? Perhaps, but Wall Street's requirement for earnings will make it increasingly difficult for U.S. companies to maintain their presence of all work within U.S. borders.

The trends affecting the future U.S. defense industrial base include the following: the "relentless" march of globalization resulting in an increased need for international cooperation, the possibility of significantly declining defense research and development and procurement budgets, the changing nature of a largely asymmetric threat, and the emergence of new and unknown technologies. Within this environment, the U.S. Government's ability to form the future base will be constrained as defense orders decline causing Wall Street to "insist" that capital be diverted out of the defense market into more profitable endeavors.

## The Future of the U.S. Defense Industrial Base: National Security Implications of a Globalized World

*Pierre Chao*

Since its inception, the U.S. defense industrial base has operated in an environment shaped by the processes of globalization. In fact, industrialization and globalization have been closely interlinked phenomena over the last 150–200 years. Certainly, the level of integration has waxed and waned over time, but some form of global interaction has always been present. Globalization is, therefore, not something to be accepted or denied; it is part of the economic landscape. The goal for policymakers should be to understand the phenomenon of globalization, to prepare the industrial base for it, and to harness it for the benefit of the Nation.

### The Waves of Globalization Impacting the Defense Industrial Base

Depending on the analyst, the world is experiencing either its second or third major wave of global integration. Tom Friedman, in his book *The World is Flat*, claims we are in the third era of globalization. Globalization 1.0 was from 1492 to the early 1800s and was characterized by countries globalizing; Globalization 2.0 was from 1820 to 2000 and was characterized by companies globalizing; and Globalization 3.0 began in 2000 and will be driven by individuals going global.[1] Historian Robbie Robertson defines the three waves of globalization as 1500 to 1800, based on the globalization of trade; 1800 to 1945, driven by industrialization; and 1945 to present, based on the post-war "architecture of a new world order."[2] Other observers, in particular world systems analysts, take a longer view and identify multiple cycles of global integration throughout history. The Roman Empire is identified as a period of greater "global" interaction. The spread of Islam in the 7th and 8th centuries has been identified as a globalization process that linked European, African, Middle Eastern and Asian peoples into a globe-spanning network.[3] The Mongol Empire of 1200–1350 managed to unify the entire Eurasian landmass, permitting a period increased "global" trade, cultural exchange and technology transfer. This Eurasian network also facilitated the spread of the Black Plague, a vivid reminder that globalization has its downsides as well as its benefits.

The U.S. defense industrial base has been subject to slightly different waves of globalization. The first era of globalization for the defense industry parallels the broader wave driven by industrialization and corporations a la Friedman and Robertson (1800s to 1945). The trade flows, technology transfers, and exchange of talent between the defense industries of Europe, North America, and Asia during that period were staggering in relation to today. The munitions, shipbuilding, and nascent aircraft industries comprised the core of this global network. Names such as Krupp, Armstrong, Vickers, Schneider, Du Pont, U.S. Steel, Wright, Curtiss, Fokker, DeHavilland, Boeing, Douglas, Lockheed and Grumman became famous, and in some cases infamous, during this period.

The next great wave of globalization relevant to the U.S. defense industrial base recently began with the fall of the Berlin Wall and the end of the Cold War. The anomalous period, in many ways, has been the intervening 45-year period from 1945 to 1990. It was unusual because it marked a time when the global defense industry was divided into two major, disconnected blocs and it was a period that began with the U.S. defense industry unchallenged in the world. World War II left major centers of aerospace/defense competence, such as the French,

German, Italian, Dutch and Japanese industries, shattered. Other European aerospace/defense competitors such as the Poles, Czechs, and Russians were locked behind the Iron Curtain. Even the once dominant British aerospace/defense industry was burdened by the legacy of the Second World War—the strategy of dispersing facilities and building shadow factories across the United Kingdom in response to the Nazi bombing campaigns resulted in gross excess and inefficient capacity. Thus, for the first 20–25 years of the post-World War II period, Europe and Japan were focused on rebuilding their defense industries and the UK struggled to rationalize its industry. Even after the rapid demobilization of America's "arsenal of democracy," U.S. industry still loomed large compared to the rest of the world in the 1950s and 1960s. For example, by the early 1950s the U.S. military aerospace industry was out-exporting the UK industry two-and-a-half or three to one, compared to the pre-war situation where the U.S. and British aerospace industries sold an equal amount in the export market.[4] Given the strong starting position, it was inevitable that the U.S. (defense and broader) industry would lose ground and market share as the rest of the world rebuilt itself.

The reintegration of the two big economic and philosophical blocs, capitalist and formerly communist, into one global system is the defining characteristic of this post-Cold War wave of globalization. The opening of "new" markets in Eastern Europe, Russia and China has brought 1.6 billion people into the global economy—new consumers, but also new sources of competition and labor. It has provided access to new sources of capital. And it has injected into the global economy the ideas (the intellectual property) of entire populations that were once trapped behind the Iron Curtain.

**What's Different This Time?**

New markets, new competitors, and new sources of labor, capital, and ideas—there is nothing particularly unusual about these elements and they have certainly been easily absorbed in the past by the global economy. This wave of globalization has three unique characteristics, however:

- The network of relations is currently "denser" than in prior rounds of globalization. The major globalization waves since 1500 have been based on networks of elites, governments and corporations. As Tom Friedman notes, however, this round is about the individual globalizing. It is a far more "bottom up" process and the sheer number of people, organizations and groups that are interacting on a global scale for the first time in history is unprecedented. The downside is that individuals like Osama bin Laden, a 14-year-old Russian hacker, or a Chinese farmer who keeps chickens in his house can morph into the global threats of terrorism, cyber-crime, and the avian flu.
- In this round of globalization, not only are the links denser but the "pipes are fatter." In the past, globalization was achieved through fairly thin connections. In the eras of proto-globalization, like the Mongol Empire, it was achieved via the trade caravans of the Silk Route and the Indian Ocean trade. In 1913, at the height of the British Empire and the industrialization-driven wave of globalization, trade in manufactured products hit a peak of 12 percent of global GDP. That figure was passed in the 1970s[5] and today manufacturing trade is 20–25 percent of global GDP. Capital flows as a percent of GDP hit a peak of 9 percent in the early part of the 1900s, while today capital flows represent

about 28 percent of global GDP.[6] The telecom bubble of the late 1990s resulted in 39 million miles of fiber optic cable being laid (enough to circle the globe 1,566 times),[7] providing the infrastructure for greater information flows. According to almost any metric used, the world is more integrated than in prior periods.

- The third difference is a byproduct of the "denser networks" and the "fatter pipes": information, technology and change propagates faster today than during any other period. In the era of proto-globalization, China held onto the monopoly of silk production for several thousand years until silkworms were smuggled to the West in the 6th century AD.[8] In the last round of globalization, the United States held onto the monopoly of nuclear weapons for four years in the late 1940s. Today, bootleg copies of the most recent Star Wars movie were available on the internet within hours of its theatrical release. The greatest challenge for governments and policymakers is this rapid pace of change brought on by globalization. The inability of government to react to the shifting global landscape as quickly as the business community or individuals remains the greatest source of tension in the system.

**The Industrial Response to Globalization**

It can be argued that the business community has delivered the most predictable response to the phenomenon of globalization. The drivers of corporate behavior are simple and time-tested—the continuous search for markets, capital, labor, and, ultimately, profits. The most nimble governments have been able to devise policies that leverage these drivers, shape corporate behavior, and harness globalization.

The search for new markets has been attracting almost every sector of the economy to the countries of the former Soviet Union, Eastern Europe and Asia. In particular, the notion of 1.1 billion Chinese shifting from a peasant, agrarian-based population to a middle-class, urban population has been particularly alluring. An industrializing China is generating the demand for every manner of raw materials, industrial goods, consumer products and high technology. Both Airbus and Boeing predict that Asia, and China in particular, will be the fastest growing air travel market for the next 20 years.[9] On the other hand, in the defense sector, the United States is the "new" and attractive market. The U.S. defense budget has grown impressively since the late 1990s and is currently $465 billion, representing about half the world's military spending and over three-quarters of the world's defense R&D spending.[10] It should be no surprise that every major defense company in the world is trying to access the U.S. market. The desire to be physically close to these new customers has been one driver behind the off shoring of facilities to Asia and other markets, and behind the establishment of U.S. operations by European defense firms.

The opening of new markets to the global economy has also introduced new competitors. In the last wave of globalization, it was Japan and the Asian Tigers (Taiwan, South Korea, Singapore and Hong Kong) that became global competitors in the automotive, machine tool, consumer electronics and high technology markets. In this round, all eyes are on an industrializing China, India and Southeast Asia. In the last 20 years, Canada and Brazil have become major aerospace powers through their development of regional jet aircraft. In the defense market, it is the United States that has benefited from the introduction of new competition. In the

1980s, the Soviet Union and the United States each had one-third of the military export market. By 2000, the United States had 50–55 percent of the export market for defense goods, with most of the gains at the expense of the Russians/former Soviet bloc countries.

The search for human capital has manifested itself in a variety ways in the globalizing economy—the legal and illegal migration of low-cost labor into more developed economies, for example. Israel benefited immensely in the 1990s from the migration of highly educated Russian Jews. India's large population of low-cost, well-educated and English speaking people has made it a central actor in this wave of globalization. One changing dynamic has been the ability to access human capital without the need for migration or movement, thanks to the global telecommunications infrastructure laid during the last decade. In the aerospace and defense worlds, Western companies now have direct access to Eastern European and Russian technical and engineering talent (throughout the Cold War the only flows were the occasional defectors). Today, for example, Boeing and Airbus have a Moscow Design Center to tap into world-class aerodynamicists. China has been relying on Russian engineering talent to improve its defense technologies for decades now.

The access to a global labor pool also means access to a world of ideas and innovation. For the aerospace/defense community this global environment returns the industry to familiar territory. Since its inception, the aerospace/defense sector has been one of the most global industries of the economy and has always relied on the considerable interchange of intellectual capital and people. A quick survey of the key elements of current U.S. military technological superiority reveals a plethora of foreign technology and technical talent. The development of atomic bomb was based upon a group of German Jewish scientists who fled Nazi Germany. An Irish immigrant invented the modern submarine. Space launch and intercontinental missiles were also thanks to a group of German scientists. The jet engine and the tank were British inventions. Stealth technology was the result of a Lockheed Skunk Works engineer coming across an obscure Soviet algorithm.[11] This tradition has continued to today. The Army's M1A2 Abrams tank uses a German 120mm cannon and British armor technology; and the Stryker armored vehicle is a Swiss design. The Marine's new howitzer is a British design. The President's next helicopter will be an Anglo-Italian design. America's next generation Atlas space launcher uses a Russian rocket engine, while the next generation F–35 Joint Strike Fighter uses British engine technology. All but one of the bidders in the Navy's new Littoral Combat Ship program is using foreign hull designs or technology.[12] The links between the U.S. and European industry are clearly deeper and broader than is commonly perceived.

Finally, the pursuit of international capital has been accelerated in this latest round of globalization. Much has been made of the fact that, in the broader economy, a significant portion of the U.S. deficit is currently being financed with Asian and European capital (half of the U.S. treasury debt is held by foreigners versus 5 percent in the 1960s).[13] In the defense sector, European governments have been privatizing their state-owned defense businesses and turning to private capital to finance them. In the 1980s the UK privatized British Aerospace (now BAE Systems) and Rolls Royce. In the last decade, France's Aerospatiale (now EADS), SNECMA and Thales; Italy's Finmeccanica; and Russia's Irkut (maker of Sukhoi fighters) have all seen stock market listings. Today, half of BAE System's shareholders are non-UK (mostly U.S.); so is it an

American or British company? Bofors of Sweden, the gun maker that was founded during the Thirty-Years War 350 years ago, was acquired by United Defense of America, which was just acquired by BAE Systems. Is Bofors Swedish because of its location or American because of its direct ownership or British because of the ultimate ownership by BAE Systems or American because half of BAE Systems' shareholders are American? The fungible nature of global capital flows is straining traditional notions of nationality, even in the defense sector where nationality has been so important.

Two assessments can be made of the overall impact on the defense-industrial base of this latest round of globalization. The first observation is that the level of international integration has risen across the entire industry. Every sector of the defense industry has become more global than it was 20–30 years ago, even recent bastions of nationalism such as naval shipbuilding. This is particularly true for the lower tiers of the defense industry, which have been at the forefront of globalization. The search for new points of competition has been the central dynamic driving the systems and subsystem providers into the global market place. What is the point of having teams of engineers developing the next generation hydraulic pump, avionics suite or landing gear unless there is a program/platform to put it on? In the face of fewer domestic programs being started, the aerospace/defense supplier base has gone global to look for opportunities. The Canadian and Brazilian regional jet manufacturers were greatly aided by international systems providers—certainly not initially by Boeing or Airbus. SNECMA, the French engine and systems manufacturer, has the U.S. Air Force as its largest customer. It is primarily this growing interaction at the system and subsystem level that has raised the overall level of globalization for the defense industry.

That being said, the second observation is that the level of globalization varies widely by industry segment. As we have noted, the commercial and military aerospace sectors are amongst the most globalized in the industry. Almost every future fighter and commercial aircraft design is being undertaken as a collaborative project and they all contain systems and subsystems provided by international suppliers. The burgeoning homeland security sector is another inherently global market—not only are the underlying technologies being developed internationally, but there is a logic to ensuring that homeland security products are widely distributed throughout the world (and interlinked) in order to solve the problem of terrorism.

Other sectors can be described as moderately global. The armored vehicle sector, which until recently was a very nationalistic market, has recently undergone a wave of international integration. Today, there are two trans-Atlantic armored vehicle groupings centered around General Dynamics (which owns the American M–1 tank business, the Canadian GM Defense armored vehicle business, the Spanish Santa Barbara Sistemas tank operations, the Swiss MOWAG armored vehicle business, and the Austrian Steyr armored vehicle operations) and BAE Systems (which owns the British Alvis armored vehicle and Vickers Defence tank operations, the American United Defense armored vehicle business and the Swedish Hagglunds armored vehicle operations). The space launch market can also be described as moderately global as it has certainly internationalized over the last 30 years (the creation of Ariane and the reintegration of the Russian industry), but the classified space side of the market has remained understandably nationalistic.

The naval shipbuilding industry, as previously noted, has also become more international in this round of globalization. As with other industry sectors, globalization in shipbuilding has been primarily at the system and component level; for example, a small American manufacturer provided the aircraft elevators for a French aircraft carrier and the next-generation British aircraft carrier will be designed by an Anglo-French team. However, relative to other defense industry sectors, shipbuilding still remains a nationalistic market. The really interesting case is information technology. In the general economy, the information technology and software industry is extremely global—so much so that it can be claimed it is driving the current wave of globalization. However, in the military world, the defense IT market remains extremely nationalistic as security conscious governments demand that software be written by domestic employees. This understandable policy is creating a growing disconnect between the commercial IT and the defense IT world that will eventually perpetuate a crisis that governments will have to address.

**The Policy Response to Globalization**

The central point to be made regarding globalization and governments' response is that "one size does not fit all." In fact, the areas of greatest tension or strain occur when governments attempt to implement policies that are either disconnected from the underlying realities or are misapplied. For example, having a 100 percent (or even 50 percent) "buy domestic" rule on cobalt, a critical mineral used in aircraft engines, would not work for the simple fact that all the sources of cobalt are outside the United States.[14] An example of a misapplied policy would be applying traditional efficiency metrics (those appropriate for manufacturing) to basic research; for example, 90 percent failure on a defense contractor factory floor is grounds for an inspector general investigation, while 90 percent failure by DARPA should be the norm.

The goal therefore becomes to look for areas of policy disconnects, where government policy is under strain either because the underlying landscape is changing due to globalization or "one size fits all" mentality is causing a misapplication. This exercise should be conducted at all levels of policy.

At the strategic level, there are significant strains currently being generated as the Pentagon attempts to shift resources away from traditional, peer competitor threats to the new challenges of irregular warfare, catastrophic events, and disruptive threats. The latter two strategic challenges, catastrophic (a bioterrorism event or an act of nuclear terrorism) and disruptive (the invention of a new technology that would obviate stealth, for example), are inherently global problems. The catastrophic challenge of the post-September 11 era will only be met by being forward leaning, engaging the world and being a global actor. The disruptive challenge, essentially a science and technology problem, is answered by scanning the world for the best technologies available.

At the level of acquisition policy, if there is a desire for the U.S. military to have the best technology at the lowest price, it will push industry toward globalizing for all the reasons described. On the other hand, if there is a willingness to pay higher prices and to devote a greater proportion of the GDP to the military, then it may be possible to have all-American products. This is the true trade space.

Creating the right policy responses to the challenges of globalization requires several key actions:

- Determine what is strategic, what provides an asymmetric advantage, in order to identify what sectors of the economy or defense-industrial base should be strengthened or defended. As any military strategist would point out, an attempt to defend everything ends up defending nothing. Without an assessment of what is strategic, it becomes impossible to prioritize. A situation then develops where government resources are spent protecting the anchor chain,[15] ball bearing,[16] and bus industries,[17] and yet little is done about the semiconductor industry (see Senator Lieberman's 2003 white paper).[18]

  In addition to assessing what is strategic, it is also important to understand the value chain of each industry sector. What provides the critical competitive advantage? Is it important to strengthen/protect the raw component, the process, the machinery that manufactures the product, the subsystem providers or the integrator? Understanding what is value added, once again, permits a better allocation of scarce resources.

  Finally, understanding the technology cycle is important. The appropriate policy will differ based on how rapidly the technology is changing. It may not be necessary to strengthen/defend a technology with short development cycles because an investment in the next generation could recover the competitive position. The fact that Japan had the world's fastest supercomputer by the mid-1990s following a decade of targeted government industrial policy in 1980s caused a considerable amount of angst in the United States. Japan held the top spot for only 2 years (1995–96), then regained the position of manufacturing the world's fastest supercomputer in 2002, and just lost it again to the United States in 2005.[19] A technology with very long cycles, however, may require closer monitoring, because it may not be possible to regain a lost leadership position. It would take decades for the United States to create a viable competitor in the regional jet market place.

- Replenish the seed corn through investment in research and development. There are two strategies to adopt in response to globalization: have the best industrial policy in the world and guess correctly each time what sector to defend or not, or have a robust economy that has a deep and wide pool of human, physical, and intellectual capital that is dynamic enough to reallocate resources and meet the next challenge. Since the first strategy is impossible to sustain over time, an incorrect guess is inevitable. The abysmal failure of the Soviet command economy should be evidence enough. Central to the second strategy is investment in research and development that allows the economy to "run faster." It requires investment in basic technology, product innovation, and process innovation. One of the major issues the defense industry is facing is the growth in military software projects. Major systems like the Army's Future Combat System will require over 30 million lines of software code (as big as Microsoft XP and hitting ctrl-alt-delete in the middle of a battle is not an option). If the size of software projects has expanded tenfold but software generation productivity has only improved fourfold, it becomes very clear that there is a major crisis on the way. Furthermore, this represents a situation where the commercial sector does not have an incentive to solve the problem,

because, unlike the defense sector, it has an escape hatch by leveraging globalization and offshoring software programming to lower cost countries like India. The defense sector is left to its own devices in this case, which represents an ideal area for government investment in process innovation.

- Align incentives with areas that matter to business. Unrealistic "sticks" will generate very bad behavior. Creating a provision that forces the purchase of domestic goods, if those products do not exist in the United States, will inevitably force industry to cheat and break the law. Equally, telling a European company they cannot sell to the U.S. military if they sell to China is a meaningless threat if they are already barred from the American market for other reasons. "Carrots" that incentivize the wrong things are also useless. In order to shape industry's behavior it is critical to understand what motivates business. It is ironic that it was a communist government that established, in the finest capitalist tradition, a set of interlocking incentives (tax subsidies, world-class housing provided to engineers, extensive stock options for scientists, government-funded industrial parks) to attract the semiconductor industry to China. Given the opportunity to lower manufacturing costs by 30 percent, it would almost be a breach of fiduciary duty not to open up a semiconductor lab in China. Contrast that with a visa policy that makes it more difficult for top, international, technical talent to travel to the United States.
- Use the full range of tools available. Bearing in mind the key point that in a globalizing world one size does not fit all, it becomes critical to be creative and use all the possible policy responses. In some cases, this requires redefining the landscape, for example, by changing the definition of a trusted person or who is an ally. If the issue is single sources of supply, it could involve diversifying the supplier base even more globally under the premise that the United States will not go to war with everyone. Or, if the issue is that semiconductor manufacturing is moving to China, perhaps the answer is not building a trusted foundry in the United States, but to develop a mechanism to do anonymous buying so the supplier does not know where the chips are going (creating a disincentive to tamper with the product). It may involve thinking about traditional parts of the defense industrial base in a different way. The arsenals and depots possess interesting capabilities; perhaps they could play a larger role in manufacturing obsolete parts (the diminishing sources of manufacturing supply problem). The central point is simply that complex problems require creative answers.

Embracing change is fundamental to surviving the globalizing environment of today. It is particularly critical for government to do so, because it will be in industry's nature to adapt to this changing environment. The challenge will be for policymakers to keep up with all this change, let alone get ahead of it and shape industries' behavior. Becoming more nimble and creative is not an option; it is a necessity.

## Endnotes

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## Synopsis of Panel Discussion

*Gerald W. Abbott*

The purpose of the afternoon panel was to discuss the trends affecting the future U.S. defense industrial base and to examine the options for the way forward including "appropriate" government responses to form the future base to be most responsive to national security needs, both current and emerging. Members of the panel ensured that many points of view were considered. The members were: Mr. Pierre Chao, CSIS Senior Fellow and Director of the Defense-Industrial Initiative; Mr. Torkel Patterson, President of Raytheon International and Vice President of Business Development; Mr. Mark Ronald, President and Chief Executive Officer of BAE Systems North America; and Dr. Harvey Sapolsky, Professor of Public Policy and Director of the Security Studies Program at MIT.

The questions to be considered included:

1. What is the character of globalization with the context of the U.S. defense industrial base?
2. What are the major national and international trends that are shaping or will shape the future U.S. defense industrial base?
3. What do you foresee as the major characteristics of the future U.S. defense industrial base in view of the shaping trends?
4. What do you believe will be the strategies followed by defense companies to ensure survival and preeminence in the future defense industrial base?
5. What will be the major challenges facing the U.S. Government as it attempts to "shape" the base and ensure base responsiveness to U.S. national security requirements?

The plan was for the moderator, Dr. Gerald Abbott, Professor and Director of the ICAF Industry Studies Program, to ask one panel member to initially answer or address a question to be followed by comments from the other panelists with supporting or contrary views. As happens with most plans when confronted with reality, this plan was largely overtaken by the vigor and intensity of discussion from which emerged the following major themes.

## Major themes and discussion

*1. Change is a relentless force shaping the U.S. defense industrial base: the forces of globalization, the changing nature of the threat, increasing international cooperation, technological breakthroughs, etc.*

*Mr. Ronald*: "Change is relentless…I'd say in a single word 'more.' We see more foreign ownership of U.S. assets…more exports from U.S. companies into the global marketplace…more global supply…more [international] partnering…the global threat and the nature of warfare are changing…"

*Mr. Patterson*: "Globalization is a fact…It is going to happen…if we don't change to adapt to globalization, we're not going to survive in the marketplace…We use [international] sales and programs to promote the efficiency of the industrial base, but we also use those sales to

promote our national interests…we're using them…to improve our ability to influence governments and influence decisions."

*Dr. Sapolsky*: "Actually, we're getting more isolated by the world, not being more embraced… we're the biggest power in the world by far and people are balancing against us, not joining us. They're trying to thwart our power…So you may want to convince yourselves that it's becoming more collaborative and more interdependent and more coalition…I think it's becoming less so. When they had someone to fear, people wanted to be on our side because we would protect them."

*Mr. Chao*: "The other comment I would make about the global community…the old game of delivering different messages to different audiences is getting almost impossible to achieve today."

*Mr. Ronald*: "Our customer doesn't fully appreciate all of the other factors that will continue as the world gets more global, as these companies become more cash rich and the market for defense products declines…the importance for the Department of Defense customer…will shrink…[and] our friends on Wall Street will ultimately force that capital to be deployed [elsewhere]…."

*2. The defense industrial base will remain ultimately tied to national politics, jobs and changes in the defense R&D and procurement accounts.*

*Dr. Sapolsky*: "You're basically dealing with a jobs program when you're talking about the defense industry…the defense budget is bigger than it would be if there were no pork in it…the government should buy out the excess capacity…we ought to…get rid of some of the [defense] industrial base that's built around platforms…[The U.S. defense industrial base is] Exactly like it looked 10 years ago…Despite the big merger wave…all the platform lines are still open that were open in 1990."

*Mr. Ronald*: "I don't think that is accurate. If you look at square feet utilization…it's significantly down. There's a million fewer people employed in this industry."

*Mr. Chao*: "If you go through the list of top 10 defense contractors for the last 50 years, you get your major shifts when there's been either a shift in the markets, in technology, or in the customer…If you would ask what are some of the trends that are shaping the base, one of them is the growing cost of the uniformed military…and as the cost continues to go up…you have a driving search for more trigger pullers relative to the [ratio] of tooth to tail. It's going to push the inevitable drive… [to] outsource...the forcing function of all these things will be budgets and price."

*3. The competition between national interests (e.g., control of technology) and the need to build international relationships necessary for global action.*

*Mr. Patterson*: "U.S. traditional companies will be doing a lot more with the European major companies and those companies will be seen as American companies…there will be a lot more partnership with those, giving DOD more flexibility in getting the solutions that they want at the price they want."

*Mr. Ronald*: "We believe we're [BAE Systems] an international or at least a transatlantic company, although we operate in probably some 60 countries. We see more partnering…"

*Mr. Chao*: "[the] issue of who is a trusted partner [is central to building international relationships]."

*4. The impact of fewer competitors.*

*Mr. Chao*: "[When] driving for competition in order to get innovation, … you're getting into areas where you're in more and more mature technologies…by definition the more mature you get, the natural number of competitors will shrink...there's only a handful of ways to generate more competition. One is the globalization route."

*Dr. Sapolsky*: "If you only have one buyer, it doesn't matter how many suppliers your have. They're all going to try to figure out what the buyer wants…if you have more than one buyer, you're better off."

*Mr. Ronald*: "We need cooperation of our allies…"

*Mr. Patterson*: "Another opportunity is looking at designing in exportability when projects are considered…allow an export variant up front in the development stage rather than thinking about it as an afterthought."

*5. Technology—how to stay ahead.*

*Mr. Patterson*: "There's a lot of work being done in a lot of different areas…that could revolutionize or dramatically affect the way weapons are developed…I think the biggest thing to do is to look ahead and figure out what, where, and stay competitive at looking at technologies… "

*Mr. Chao*: "If you want to create competition for a particular technology, you usually try to have somebody undo the technology with something better or something different…UAVs, for example, is a way to introduce competition…without actually creating another competitor."

*Mr. Ronald*: "I would say it's ultimately the combination of technology and the asymmetric solution inevitably…when the next wave of technology comes up, the incumbent is in trouble…you have a vested interest in a particular technology and you've got…the factory and the know-how…that's a big anchor in going forward…there's a lot of different changes in the threat…we always seem to be…one step behind as opposed to one step ahead…[and]the enemy will continue to use…our technology."

*Mr. Chao*: "Who knows what's the next set of technology—anybody want to bet that there's a biotech company in that list of the top 10 [defense companies] in the next 20 years, 30 years? A directed energy company…. The customer wants two things. He wants lots of innovation and at the same time, the customer wants big over-arching architectures, system of systems."

*Dr. Sapolsky*: "I would be for less systems integration on the global scale."

*Mr. Ronald*: "The nature of our workforce has dramatically changed…this was a blue-collar industry. It's now almost exclusively white collar…the nature of our products has changed… British Aerospace [started with] airplane companies coming together and today airplanes is

about 7 percent of our business…we're electronics, we're software…which is what the other large aerospace companies are."

*6. We need more rivalry when thinking about the future.*

*Dr. Sapolsky*: "The way we maintained our technological edge during the Cold War was by inter-Service rivalry. We had the world's best air force because we had three other air forces that [were] right on our tail all the time…[with] the Joint Strike Fighter…you can get yourself into a very, very less innovative situation, and I think we're moving in that direction."

*Mr. Ronald*: "You can't take companies that are highly vertically integrated, let them team and then let them decide the future…You need alternative approaches….'

## Audience Question-and-Response Summary

*1. What is the likely effect on our defense industrial base of the French and Dutch "no-vote" on the European constitution?*

*Mr. Ronald*: "We tend to think of Europe as one place…it's a whole bunch of different places… they've got a huge challenge really trying to unify and it's questionable."

*Mr. Patterson*: "After the no votes…this will actually require less change of us in a way and is probably better for us…Although budgets are continuing to decrease, maybe more emphasis will be back on NATO acquisition and less movement toward EU acquisition…"

*Mr. Chao*: "Actually, if you look at the structure of the European industry, they're still structured for the pre-constitution…a slowing of EU integration probably does not have an impact on the defense industry. It has broad impact on industries that were relying on the synergies of bringing together Europe on a deeper fashion…interest in transatlantic cooperation has… dipped in terms of continental Europeans…We were supposed to end up…with a series of large transatlantic competitors…we certainly did not end up there."

*Dr. Saplolsky*: "I want European integration, so that we can stop paying for their defense and… they can take over at least some of the burdens in the world."

*2. We gathered an impression from international field studies that most of the international defense industrial base is not in a position to keep up with technological change being driven by the U.S.. Your thoughts, please.*

*Mr. Ronald:* "I think the U.S. does move faster than most…of the other countries. I don't think we move fast enough…the enemy is pretty darn innovative, but I don't see the Europeans getting any faster."

*Mr. Patterson*: "There are a few countries who are trying to keep up…They pick their niche and they work at it in net centric areas. I think Sweden and Singapore are really trying to keep pace."

*Mr. Chao*: "One of your solutions to globalization…[is] this issue of who is a trusted partner…it is time to kind of redefine the box of who is trusted and who is not trusted…because

otherwise you're going to be driving away the handful of people who are willing to keep up with us…you do need allies."

*3. Is there any remaining strategic case for keeping any portion of defense manufacturing in this country?*

*Mr. Chao*: "It's a question that frankly other countries have gone through and have literally done…We actually by luck of history or resources…are the primary guarantor of security around the world…the three colors of our strategic advantage…We have superior people. We have superior training and doctrine…and we have superior technology…that's been the argument for the manufacturing."

*Mr. Ronald*: "I don't want to wax philosophically…There is something unique about our basic philosophy…We have this fundamental belief that we can bring peace and democracy to the world. I don't know whether we can or cannot, but…we're going to try our damnedest to do that and protect our freedoms…"

## Summary

Trends affecting the future U.S. defense industrial base include the relentless march of globalization resulting in an increased need for international cooperation, the possibility of significantly declining defense research and development and procurement budgets, the changing nature of a largely asymmetric threat, and the emergence of new and unknown technologies. Within this environment, the U.S. Government's ability to form the future base will be constrained as defense orders decline, causing Wall Street to "insist" that capital be diverted out of the defense market into more profitable endeavors.

# Chapter 5
# Two Strategies for Maintaining U.S. Competitive Advantage

## Overview

*Sheila R. Ronis*

The vision for the Industrial College of the Armed Forces (ICAF) is usually attributed to Barnard Baruch and has remained relatively stable since its inception.

During World War I, American industries were unable to support the war effort. During the post war assessment and the concurrent Congressional hearings, a review of America's industrial preparedness ensued leading to the creation of an Assistant Secretary of War charged with the responsibility to be prepared for future wartime mobilization efforts. Out of the work of this Assistant Secretary of War and the then Chairman of the War Industries Board, Bernard Baruch, proposals of how to train and educate individuals in the arena of industrial support for a war were discussed frequently by the staff and reviewed by Baruch.

ICAF's most famous graduate was Major Dwight D. Eisenhower, who attended in 1932 immediately following his graduation from the Army War College. Eisenhower graduated and taught at the Army Industrial College, ICAF's predecessor, during the interwar years. During this time he established a close relationship with Bernard Baruch. While a student at ICAF, Major Eisenhower proposed a vision for the future of the military industrial base of the Nation. This paper would one day be the blueprint for the future military industrial base activities to support his efforts in World War II and in the early Cold War period during his Presidency.

In the spirit of Eisenhower's work at ICAF as a student, the leadership of the college is publishing the two best papers written this year that can provide insight and potentially shape the future of military industrial base policy.

The first paper is "Human Capital Strategy and the Future of our Nation's Space Industry Workforce," by Susan W. Pollack, Missile Defense Agency. Ms. Pollack states, "There is a crisis looming in America's science, technology, engineering, and mathematics (STEM) workforce base that has serious implications for the future of America's space industry, and our nation's national and economic security. … America's economic progress depends on a continuing supply of STEM talent engaged in and funded across the R&D spectrum. The future of our space industry, knowledge base, and economic prosperity requires an urgent response from the government to accelerate and resource current initiatives and develop a collaborative and integrated, national human capital strategy and vision to inspire the next generation workforce that will replace the intellectual capital lost by the aging of the current workforce. The implications for the space industry are significant and the government must act quickly to enable the development of a solid domestic STEM workforce as well as continuing to attract the best and brightest from around the world. The challenge for the government regarding foreign students

is to find the right balance between scientific exploration and security. There can be no security without the economic vitality that innovation creates, just as there can be no economic vitality without a secure environment in which to live, work, and create."

The second paper is "An Aerospace Business Case for Transatlantic Cooperation," by Lieutenant Colonel Michael Brewer, USAF. Lt. Col. Brewer asserts that "the domestic budgets and demand for U.S. defense aerospace industry are not sufficient to maintain the current industrial base … the market is again faced with lagging profits, weak viability, difficulty in attracting high technology research scientists and engineers, and progressively less robust demand for higher profit large scale production runs in favor of lower profit cost-plus developments. Since domestic consolidation has begun to reach its limits and both European and American manufactures each need a foothold in each others markets to ensure sufficient business, the aerospace industry has increasingly responded by transatlantic acquisitions, mergers and cooperative agreements. Due to the increasing budgetary pressures, as much as legislators want to keep the tax funds in the domestic markets, the only way to maintain a high quality defense infrastructure will be through cooperation. In the future, neither Europe nor America can afford to sustain an independent defense aerospace industrial base, keep the companies profitable, and have low cost defense systems for their militaries. As a result, the aerospace defense industry business case clearly points to the optimum approach: transatlantic cooperation based on specialization, economies of scale and best value."

## Human Capital Strategy and the Future of Our Nation's Space Industry Workforce

*Susan W. Pollack*

There is a crisis looming in America's science, technology, engineering, and mathematics (STEM) workforce base that has serious implications for the future of America's space industry, and our nation's national and economic security. Since World War II, the United States has been a world leader of strength and power in scientific discovery and technological innovation that has been key to our nation's prosperity. Today, trends indicate other nations are on the verge of passing the United States in scientific excellence and technological innovation, which reflects a growing global competition for scientific and engineering talent.[1] This comes at a time when America is more dependent on its space assets than any other nation across the military, civil, and commercial sectors. To maintain American preeminence in space, our nation needs to reinvigorate and inspire a new generation of STEM talent as well as increasing investments in research and development (R&D) and infrastructures. I will address the STEM education-R&D connection, trends in STEM education, and the military use of space, and offer possible solutions to reverse current trends.

### STEM Education and the R&D Connection

The Council on Competitiveness found that innovation will be the single most important factor in determining America's success through the 21st century.[2] The *Hart-Rudman Commission Report on National Security for the 21st Century*, released in early 2001, emphasizes the need to improve math and science instruction across the country to develop a new generation of U.S. citizens who will have the knowledge and skills in STEM education. The second of five recommendations the report discusses is "recapitalizing America's strengths in science and education," and further recommends a doubling of the federal R&D budget by 2010 and establishing a new education law to fund the development of science and engineering professionals and science and math teachers.[3]

The Hart-Rudman report also recommends increasing investments in our two core strength areas of basic scientific research and education to maintain our global position into the 21st century.[4] To do this means the Nation has to generate the high-skilled workforce to create new knowledge, which requires a bigger investment in basic research, and the stakeholders in education policy must be proactive in addressing the problems of math and science education.

While the report recommends increased funding in R&D, the U.S. Government has, in fact, reduced funding in national R&D over the past 10 years including cuts in the President's FY 2006 R&D budget. During this time, the Nation has lost over 600,000 scientific and technical aerospace jobs which has adversely impacted the number of graduates earning degrees in STEM.[5] This comes at a time when nearly 30 percent of the aerospace workforce will be eligible to retire in 2008. The current U.S. educational system is not prepared to provide enough students with the needed STEM skills to fill the critical positions being vacated by the retiring

baby-boomers.[6] Concurrently, other nations are building up their science and technology infrastructures and capabilities.

The Bush administration has made an attempt to fund STEM education, but not at the levels of the 1958 National Defense Education Act. This act served as a foundation allowing students, who were eager to achieve President Kennedy's vision of going to the moon, to more readily pursue their science and engineering education.

In the mid-1980's the Department of Education and the National Science Foundation (NSF) invested in broadening mathematics and science education to all students and teachers. Currently, dozens of on-going initiatives are being funded by the NSF, the Department of Education, and the Department of Energy, as well as outreach initiatives implemented by the National Aeronautics and Space Administration (NASA) and the respective Services within the Department of Defense (DOD).

## Troubling Trends

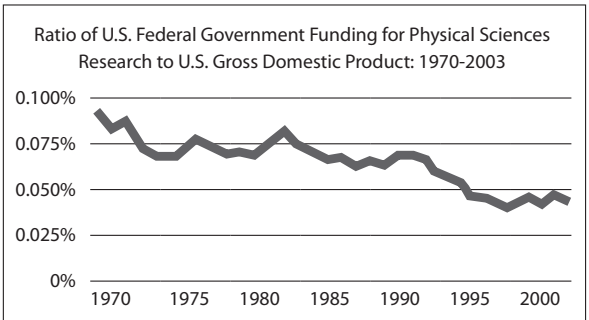
A most disturbing trend is the low performance of American students in the math and science subjects. Despite national, state, and institutional efforts, math and science achievement scores for U.S. students fall below international averages.[7] The results of a recent international survey, conducted by the Program for International Student Assessment in the spring of 2003, indicate the learning gap between the United States and its competitors in Europe and Asia is widening regarding basic math and science skills at the eighth through twelfth grade levels. The survey ranks the United States 24$^{th}$ out of 29 countries in the Organization for Economic Cooperation and Development.

Ronald Sega, who oversees all science and technology programs for the military, recently stated that the need for American citizens in defense work is critical and that the downturn in the science and engineering workforce has become "an issue of national security."[8] Through 2010, the Bureau of Labor Statistics estimates a 20 percent increase in the demand for aerospace engineers, yet a 2003 report by the NSF indicates the number of native-born science and engineering graduates will not increase during this timeframe.[9]

These negative trends are attributed to a number of issues. First, there appears to be a general lack of interest among American-born youth, especially women and minorities, to pursue education in mathematics, science, and engineering. This may be attributed to low expectations and discriminatory attitudes in our educational system in which girls and minorities are viewed as neither interested nor capable of pursuing STEM subjects. Second, Federal investment in R&D, as a percentage of the gross domestic product, has been declining and has not kept pace with the demands of a knowledge-based economy (Figure 1).[10] Third, the proportion of U.S. citizens in science and engineering graduate studies within the United States declined by 10 percent during the period 1994 to 2001, while the percentage of foreign born students in the same studies increased by 25 percent ).[11] Even more staggering is the 57 percent of students holding postdoctoral positions at U.S. universities in 2001 were foreign born.[12] At U.S. universities, 60 percent of R&D efforts are funded by the government. Studies link a strong correlation between reduced R&D funding to the diminishing number of graduates in the STEM subjects.[13] Fourth, the percentage of U.S. based science and engineering papers

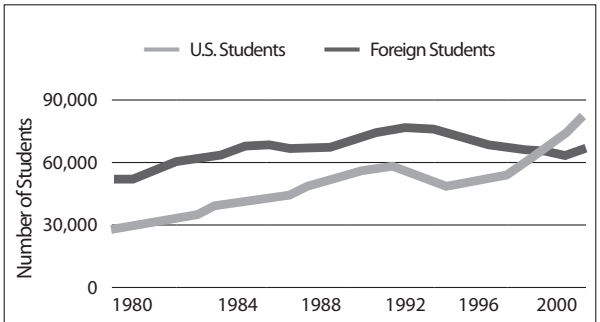
published worldwide has declined which provides a clear indication that there is less emphasis on knowledge creation. The Nation increased its number of published science and engineering articles by only 13 percent from 1992 to 2001 as compared to a 59 percent output increase in Western Europe as well as increased output from other nations.[14] Fifth, the Hart-Rudman Commission concluded that American students usually find salaries more lucrative in areas that do not require as rigorous study as careers in mathematics and science. Sixth, the majority of students taking science and math are taught by out-of-field school teachers. More than one in four high school mathematics teachers and nearly one in five high school science teachers lack even a minor in their main teaching field.[15]

Figure 1: **Federal Investment in Physical Sciences in Significant Decline**




Source: American Association for the Advancement of Science. <www.aaas.org/spp/rd/guihist.htm> Compiled by the APS Office of Public Affairs

Figure 2: **U.S. Graduate Institutions: Foreign Students Outnumber U.S. Students**




Source: National Science Foundation, *Graduate Students and Postdoctorates in Science and Engineering: Fall 2001*, Tables 8-9. Compiled by the APS Office of Public Affairs.

## DOD's Space Human Capital Strategy and Military Space Dominance

Secretary of Defense (SECDEF), Donald H. Rumsfeld, refers to space as the "ultimate high ground."[16] Since the 1991 Gulf War, the U.S. military has become more reliant on space-based technologies for global communications, intelligence imagery, precision targeting, close air support, weather forecasting, navigation signals, and missile warnings.

The SECDEF signed a National Defense Strategy document on March 1, 2005, that articulates the strategy is "to ensure our access to and use of space and to deny hostile exploitation of space to adversaries."[17] Space is an area the United States must protect and control to preserve the advantage the military gains from space, and to ensure freedom of action in space. To achieve these goals, the Nation needs to focus on developing the STEM talent for the future workforce.

In October 1999, Congress chartered a Space Commission to assess the U.S. national security space management and organization within DOD. The January 2001 Space Commission Report identified numerous areas of concerns and recommendations for DOD. First, DOD must improve coordination, execution, and oversight of space activities. Second, the need for DOD to create and maintain a highly trained and experienced cadre of space professionals, as well as developing new concepts of operations for offensive and defensive space operations. Third, the report highlights the upcoming retirement of experienced scientists, engineers and operators, and notes that recruitment and retention of space-qualified

personnel is a problem.[18] Fourth, the Space Commission concludes that DOD does not have a strong military space culture.

As a result of the Space Commission's recommendations, the Secretary of Defense issued a memorandum directing the military departments to create a plan for developing, maintaining, and managing a cadre of space-qualified professionals. The 2004 National Defense Authorization Act reiterated the requirement for DOD to develop a skilled space cadre as well as a strategy to integrate space-related jobs across service personnel systems.

DOD issued a space human capital strategy in February 2004 that establishes overall goals for developing and integrating space personnel. A GAO report notes that DOD has not yet developed an integrated implementation plan for achieving and measuring the space human capital strategy goals.[19] The GAO auditors further state that failure to develop a joint implementation plan between the DOD Executive Agent for Space and the military services and the National Reconnaissance Office "could jeopardize U.S. primacy in this critical and evolving national security area," and curtail cohesion for a DOD total space force. [20] The continued success in space operations depends on having qualified and competent personnel to develop technology and doctrine.

## Possible Solutions to Improve the National STEM Workforce

It is imperative our Nation take action to reverse the negative trends in the education system and investment in R&D to ensure the scientific proficiency needed in the future workforce. The National Science Board notes that even if action is taken today to change the negative trends, the reversal is 10 to 20 years away. Students who are entering the workforce with advanced degrees in 2004 decided to take the necessary STEM courses as long as fourteen years ago when they were in middle school.[21] The Council on Competitiveness reinforces the notion that we lose our future scientists and engineers around the junior high school years.[22] There are numerous policy improvements and on-going initiatives the government should pursue to increase student interest in math and science in the formative years and to widen the pipeline of scientists and engineers who drive innovation. The U.S. Government and industry are taking some steps in the right direction to address the issues discussed in the first three points below.

First, the Federal Government needs to develop a clear and robust policy of sustaining long term research to encourage young people to enter careers in science, mathematics or engineering. Developing a top-notch space industry workforce requires a top-down vision by the President that reaches out to the nation and across the government as the inspirational basis necessary to develop and sustain a knowledgeable and skilled workforce. The administration recently announced a 5-year Mathematics and Science Initiative that will engage in a public campaign to highlight the importance of mathematics and science education, and to recruit, train and retain teachers with strong backgrounds in mathematics and science. Concurrently, Congress established a STEM caucus in 2004 to promote and improve all areas of science and math education, and to address workforce issues.

Second, early outreach programs are vital to developing and sustaining a knowledgeable workforce. The Department of Defense has implemented a Starbase program for students in

grades K–12 with a week of math- and science-based simulations and experiments in space-related fields.[23] Starbase currently has 45 academies in 28 states. The Army scientists, engineers and soldiers coach students in grades six through nine on an e-cybermission Web-based adventure. NASA's educational outreach program, "Inspiring the Next Generation of Explorers," influences youth to pursue science and engineering educational opportunities. The Boeing Company has instituted a Summer Science Camp that has been praised for its efforts to track participants for a few years to determine whether their camp experience influenced them to pursue careers in science and engineering.

Third, the Aerospace Commission established by Congress in 2004, recommends that the Nation promote the growth of a scientific and technologically trained U.S. aerospace workforce by creating an interagency task force to attract public attention to the importance and opportunities within the industry. A key element is to establish life-long learning and make a long-term investment in education and training with an emphasis in math and science.[24] In response to the Commission's recommendation, Congress recently introduced bill HR5388 to establish an interagency aerospace revitalization taskforce to develop a national strategy for aerospace workforce cultivation, training and recruitment.[25] The task force will establish partnerships with academia, industry, labor, and government to coordinate resources.

Fourth, the United States should seriously consider lifting the visa restrictions for foreign students. For decades, foreign students graduating from U.S. universities with degrees in sciences and engineering have been an important asset to our industry workforce. In fact, one-third of today's U.S. workforce of scientists and engineers were born outside the United States.[26] The post 9/11 immigration controls have resulted in a 32 percent drop in the number of international student applications in 2004.[27]

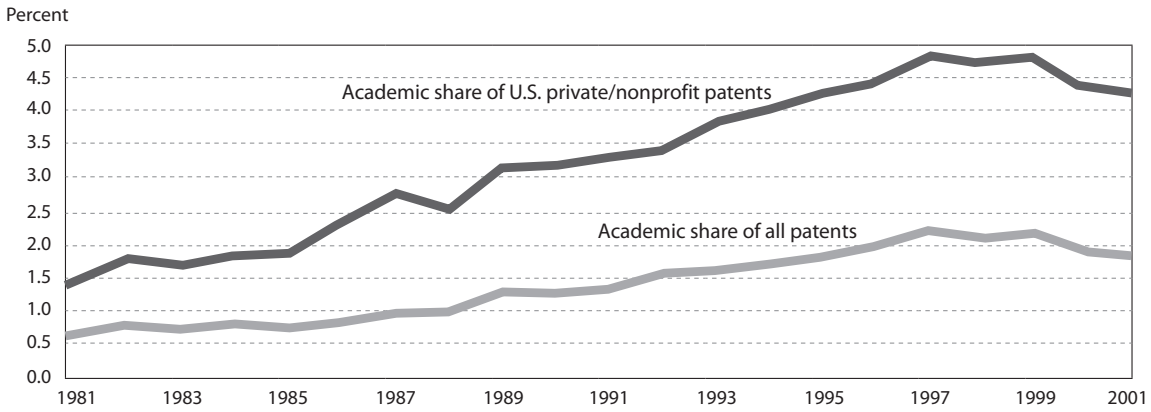
Fifth, Congress should resist cuts in R&D being proposed by the President's FY 2006 budget. Federally-funded research has long been a significant factor in U.S. patent productivity and economic strength (Figure 3).[28] Although R&D funding for NASA increased 4.7 percent in the FY06 President's budget, other R&D programs in mathematics and engineering are seeing decreases as the government is trying to reduce its budget deficits.[29]

Sixth, Congress should also pass a tax credit law for companies that invest heavily in R&D, as well as training workers in aerospace type skills.

Seventh, the Nation desperately needs to create an educational system of science and technology high schools similar to Thomas Jefferson School of Science and Technology in Fairfax, Virginia. At a minimum, we should be offering and requiring advanced Earth and space science courses at the middle and high school levels and help the students to integrate what they are learning to future careers. Another positive example of a math and science educational opportunity available to interested students is Montgomery County, Maryland's new middle school magnet program in aerospace and robotic engineering.[30]

Eighth, sufficient training for teachers is critical since they are the ones who inspire and motivate our nation's children to dream and learn. The Hart-Rudman report recommends raising teacher salaries, providing high quality training, restoring professional status for teachers,

Figure 3: **Significance of U.S. academic patenting activity: 1981–2001**




Notes: Patents issued by U.S. Patent and Trademark Office to U.S. universities and corporations. U.S. private/nonprofit sector includes U.S. corporations (which are issued the bulk of patents in this category), nonprofits, small businesses, and educational institutions. All patents include U.S. patents issued to U.S. and non-U.S. organizations and individual inventors.
Sources: U.S. Patent and Trademark Office (USPTO). Technology Assessment and Forecast Report: U.S. Colleges and Universities, Utility Patent Grants, 1969-2001 (Washington, DC, 2001); and USPTO, special tabulations.
Science & Engineering Indicators—2004

and creating a more flexible certification process. In addition, institutions and companies with education outreach programs need to be more proactive in reaching out to collaborate with teachers.

Ninth, the Federation of American Scientists has reported the infrastructure for providing science advice to Congress and the White House is in a crisis.[31] The report recommends creating a permanent professional staff with sufficient resources at the White House Office of Science and Technology Policy.

Tenth, President Bush's Council of Advisors on Science and Technology recently released a report, which recommends improving our country's kindergarten through twelfth grade education to ensure future innovation. Specifically, the report assesses options to improve the nation's "innovation ecosystem" or its STEM capabilities by hiring better-trained teachers and establishing national standards.[32]

Lastly, the Federal Government should assist those entrepreneurs who have long-range plans to build space components and systems, but do not have the capital to go from concept to delivery.

## Conclusion

America's economic progress depends on a continuing supply of STEM talent engaged in and funded across the R&D spectrum.[33] The future of our space industry, knowledge base, and economic prosperity requires an urgent response from the government to accelerate and resource current initiatives and develop a collaborative and integrated, national human capital strategy and vision to inspire the next generation workforce that will replace the intellectual capital lost by the aging of the current workforce. The implications for the space industry are significant and the government must act quickly to enable the development of a solid domestic STEM workforce as well as continuing to attract the best and brightest from around the world. The challenge for the government regarding foreign students is to find the right balance between scientific exploration and security. There can be no security without the economic

vitality that innovation creates, just as there can be no economic vitality without a secure environment in which to live, work, and create.[34]

It is clear that a long-term solution to developing a knowledgeable and skilled space industry workforce begins with improved math and science education, from kindergarten through graduate school. We must take deliberate steps to nurture our Nation's children in the fields of math and science in the formative years, and attract and retain enthusiastic educators to hand off the pride and the passion to the next generation. Just as President Kennedy inspired the country in the race to the moon, we must now inspire young people to create a new generation of innovators to protect our national interests in space across the military, civil, and commercial sectors.

The 2004 president of the American Association for the Advancement of Science articulated the decline in the U.S. science and engineering base as a "quiet crisis" slowly eating away at America's STEM talent base and science and technology infrastructure. Thomas Friedman recently repeated the words of a Stanford economist that "a crisis is a terrible thing to waste."[35] The children we are educating today are the STEM workforce that will successfully lead the Nation in the 21st century and we must not waste their potential. STEM talent is the center of gravity in a knowledge-based economy that has raised the bar on innovation. We must ensure our children are equipped with the mathematical and scientific tools they will need to make the decisions that will shape a new America. It takes 15 years to develop and educate an engineer because it really is rocket science when the ultimate goal is to invent and create breakthrough technologies for the future!

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## An Aerospace Business Case for Transatlantic Cooperation

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European defense budgets have been flat or declining over the last decade. Although under increasing strain, American spending on defense procurement is over twice the total of European defense procurement in real terms. This has driven the European defense industry to aggressively attempt to secure a piece of the American defense pie via direct sales and joint ventures with U.S. defense firms. Simultaneously, both American and European governments are attempting to ensure domestic industries prosper and that the tax dollars remain in their respective domestic economies. These economic and political pressures are changing the European/American defense relationship. The exact nature of this transatlantic defense relationship is not clear. However, an analysis of the conditions that brought about the consolidation of the U.S. defense aerospace industry in the early 1990s compared to today's emerging market conditions, provides a business case study that argues for future transatlantic defense cooperation.

## The 1990s Wave of U.S. Aerospace Consolidation

In 1993, Secretary of Defense Aspin met with top leaders of the defense industry in what became known as the "Last Supper." The Secretary made it clear that future defense budgets could not support the current defense industrial base.[1] The falling procurement budget combined with the government's encouragement to consolidate had dramatic effect on the aerospace industry. Between 1987 and 1991, the U.S. procurement budgets hovered at $80 billion. By 1996, the procurement budget fell to $50 billion, a nearly 40 percent reduction.[2] During this same period, DOD's aircraft procurement budgets fell by over 50 percent from almost $32 billion to $14.3 billion. As would be expected, the procurement reduction had a dramatic effect on aircraft production rates. In 1988, 1,305 military aircraft were produced in the United States for both domestic and export consumption. This production rate decreased almost linearly to a production rate of only 333 military aircraft by 2000. While exports of some aircraft, such as the F–16, kept production lines open, the rates of U.S. production for both the domestic and export market decreased, almost in lock step, pointing to a decreased demand for military aircraft, not only in the United States but worldwide.[3]

While all segments of the military aerospace production market demonstrated rapid drawdown, fighter/attack production was the heaviest hit. By 1990, bomber production had already bottomed. However, from 1990 to 1996, the number of fighter/attack aircraft that the DOD accepted declined from 554 to 167. While there was a modest increase in accepted aircraft in the late nineties, yearly fighter/attack acceptances has leveled, since 2000, at about 100 aircraft per year. Like the fighter/attack segment, helicopter deliveries experienced a decline of over 85 percent through the 1990s ending in only 33 aircraft acceptances by 2000.[4]

Not only did production funding decline, but also, a simultaneous steep decrease in research and development (R&D) funding occurred. During the 1990s, the R&D funding for the industrial segment as a whole was experiencing a steady rise, $132 billion in 1993 to almost $200 billion by 2000 in constant FY2000 dollars. In contrast, R&D funding for the aerospace industry was on the decline. In 1987, over $33 billion was invested in aerospace R&D. By 1994, R&D investment was less than $16 billion. The majority of this reduction can be attributed

to the decline of government investment in aerospace R&D. While the industry maintained a relatively constant level of investment in aerospace R&D, the change in ratio of government to private sector R&D investment sent clear indications of the willingness of government to continue to fund the expansive aerospace industrial base.

The U.S. aerospace industry responded with an unprecedented consolidation. In 1990, there was a robust cadre of major prime contractors in the aerospace defense industry. By the end of the decade, 26 of these major players had consolidated into four aerospace giants: Lockheed Martin, Northrop Grumman, Raytheon, and Boeing. Consolidation focused on reducing excess infrastructure and overhead costs. More importantly, consolidation allowed the companies to achieve better economies of scale in purchases of parts and supplies.[5] The nature of the aerospace defense industry consolidation is demonstrated by the increase of the number of subsidiaries for the top five aerospace defense contractors as well as the industry's concentration ratios. Four of the five top contractors more than doubled their number of subsidiaries.[6] The top aerospace prime contractor now has over 25 subsidiaries compared to only four in 1986. Consequently, the number of competing prime contractors declined in all of the aerospace market segments.[7] For example, the number of prime contractors of DOD fixed-wing aircraft contractors declined from eight in 1990 to three in 2000.

Concentration ratio, or percent of market share, gives an insight into the level of market competitiveness. The market share commanded by the DOD's top five prime contractors increased from less than 20 percent to over 25 percent in 1997.[8] During the same period, the top contractor grew from less than 5 percent to over 10 percent of the market. However, note that for DOD contractors as a whole, most of the market share increase was obtained from companies smaller than the top 100 being absorbed or leaving the market. This change pattern is indicated by all concentration increments (single, 5 largest through 100 largest receipts) having market share gains between 1992 through 2002 despite the consolidation occurring throughout the DOD industrial base. In terms of only aerospace, the share of total DOD prime contractor awards for the top four contractors increased from almost 17 percent in 1986 to 23 percent in 1996. Currently, the top four aerospace contractors commanded 25 percent of all DOD prime contracts in 2004.[9]

The decrease in DOD procurement and the associated consolidation of the aerospace industry required a significant adjustment in production employment. In 1991, over 500,000 workers were employed in aerospace production. By 1995, production employment declined to just over 300,000. Following a brief increase in the late 1990s, production employment continued to decline to less than 250,000 employees.[10] Compared to overall U.S. manufacturing during the same period, aerospace manufacturing employment suffered a 10 percent greater decline.[11]

## European Response

In order to compete more effectively against the emerging U.S. aerospace giants and respond to budgetary pressures, the European aerospace industry followed, albeit slower, with consolidation initially along national lines. This European consolidation has reached its limits in most areas.[12] While the U.S. industry consolidated to four major players, the Europeans

formed three competing European giants: BAE Systems, EADS, and Thales.[13] Marking a similar level of consolidation to the U.S. aerospace market, BAE Systems, as organized today, is formed from what were twenty-three different companies in 1977. The largest of BAE's consolidation came between the years of 1996 and 2001. In this six-year period, 11 entities combined under the BAE umbrella. Most notably (although the early consolidation was United Kingdom- and European-centric) since 2000, seven of the nine acquisitions and agreements have occurred with U.S. companies including two elements previously owned by Lockheed Martin (Control Systems and AES groups). Similarly (while European centric) since 1985, 12 companies combined under the auspices of EADS with 8 of these combinations occurring since 1998.[14]

## Business Performance During Consolidation

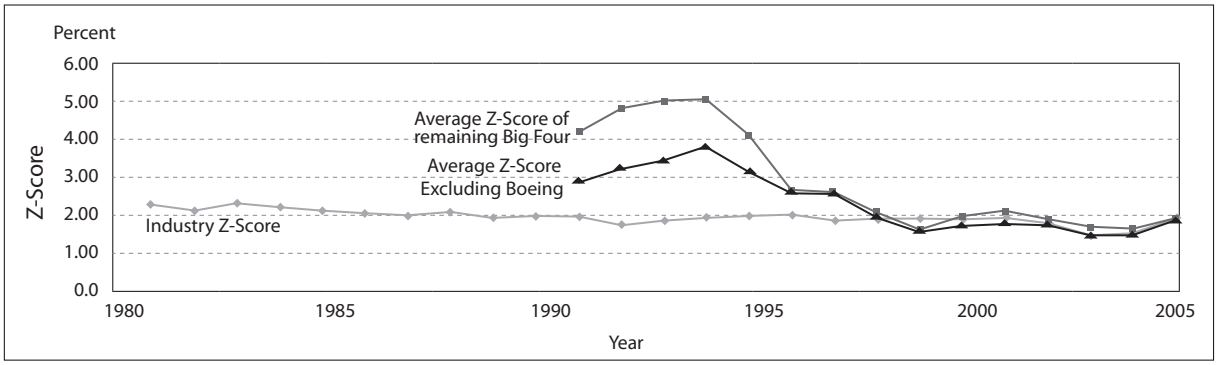
The primary goal of the consolidation of the U.S. aerospace industry was to maintain profitability in the environment of rapidly declining defense budgets. Secondly, the market sought consolidation to maintain the necessary levels of skill to continue to compete in key defense areas.[15] In the period from 1986 to 1993, the overall economic downturn had dramatic effects on the profits for all industrial segments. However, this was a particularly heavy burden on the aerospace industry, which matched in sequence the industrial market downturn.[16] The aerospace industry has consistently marked lower profits than the overall manufacturing industry. However, despite a deep downturn of the average profits in the industry as a whole, the top four defense aerospace contractors maintained a relatively constant average. Through the 90s, the defense aerospace giants largely achieved net average profits above four percent.[17] While there were certainly many contributing factors to these weak but consistent profit margins, the ability of the larger contractors to consolidate had a significant effect in maintaining profit levels given the federal budget declines.

A financial analysis of the industry and major contractors' financial statements paints a different picture. Altman's Z–Score is a quantitative indicator in predicting a company's financial failure. In essence, the Z–Score attempts to predict the financial health of a corporation. Historically, the Z–Score is over 80 percent reliable in predicting failures within two years.[18] The Z–Score is calculated as a simple, linear, algebraic calculation using the following financial indicators: working capital, total assets, retained earnings, earnings before interest and taxes, market value of preferred and common equity, and total liabilities.[19] The interpretation of the Z–Score has shown that for public companies, scores above 3.0 indicate the company has a low probability of bankruptcy. The gray area requiring careful monitoring is between 1.9 and 3.0. Finally, Z–Scores below 1.8 indicate a troubled company with a likelihood of insolvency within 12 months.

Despite the dramatic dip in profits through the middle 1990s, the Z–Score for the industry as a whole remained very low but constant with a minimal value of 1.8 through 2000 (Figure 1).

The big players in the aerospace industry did not share the same level of success in maintaining overall financial strength as indicated by Z–Scoring. From 1990 to 1994, the big four aerospace companies (Lockheed Martin, Northrop Grumman, Boeing, and Raytheon)

Figure 1: **Z–Score Comparison Industry Average to Remaining Big Four (Lockheed Martin, Boeing, Northrop Grumman, Raytheon)**




demonstrated excellent solvency with a composite Z–Score above 4.0. Even after removing Boeing from the composite score (Boeing has a large portion of profit and sales from commercial work), the remaining top three players demonstrated Z–Scores greater than 3.0. However, as the consolidation wave reached conclusion in the latter half of the 90s, the Z–Score for the major aerospace systems integrators began a serious decline. The composite score for the top four aerospace companies declined from a 1994 high of over 4.9 to a low of 1.5 in 1999. Even after a brief rally, the Z–Score of the top four companies did not significantly rise above the anemic industry average. More importantly, if you exclude Boeing and focus on the three companies that are dominated by government sales; the Z–Score is below the industry average from the years 2000 to 2004.

As a result of the shrinking defense market, the aerospace industry is having difficulty attracting high technology personnel. During the 90s consolidation, the demand for R&D scientists and engineers declined.[20] However, since 2000, partly because of the aging of the workforce, the aerospace industry has seen an increase in the demand for R&D scientists and engineers. If price is an indication of the industries' ability to attract new talent, then the industry is facing a significant challenge. R&D scientists and engineers for all industries and the aerospace industry increased at basically the same rate through 1995.[21] However, since 1995, the period of mass industrial consolidation, the cost of aerospace R&D scientists and engineers has exploded increasing from just over $170,000 per year to over $370,000 per year. This represents an increased aerospace employment cost of approximately $200,000 per year compared to an increase of only $10,000 per year for R&D scientists and engineers for industry as a whole.

## Market Pressures Exceeding Consolidation Benefits

The market consolidation that occurred on both sides of the Atlantic served to preserve some profitability in the defense aerospace industry during the downturn of defense budgets. However, the trends of the last five years indicate that consolidation has hit its limit in maintaining profitability. Despite the significant increase in aircraft and missile procurement budgets in the last 5 years ($5.2 billion and $2.7 billion, respectively), the profitability of the

industry over the same period declined. For example, net profits declined from typically above 5 percent in the late 90s to just above 4 percent by 2000.[22] As already discussed, the Z–Score analysis of the last 5 years, depicts an industry that is operating on the margin of viability. Additionally, the declining investment in the future of defense aerospace has taken a significant reversal. While climbing constantly since 1980, in 2000, the level of government investment in R&D decreased by over $12.5 billion while the industry experienced the discussed significant increase in cost of research engineers and scientists.

The increase in procurement funding, which helped sustain profits, experienced since 2000 will likely be short lived. As noted by Standard and Poors, "Congress is not likely to authorize outsized military spending over the long term. Anticipated sluggish growth in tax receipts and political pressure to balance budgets, bolster Social Security, and fund various homeland security and overseas peacekeeping initiatives appear likely to temper big increases in procurement spending."[23] Additionally, the debt has made a significant reversal. Following continual national debt growth from 1976, the debt began a relatively steep reduction from 1996 to 2001. However, this positive debt trend came to an abrupt halt and the debt returned to parallel the steep growth rates seen through the 1980s.[24] This has resulted in pressure on defense spending and, in particular, defense procurement spending. If the premise is accepted that the gross level of entitlement spending will increase over the next decade and that increasing government spending will need to be curtailed in order to control the increasing budget deficit, the portion of government outlays for defense will decrease at a growing rate. Additionally, if operations and maintenance (O&M) budget demands continue as a result of the War on Terrorism and the continued stabilization efforts in Iraq and Afghanistan, procurement budgets will be squeezed even tighter.[25] The growth in military personnel costs provides an additional internal pressure that will limit further growth in procurement budgets and, in turn, the viability of a robust aerospace defense industry.

Finally, the current nature of aerospace acquisitions is affecting profitability. The tendency to short production runs and the penchant for sophisticated, high-tech equipment in the defense aerospace markets leads to low profits. New weapons are developed under cost-plus contracts where the government reimburses for the cost plus a performance related fee to generate profit for the company. While this reduces risk for the company, the profits associated with cost-plus contracts are in the modest range of 5 to 9 percent on average. In contrast, in long production runs, firm fixed price contracts tend to generate respectable profit margins of up to 15 percent.[26]

## Aerospace Market Response – Transatlantic Cooperation

Just as the industry responded to the pressure of reduced demand in the 1990s, the defense aerospace industry is currently responding to a second wave of demand reduction driven by a decline in exports from 1998–2004. The response has apparently been a substantial increase in trans-Atlantic cooperation in two forms: acquisitions/mergers and cross border relationships. From 2001 to 2003, there have been well over twenty major acquisitions and mergers between Western European and U.S. aerospace defense manufactures.[27] [28] These acquisitions indicate a new type of transatlantic consolidation necessary to achieve economies

of scale given the enormous fixed and start-up costs associated with the development of high-technology aerospace equipment.

In addition to acquisitions and mergers, the aerospace industry, as well as the defense industry as a whole, is engaging in greater and greater numbers of cross-border relationships. These cross-border arrangements, at the prime contractor level, include: Boeing, BAE Systems, Raytheon, Thales, Lockheed Martin, Finmeccanica, EADS and General Dynamics.[29] In fact, most future aerospace production programs are structured as international production efforts. The largest of these cross border relationships for the aerospace industry is the Joint Strike Fighter partnership between Lockheed-Martin, Northrop Grumman and BAE Systems. This program currently has 10 partner nations with each nation's subcontractors competing not on the basis of offsets but on best value to the program. The U.S. military's primary beyond visual range air-to-air weapon, the AMRAAM (Advanced Medium Range Air to Air Missile) has been procured by over 20 nations and is manufactured using 14 foreign subcontractors. The C–130J transport aircraft is 20 percent owned by the United Kingdom. The content of the C–130J is provided using the labor of over 2,500 U.K. employees.[30]

Just as the "Last Supper" marked a change in DOD's willingness and ability to support the size and shape of the 1980s industrial base, the two recent contract selections mark the willingness of DOD to support transatlantic cooperative teams. For example, for the emotionally charged and high profile replacement of the U.S. Presidential helicopter, an Agusta Westland helicopter team formed with Lockheed Martin and Bell won over the domestic American Sikorski helicopter manufacturer. As further acknowledgment of the need for teaming, while not European, a Brazilian airframe was selected as the platform for the aerial common sensor. Similarly, America's newest heavy spacelift vehicle is being by powered by the Russian built RD–180 engine.

In response to the requirements of the 2001 Floyd D. Spence National Defense Authorization act, DOD evaluated the effect of foreign sources on certain weapon system programs: AH–64D Apache, F/A–18 E/F, M1A2 Abrams Tank System Enhancement Package, AIM–120 AMRAAM, Patriot Missile Ground Station, AGM–114L Hellfire Missile, Joint Direct Attack Munition (JDAM), and Advanced Amphibious Assault Vehicle. As an indication of the DOD embracing the economic necessity of international partnering, this report indicated that, while foreign subcontracts represented less than 2 percent of the value of all subcontracts, the appropriate use of non-U.S. suppliers promoted consistency and fairness in dealing with U.S. allies. This consistency and fairness were obtained by giving evidence to non-U.S. suppliers that they have a fair opportunity to be awarded contracts and subcontracts for DOD weapon systems. Additionally, from an industrial health perspective, the development of mutually beneficial industrial linkages enhanced the U.S. industry's access to global markets while simultaneously exposing U.S. industry to international competition, which helps ensure that U.S. firms remain innovative and efficient.[31]

From the manufacturer's perspective, the risks associated with development of new systems are too great for any one company to undertake. According to a Sikorski executive, the company was unable to assume the over $100 million dollar investment in a new helicopter program. Additionally, to help ensure a large enough potential customer base to justify the

investment, Sikorski preferred international partners. Ironically, in addition to the risk mitigation provided by industrial partners, the protectionist activities of governments on both sides of the Atlantic drove a greater level of international cooperation on the program. Similar views were expressed by members of Pratt and Whitney as well as Lockheed Martin.

## Conclusion

As in the 1990s, the domestic budgets and demand for U.S. defense aerospace industry are not sufficient to maintain the current industrial base. Previously, the U.S. industry responded with a great domestic consolidation resulting in four U.S. prime contractors. Similarly, while constrained by national considerations, European aerospace defense contractors responded with a comparable consolidation. As occurred after the Reagan build-up, the market is again faced with lagging profits, weak viability (as indicated by the industry's low Z–Scores), difficulty in attracting high technology research scientists and engineers, and progressively less robust demand for higher profit, large-scale production runs in favor of lower profit, cost-plus developments. Since domestic consolidation has begun to reach its limits and both European and American manufactures each need a foothold in each others' markets to ensure sufficient business, the aerospace industry has increasingly responded by transatlantic acquisitions, mergers and cooperative agreements. While not as overt as Secretary Aspin's "Last Supper," policy actions by the Department of Defense are clearly indicating that, in order to ensure the best quality product at the lowest price, transatlantic cooperation will not be discouraged. Due to the increasing budgetary pressures, as much as legislators want to keep the tax funds in the domestic markets, the only way to maintain a high quality defense infrastructure will be through cooperation. In the future, neither Europe nor America can afford to sustain an independent defense aerospace industrial base, keep the companies profitable, and have low-cost defense systems for their militaries. As a result, the aerospace defense industry business case clearly points to the optimum approach: transatlantic cooperation based on specialization, economies of scale, and best value.

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# Chapter 6
# Synthesis and Conclusion

*Sheila R. Ronis*

This symposium offered much discussion, often lively and spirited, but rarely with agreement or consensus.

Some panel members described the state of the industrial base that supports the military in an eroding situation with increased foreign ownership of the means of production and a growing dependency on foreign companies, sometimes state-owned for critical components for U.S. weapon systems. The eroding industrial base, declining R&D investment, and reductions in the number of U.S. science and engineering graduates are described as a clear and present danger to the long-term health and leadership of the U.S. economy and military readiness.

Others thought that access to the best products and technology around the world is essential to the ability of the Department of Defense to equip its troops with the best in the world. A component's nation of origin is not considered an important knowledge set, though some do indicate that a few significant technologies are essential for U.S. leadership.

Examples of issues raised include the following.

- How the United States fights is determined by the acquisition process of DOD. The process itself has many second, third, and fourth order effects that ripple through the economy.
- The American government role should be to ensure that states are competing on a level playing field and states are playing by the World Trade Organization rules.
- Acquisition reform is difficult but necessary to improve efficiency.
- Investment should be made in strategic, operational, and tactical technologies.
- Scandals can inadvertently hurt the acquisition process.
- The national debt may have more impact on the overall industrial base health than anything else.
- The Nation has always depended on foreign countries for critical components and systems. With globalization, the United States may have lost its ability to design, engineer, and manufacture weapon systems, manage the acquisition process, or control supply chains.
- As OEMs around the country (both for the military and U.S. industrial corporations) accelerate the outsourcing of their engineering, manufacturing, and software development, the ability to control IP and supply chains for U.S. military production is disappearing.

- As a nation, the United States should ask itself whether or not a U.S.-"owned" or controlled industrial base matters. Engagement of all global companies with technology and innovation is essential.
- It appears that the globalization process is not the enemy, but a lack of managing the process is the enemy.
- Other nations have done a much better job of promoting "free trade" and developing the kind of trade policies that permit them to trade effectively around the world without destroying their own industries in the process.
- When a U.S. company outsources jobs and technology know-how to a place like China, the company and country have lost all control over the technology. Offsets are giving future competitive advantages to other countries, thereby ensuring the long-term demise of U.S. industries.
- Globalization is essential to facilitate the long-term peace and prosperity requirements for the world at large. The issue is a balance of common sense policies. Balance between trade and offset policies and the country's military manufacturing capabilities is critical, but such a balance does not exist.
- The Nation needs military manufacturing capabilities and what the military calls surge capacity, the ability to use national industrial capabilities in times of war.
- Increased investment in R&D is crucial for leadership in many technologies. Future wars will be vastly different from the ones in the past, though the United States cannot assume that everything needed to mobilize for war will be available where and when needed if the country no longer controls its manufacturing capability or global supply chains.
- The national industrial base provides more than jobs. It is critical that the Nation maintain the knowledge that creates war machines when necessary.
- Risk management of supply chains and their transparency is a critical new requirement of the Department of Defense.

A few final thoughts.

On November 3, 1953, in a top-secret memorandum to Admiral Arthur William Radford, Chairman, Joint Chiefs of Staff, President Dwight David Eisenhower wrote:

> Permeating all of our hard problems in security, including force levels and budget allocations, is the question of the mobilization base. This base must at once be economical enough to be bearable for the long pull—the lean years and the boom years— but at the same time, it must be quickly and fully responsive to the complicated and ever-changing requirements of modern war.

How prescient. In many ways, little has changed.

This symposium brought forth many points of view and provided a rare glimpse into the history of how the state of the industrial base evolved to be the way it is today in a globalized world. Perhaps the only thing that is clear is that the questions posed during the symposium have no easy answers. The world systems known over the last several decades have

experienced tectonic shifts since the end of the Cold War and their future is complex and uncertain. The Global War on Terrorism has only exacerbated this situation.

At the end of World War II, General George C. Marshall said, "We are now concerned with the peace of the entire world, and the peace can only be maintained by the strong." You can read it on the wall of Marshall Hall next door.

But, how does the United States remain strong? What does that mean in a globalized world?

As a systems scientist, I am not trained to look at parts of a puzzle. I am trained to step out into the next larger system or the system beyond that to look across the entire mosaic at the elements and their interdependence and interactions to better understand the whole and its behavior.

What is critical for a systems scientist is the context in which everything exists. For the defense industrial base, that context includes several system layers. First is the U.S. defense industrial base, then the overall U.S. economy, then the global industrial base, then the overall global economy, and finally the global geo-political-economic-diplomatic-military system that the world operates in.

We look at the defense industrial base as an element of our national power—the sum total of our country's ability to use our power to shape world events, and ultimately, implement our National Security Strategy.

But the global system is a large, complex, adaptive system in the classic sense, and its nonlinearity makes it a "messy" system in the truest Russell Ackoff sense.

Whether we look at the defense industrial base or the entire National Security Strategy, they cannot be looked at without their context.

"Systems are not the sum of their parts, but the product of their interactions," according to systems theorist Dr. Russell Ackoff. To understand a system, you do not break it down into its component parts, you must look at the whole that is created when the pieces fit together.

If the system we are looking at is the defense industrial base within the National Security Strategy and its economic and military components, what is the next larger system? Ideally, it should be the holistic, integrated National Strategy of the United States—its foreign policy, economic, diplomatic, military, education, energy, and so on, including all of its policies, woven together to create a holistic vision of who we are and who we need to become in the future.

Unfortunately, we do not have such a strategy or vision—nor do we have any mechanism to develop one anywhere within the Federal Government. How can we possibly be effective at shaping our environment, or developing effective plans for shaping, if we have no way to think through the whole and think in long time horizons beyond the next election?

There will be little ability to secure our homeland, and even less ability to protect American interests around the world, without American leadership. That leadership requires a holistic, integrated and, most likely interagency planning and decisionmaking apparatus.

The future global geopolitical environment and internal environment in the United States need to be effectively "shaped." In addition, a contemporary role for the United States in the world of the 21st century needs to be developed.

That vision needs to include all elements of national power.

We may want to use the creation of the *National Security Strategy* to more effectively develop the integrative mechanisms and formal interagency processes and doctrine that we will need to ultimately develop our National Strategy, including one to ensure a healthy market-oriented, innovative economy that addresses the defense of the Nation, ensures economic as well as military security, and identifies what it will take to keep the United States strong . . . an integrated set of policies that include:

- Economic security
- Education
- Strong military capabilities
- Leadership in innovation and R&D
- Energy alternatives
- World class manufacturing capabilities
- Job creation mechanisms
- Diplomacy and integrated foreign policy
- Trade, offsets and export controls
- Health care, pension, social security reform

In other words, the National Strategy should include all the elements of national power that will keep us strong.

The bad news is that keeping ourselves strong will not be easy. It requires executive leadership across the Federal Government and the Congress will play a role whether we like it or not. The good news is that every one in this room will have an opportunity to participate in creating the future we want and need. Each one of you will return to your organization and play your role.

The debate has begun and will continue and I want to thank you all for participating in today's discussion.

## Biographies of Contributors

**Dr. Gerald W. Abbott**

Dr. Gerald Abbott joined the faculty in June 1987. He holds a bachelors degree in history and English from Central Connecticut State College, a master's degree in business from the Wharton School and a doctorate in public policy from the University of Southern California. He teaches courses in acquisition, economics, industry analysis, and the history of logistics. His major areas of academic interest include the affects of the federal resource allocation system on the defense industrial base and studies in international comparative acquisition systems. Since 1988, he has been the Director of the Industry Studies Program that examines the readiness of the U.S. and allied industrial bases to respond to the materiel requirements of national defense. His publications include the chapter on the Productive and Technological Base in the Institute for National Security Studies book, *Strategic Assessment 1996: Instruments of U.S. Power*; a monograph on the Defense Industrial Base; a monograph for the Norwegian School of Management entitled *Insights into the U.S. Acquisition System*; and the annual ICAF book, *In Touch with Industry*, which addresses the ability of U.S. industry, in a global context, to support the U.S. national security strategy.

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Lt. Col. Brewer was a Distinguished Academic Graduate of the Industrial College of the Armed Forces class of 2005. Some of his assignments in the USAF before attending ICAF included piloting F-111F, F-15E, and test aircraft. Additionally, he was the test program manager for the F/A-22 program. He has a Master of Science degree in international relations from Troy State University and is a graduate of Air Command and Staff College.

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Dr. Shannon Brown holds a Ph.D. from the University of California at Santa Cruz, where his studies focused on the history of technology and modern world history. Now serving as a professor in the Department of Grand Strategy and Mobilization at the Industrial College of the Armed Forces, Dr. Brown has worked in and around Washington, DC, as a contract historian and analyst for a number of years. His clients have included the U.S. Air Force, U.S. Army Corps of Engineers, and several private organizations and companies, among them the National Electrical Manufacturers Association and the Tokyo Electric Power Company. He is the editor of *Providing the Means of War: Historical Perspectives on Defense Acquisition, 1945-2000* (U.S. Army Center of Military History, 2005).

**Mr. Pierre A. Chao**

Mr. Pierre Chao is a Senior Fellow and the Director of Defense Industrial Initiatives at the Center for Strategic and International Studies (CSIS). His expertise includes the U.S. and European defense industry, the global defense industrial base, trans-Atlantic defense-industrial relations, commercial aerospace industry and procurement reform. Before joining CSIS in 2003, he was a managing director and senior aerospace/defense analyst at Credit Suisse First Boston. He also has held senior aerospace/defense analyst positions at Morgan Stanley Dean Witter, Smith Barney and Prudential-Bache Capital Funding. He has been sought out as an expert analyst of the defense and aerospace industry by the Senate Armed Services Committee, the House Science Committee, Office of the Secretary of Defense, Defense Science Board, Army Science Board, NASA, DGA (France), NATO and AIA. Mr. Chao earned dual Bachelor of Science degrees in Political Science and Management Science from MIT.

**Dr. B.F. Cooling**

Dr. Frank Cooling is currently Associate Dean of Academic Programs at the Industrial College of the Armed Forces. Formerly Chair, Department of Grand Strategy and Mobilization, where he teaches courses in that field as well as Business and the American Way of War. He has been on the faculty since 1995. A graduate of Rutgers University with advanced degrees from the University of Pennsylvania, he is a veteran of the U.S. Army Reserve of the Cold War era, and has served with Interior, Army, Air Force and Energy departmental history programs, as well as teaching at the University of Pennsylvania, Weidner University, Army War College and George Washington University. He has written or edited numerous books and articles in military, naval, and air history. Those pertinent to today's symposium include *Gray Steel and Bluewater Navy* (1979) and the edited *War, Business and American Society* (1977) and *War, Business, and World Military Industrial Complexes* (1981).

**Lieutenant General Michael M. Dunn, USAF**

Lt. Gen. Michael Dunn, is President of the National Defense University. NDU is composed of four colleges; the Industrial College of the Armed Forces, the National War College, the Joint Forces Staff College, and the Information Resources Management College, two institutes, five centers, and eight special programs. General Dunn is responsible directly to the Chairman, Joint Chiefs of Staff for NDU's mission: to provide world-class professional military education in joint, multinational, and interagency operations. General Dunn graduated fourth in his class from the U.S. Air Force Academy with a Bachelor of Science degree in astrodynamics. He has a Master of Science degree in systems management from the University of Southern California. He also graduated from the Air Command and Staff College, Air War College, and ICAF, as well as completing several executive courses from Harvard and MIT. General Dunn is a command pilot with more than 2,500 flying hours. He has held joint commands in Europe and Asia, including his assignment in Korea as the lead negotiator in talks with the North Korean Army.

**Lieutenant General Lawrence P. Farrell, Jr., USAF (Ret.)**

Lt. Gen. Lawrence P. Farrell Jr., USAF (Ret.) is President and CEO of the National Defense Industrial Association (NDIA)—the largest defense association in the United States. Its mission is to advocate a healthy, ready industrial base; to advocate the fielding of technologically superior weapons systems; and to provide a forum for legal and ethical dialogue between government and industry. General Farrell's Air Force career spanned several disciplines: Deputy Chief of Plans for Planning and Programming; Acquisition; Logistics; Operations, Command Pilot, Wing Commander, Squadron Commander, Combat Pilot; Staff, Deputy Director, Air Force Programs, Pentagon; Chief, Strategy Division, Pentagon; Chief, Capability Assessment division, Pentagon; Command briefing Officer, USAF HQ, Europe; Staff Officer, 17th Air Force, Europe. General Farrell, a 1965 graduate of the USAF Academy with a BS in Engineering Science, also has an MBA from Auburn University. General Farrell currently serves on the Boards of the Advanced Technology Institute (ATI), the Falcon Foundation, National Center for Defense Manufacturing and Machining (NCDMM) and Global Healthcare Exchange, LLC.

**Dr. Kenneth Flamm**

Dr. Kenneth Flamm has been Professor and Dean Rusk Chair in International Affairs at the Lyndon B. Johnson School of Public Affairs, University of Texas at Austin, since the Fall of 1998. He had previously been at the Brookings Institution since 1995 as a Senior Fellow in the Foreign Policy Studies program, a position he also held from 1987 to 1993. From 1993 to 1995, Flamm served as Acting Assistant Secretary of Defense (Economic Security), Principal Deputy Assistant Secretary of Defense and Special Assistant to the Under Secretary (Dual Use Technology Policy and International Programs), then as Special Assistant to the Deputy Secretary of Defense (Dual Use Technology Policy) and Principal Deputy Assistant Secretary of Defense (Economic Security). He was awarded the Department's Distinguished Public Service Medal by the Secretary of Defense. Flamm was awarded an AB with honors in economics from Stanford University in 1973 and a PhD in economics from MIT in 1979.

**The Honorable Jacques S. Gansler**

The Honorable Jacques Gansler is Vice President for Research at the University of Maryland. He holds the Roger C. Lipitz Chair in Public Policy and Private Enterprise in the School of Public Policy where he teaches graduate school courses and leads the School's Center for Public Policy and Private Enterprise. Dr. Gansler is also the Glenn L. Martin Institute Fellow of Engineering at the A. James Clarke School of Engineering; an Affiliate Faculty member at the Robert H. Smith School of Business; and a Senior Fellow at the James MacGregor Burns Academy of Leadership (all at the University of Maryland).

Previously, Dr. Gansler served as the Under Secretary of Defense for Acquisition, Technology and Logistics from November 1997 until January 2001. In this position, he was responsible for all matters relating to Department of Defense acquisition, research and development, logistics, acquisition reform, advanced technology, international programs, environmental security, nuclear, chemical, and biological programs, and the defense technology and industrial base. (He had an annual budget of over $180 billion, and a workforce of over 300,000.)

Prior to this appointment, Dr. Gansler was Executive Vice President and Corporate Director for TASC, Incorporated, an applied information technology company, in Arlington, Virginia (from 1977 to 1997), during which time he played a major role in building the company from a small operation into a large ,widely recognized and greatly respected corporation, serving both the government and the private sector. From 1972 to 1977, he served in the government as Deputy Assistant Secretary of Defense (Materiel

Acquisition), responsible for all defense procurements and the defense industry; and as Assistant Director of Defense Research and Engineering (Electronics) responsible for all defense electronics Research and Development.

**Dr. Alan Gropman**

Dr. Alan Gropman is the Distinguished Professor of National Security Policy at the Industrial College of the Armed Forces. He served 27 years in the United States Air Force, including two tours in Vietnam where he accumulated more than 670 combat missions. He also served as a war planner in Europe and the Pentagon, retiring as a Colonel. He earned the Defense Superior Service Medal, the Legion of Merit, the Distinguished Flying Cross, the Air Medal with five oak leaf clusters, and the Vietnam Cross of Gallantry with Palm among other awards and decorations. He has a PhD from Tufts University, earned a diploma from the National War College, and is a distinguished graduate of the Air War College. He is also an Adjunct Professor at Georgetown University. He has published three books and edited one, and published more than 250 book reviews, essays, op-ed pieces, articles, and book chapters.

**The Honorable Suzanne Patrick**

Ms. Patrick was appointed Deputy Under Secretary of Defense for Industrial Policy in 32001. In this position, she is responsible for all decisions regarding mergers and acquisitions (domestic and foreign) affecting the U.S. defense industry; the Department's relations with NATO defense and aerospace industries; and the overall health of the U.S. defense industrial base. Ms. Patrick brings to this position over 20 years of experience in aerospace industry finance and weapons systems acquisition for U.S. and NATO forces. She also has extensive experience in the economies and defense establishments of new NATO allies in Eastern Europe.

**Mr. Torkel L. Patterson**

Mr. Torkel Patterson is the Vice President Business Development and President Raytheon International, Inc. From 1998-2000, he was headquartered in Tokyo as President of Raytheon Japan, Senior Country Manager for Taiwan and President, North Asia Division, Raytheon International, Inc. More recently, he served as a Deputy Assistant Secretary of State, South Asian affairs. Prior to that, he was Special Assistant to the President and Senior Director of Asian affairs for the National Security Council. From 1994-2000, he was also Senior Associate at Pacific Forum CSIS. From 1994-1998, he was a managing Director of Pacific Century, Inc., and President of Group Pacific, firms specializing in business development through the Pacific Rim, and served as a consultant to Armitage Associates L. C. and The Scowcroft Group. Mr. Patterson retired from the United States Navy in September 1994. From 1991 to

1993, he was Director of Asian Affairs on the National Security Council staff. He graduated from United States Naval Academy in 1976 and was an Olmsted Scholar at Tsukuba University graduate school in Ibaraki Prefecture, Japan.

**Ms. Susan Pollack**

Ms. Pollack graduated as a member of the Industrial College of the Armed Forces class of 2005. Some of her assignments prior to attending ICAF include contracts specialist at the Space and Naval Warfare Systems Command and deputy director of the acquisition support cadre at the Missile Defense Agency. She has a Bachelor of Arts degree in international relations from Saint Joseph's University and has completed the Advanced Program Management Course at the Defense Systems Management College.

**Mr. Mark H. Ronald**

Mark Ronald is Chief Operating Officer and member of the Board of Directors, BAE Systems plc. and President and Chief Executive Officer, BAE Systems North America, Inc. He brings 35 years of aerospace and defense experience to his position, overseeing all aspects of BAE Systems' North American operations. Mr. Ronald is also responsible for overseeing the entire engineering function for BAE Systems plc. Prior to joining BAE Systems, he was President, Chief Operating Officer and member of the Board of Directors of AEL Industries. Mr. Ronald also spent 10 years with Litton Industries, rising to the position of Vice President, Program Management. He received a BA and a BS in Electrical Engineering from Bucknell University and a MS in Electrical Engineering from Polytechnic Institute of New York. Mr. Ronald holds the Honorary Commander of the Most Excellent Order of the British Empire (CBE), awarded in recognition of the valuable services he has rendered to furthering closer transatlantic cooperation in the U.S.-UK defense industries.

**Dr. Sheila R. Ronis**

Dr. Sheila Ronis is President of The University Group, Inc., a management consulting firm specializing in strategic studies and public policy. She is a systems scientist with a BS in physics and mathematics and a PhD in Organizational Behavior and Large Complex Adaptive Systems received from The Ohio State University. She is an adjunct professor at the University of Detroit Mercy and Oakland University where she teaches courses on business management and globalization. She participates annually in the National Security Strategy Exercise at the Industrial College of the Armed Forces at the National Defense University and serves as Vice President of the National Defense University Foundation. She has worked with many clients from the Pentagon and General Motors to the U.S. House of Representatives. Earlier in her career, Dr. Ronis worked at AT&T, Ohio State University, and the Energy Research and Development Administration (now the Department of Energy). She began her career working at North American Rockwell in Columbus, Ohio.

**Professor Harvey M. Sapolsky**

Mr. Harvey Sapolsky is Professor of Public Policy and Organization in the Political Science Department of the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts; and the Director of the MIT Security Studies Program, a graduate-level

research and educational program that focuses on issues in international security. He has worked on science, defense, health, and environmental policies and has consulted for a number of government agencies, firms, and not-for-profits. Among his publications are books and articles on the development of the Polaris missile and other weapon systems, national strategy, government funding of academic research, the role of scientists as government advisors, product risks, comparative health systems, hospital regulation, and civil-military relations. Currently, he is working on a history of military innovation.

**Dr. Lynne C. Thompson**

Dr. Lynne Thompson is Professor of Behavioral Science at the Industrial College of the Armed Forces. He joined the faculty in May 1999 and holds a bachelor's degree in communications from The College of the Ozarks, a master's degree in sociology from Pepperdine University, and a doctorate in human resources development from The George Washington University. He has taught courses in strategic leadership, information strategies for senior leaders, analysis of the information technology industry, and Southeast Asia Regional Security Studies. Dr. Thompson served over 31 years in the United States Air Force, completing his tour of active duty as ICAF's Associate Dean of Faculty for Academic Programs. His major areas of academic interest include leadership development and leveraging technology to improve organizational effectiveness.

**Mr. Alan Tonelson**

Alan Tonelson is a Research Fellow at the U.S. Business and Industry Council Educational Foundation in Washington, D.C. He is also a columnist for the Foundation's globalization website, Americaneconomicalert.org, and a Research Associate at the George Washington University Center for International Science and Technology Policy. In Fall 2002, he won a Henry L. Stimson Center Visiting Fellowship in China. *The New Republic* called Tonelson "probably the most significant economist spreading the nationalist gospel." And, *The International Economy* magazine named Mr. Tonelson one of "Washington's Top China-Watchers" for 2004. Mr. Tonelson is also a consultant for CNN anchorman Lou Dobbs. Tonelson's book on globalization, *The Race to the Bottom*, was published in 2000 by Westview Press. His articles and reviews have appeared in many leading national publications, including *Foreign Affairs, The Atlantic, The New York Times,* and *The Washington Post*. He has also lectured frequently on these subjects in the United States, Europe, and Asia.

**Major General Frances C. Wilson, USMC**

Maj. Gen. F. C. Wilson is the Commandant, Industrial College of the Armed Forces, National Defense University, Fort McNair, Washington, DC. General Wilson's previous assignments have included Manpower Management Analyst, Manpower and Reserve Affairs (M&RA) Department, Headquarters, U.S. Marine Corps; Special Assistant for General and Flag Officer Matters, the Joint Staff; Executive Assistant to the Vice Director, Joint Staff; Commander, Fourth Recruit Training Battalion, Marine Corps Recruit Depot, Parris Island; sponsored Federal Executive Fellowship at the Brookings Institution, Washington, D.C.; Requirements and Programs officer, Headquarters, Marine Forces Pacific, Commander,

Camp H. M. Smith and concurrently commanded Headquarters and Service Battalion, Marine Forces Pacific; and Secretary, Joint Staff. Completing the Capstone course at National Defense University, General Wilson was assigned as the Commanding General, Marine Corps Base, Quantico, VA; Commanding General, Okinawa, Japan, Third Force Service Support Group; and Director, Personnel Management Division, M&RA, Headquarters, Marine Corps, and the Secretary of Defense's Reserve Force Policy Board.

General Wilson was born in Nassau County, Long Island, New York, and raised in Arlington, Virginia. She completed her Bachelor of Science degree in social sciences from Michigan State University. Commissioned a Second Lieutenant in November 1972, she was the Honor Graduate and recipient of the Leadership Award from Marine Corps Women Officer Basic School. General Wilson is also a graduate of Pepperdine University with a Master of Arts in Education, the University of Northern Colorado with a Master of Arts in psychology, Salve Regina College with a Master of Science in business management, Naval War College with a Master of Arts in National Security and Strategic Studies, and the University of Southern California with a Doctor of Education.